ENGINEERING MATHEMATICS –III			
COMMON TO ALL BRANCHES			
Course Code	18MAT31	CIE Marks	50
Contact Hours/Week	04	SEE Marks	50
Total Hours	50	Exam Hours	03
Semester	III	Credits	04

Course Learning Objectives:

This course viz., Engineering mathematics-III (18MAT31) aims to prepare the students:

- Introduce most commonly used analytical and numerical methods in the different engineering Fields .
- Learn Laplace transform and Z-transforms, statistical methods, numerical methods.
- Solve the problem on Interpolation.
- To discuss the random variable and associated probability distributions.

Course Outcomes(COs):

After completion of course, the student will able to

CO#	Course Outcomes	Pos
CO1	Apply the knowledge of Laplace transform from time domain to frequency domain in Signal and image processing and to find inverse Laplace transform.	1, 2,12
CO2	Apply the knowledge of Z-transforms in solving the difference equation arising in the time signals and digital processing.	1, 2,12
CO3	Apply the concept of correlation and regression lines for solving the problems and numerical techniques to solve engineering problems.	1, 2,12
CO4	Understanding the concepts of Finite differences to solve the problems on interpolation and numerical integration.	1, 2,12
CO5	Learn to solve the random variable in both discrete and continuous and their probability distribution, Mass on various engineering problems.	1, 2,12

Bloom's level of the course outcomes:

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√	√			
CO2	√	√	√			
CO3	√	√	√			
CO4	√	√	√			
CO5	√	√	√			

Course Articulation Matrix / Course mapping:

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

MODULE-1: LAPLACE TRANSFORMS

Definition, Laplace transforms of Elementary functions, properties(without proof) periodic function, Unit step function, Unit impulse function.

INVERSE LAPLACE TRANSFORMS: Definition, Convolution Theorem (without proof), Finding Inverse

Laplace transform by convolution Theorem. Solution of Linear Differential equations using Laplace Transforms and Applications (5 Assignment Problem).

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

MODULE-2: Z- TRANSFORMS

Z- **TRANSFORMS:** Difference Equations, Basic definitions, Damping rule, Shifting rule, Initial and Final Value theorems(without proof) and problems.

Inverse Z-transforms. Applications of Z-transforms to solve difference equation (5 Assignment Problem).

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

MODULE-3: STATISTICAL METHODS

Correlation-karl Pearson's co-efficient of correlation problems. Regression analysis lines of regression (without proof)-problems.

CURVE FITTING: Curve fitting by the method of least square. Fitting of the curves of the form $y = ax + b, y = ax^2 + bx + c$ & $y = ae^{bx}$.

Numerical Methods: Numerical solution of algebraic and transcendental equations by Regula - Falsi Method and Newton-Raphson method.

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

MODULE-4: FINITE DIFFERENCE & NUMERICAL INTEGRATION

FINITE DIFFERENCE: Forward and Backward differences, Newton's forward and backward interpolation formulae. Divided difference-Newton's divided difference formulae. Lagrange's-interpolation formula and inverse interpolation formula(all formula without proof) problems.

NUMERICAL INTEGRATION: Simpsons$(\frac{1}{3})^{rd}$, $(\frac{3}{8})^{th}$ rules, Weddle's rule (without proof) problems.

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

MODULE-5: PROBABILITY DISTRIBUTION

Probability Distribution: Random variables (discrete and continuous) probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and Normal distributions. Problems.

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question carries 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module .
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module .

CIE + Assignments: 15+35=50 Marks

There will be a 3 CIE's, the average of best of 2 CIE's will be considered and there will be a 35 marks for Assignments

Text Books:

1. B.S. Grewal : Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.
2. E. Kreyszig : Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed.(Reprint), 2016.

Reference books:

1. *N. P. Bali and Manish Goyal : A Text Book of Engineering Mathematics, Laxmi Publishers , 7th Ed., 2010.*
2. *B.V.Ramana:"HigherEngineering Mathematics" Tata McGraw-Hill, 2006.*
3. *H. K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics", S. Chand Publishing , 1st edition, 2011.*

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org.

ELECTRIC CIRCUIT ANALYSIS

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-III

Subject Code	18EE32	CIE Marks	50
Number Lecture Hour/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-04

Course Objectives: This course will enable the students to:

- **Gain proficiency** in fundamental electrical laws, source transformations, and systematic circuit analysis methods, including Mesh and Node analysis.
- **Apply network theorems** such as Thevenin's, Norton's, Superposition, and Maximum Power Transfer for effective circuit simplification and problem-solving.
- **Comprehend resonance** in electrical circuits and perform transient analysis by evaluating initial conditions in circuits with reactive components.
- **Utilize Laplace Transform techniques** for the analysis of electrical circuits in the s-domain, enabling efficient problem-solving for dynamic systems.
- **Analyze three-phase circuits** under various conditions and evaluate the performance and parameters of two-port networks for interconnected systems.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Basic Concepts: Active and passive elements, Concept of ideal and practical sources. Source transformation and Source shifting, Concept of Super-Mesh and Super node analysis. Analysis of networks by (i) Network reduction method including star – delta transformation, (ii) Mesh current and Node voltage methods for dc and ac circuits with independent and dependent sources. Duality.	**10 Hours**	**L1**
Module -2		
Network Theorems: Super Position theorem, Reciprocity theorem, Thevenin's theorem, Norton's theorem and Maximum power transfer theorem. Analysis of networks dc sources and with and without dependent ac sources.	**10 Hours**	**L1,L2**
Module -3		
Resonant Circuits: Analysis of simple series RLC and parallel RLC circuits under resonance. Problems on Resonant frequency, Bandwidth and Quality factor at resonance. **Transient Analysis:** Transient analysis of RL and RC circuits under dc and ac excitations: Behavior of circuit elements under switching action , Evaluation of initial conditions.	**10 Hours**	**L1,L2,L3**
Module -4		

Laplace Transformation: Laplace transformation (LT), LT of Impulse, Step, Ramp, Sinusoidal signals and shifted functions. Waveform synthesis. Initial and Final value theorems.	**10 Hours**	**L1, L2,L3**

Module-5

Unbalanced Three phase systems: Analysis of three phase systems, calculation of real and reactive powers. **Two Port networks:** Definition, Open circuit impedance, short circuit admittance and Transmission parameters and their evaluation for simple circuits.	**10 Hours**	**L1,L2,L3**

Course Outcomes: At the end of the course, the student will be able to:

CO1: Apply fundamental electrical laws, including Ohm's and Kirchhoff's laws, along with source transformations, Mesh analysis, and Node analysis to systematically evaluate and solve electrical circuits.

CO2: Utilize advanced network theorems, such as Thevenin's, Norton's, Superposition, and Maximum Power Transfer, to analyze and simplify complex electrical circuits.

CO3: Determine initial conditions and perform transient analysis of electrical circuits involving capacitors and inductors, and interpret the behavior of resonant circuits under varying frequency conditions.

CO4: Employ Laplace Transform techniques to analyze electrical circuits, enabling the solution of differential equations and the study of circuit behavior in the s-domain.

CO5: Conduct a comprehensive analysis of three-phase circuits under unbalanced conditions and evaluate the performance parameters of two-port networks, including impedance, admittance, and transmission matrices.

Text Book:

1 Engineering Circuit Analysis William H Hayt et al Mc Graw Hill 8th Edition,2014
2 Network Analysis M.E. Vanvalkenburg Pearson 3rd Edition,2014
3 Fundamentals of Electric Circuits Charles K Alexander Matthew N O Sadiku Mc Graw Hill 5th Edition,2013

Reference Book:

1 Engineering Circuit Analysis J David Irwin et al Wiley India 10th Edition,2014
2 Electric Circuits Mahmood Nahvi Mc Graw Hill 5th Edition,2009
3 Introduction to Electric Circuits Richard C Dorf and James A Svoboda Wiley 9 th Edition,2015
4 Circuit Analysis; Theory and Practice Allan H Robbins Wilhelm C Miller Cengage 5 th Edition,2013

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO 3
1	CO1	3	2	1		3		1					1	3		
2	CO2	3	2	1		3		1					1	3		
3	CO3	3	3	2	1	3	2						1	3		
4	CO4	3	3	2	1	3	2						1	3		
5	CO5	3	3	2	1	3	2						1	3		
	AVERAGE	3	2.6	1.6	1	3	2	1					1	3		

ELECTRICAL MACHINES-I

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-III

Subject Code	18EE33	CIE Marks	50
Number Lecture Hour/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-4

Course Objectives: This course will enable the students to :

- **Comprehend the fundamental principles, construction, and operation** of single-phase and three-phase transformers, emphasizing their practical applications.
- **Analyze the conditions for parallel operation** of transformers, evaluate load sharing, and perform standard tests such as open-circuit, short-circuit, and load tests to assess performance.
- **Understand the principles and performance characteristics** of three-phase induction motors, including phenomena like cogging and crawling, through detailed evaluation.
- **Examine various starting methods and speed control techniques** for three-phase induction motors to optimize performance in industrial applications.
- **Explore the construction, operating principles, and functional characteristics** of single-phase induction motors and synchronous motors, highlighting their practical uses and advantages.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Single phase Transformers: Operation of practical transformer under no-load and on-load conditions with phasor diagrams. Open circuit and Short circuit tests, calculation of equivalent circuit parameters and predetermination of efficiency-commercial and all-day efficiency. Voltage regulation and its significance. **Three-phase Transformers:** Introduction, Constructional features of three-phase transformers. Choice between single unit three-phase transformer and a bank of three single-phase transformers. Transformer connection for three phase operation– star/star, delta/delta, star/delta, zigzag/star and V/V, comparative features. Phase conversion-Scott connection for three-phase to two-phase conversion. Labeling of three-phase transformer terminals, vector groups.	**10 Hours**	**L1,L2,L3**
Module -2		
(Transformers contd.): Polarity test, Sumpner's test, separation of hysteresis and eddy current losses. **Parallel Operation of Transformers:** Necessity of Parallel operation, conditions for parallel operation– Single phase and three phase transformers. Load sharing in case of similar and dissimilar transformers. **Auto transformers and Tap changing transformers:** Introduction to autotransformer-copper economy, equivalent circuit, no load and on load tap changing transformers.	**10 Hours**	**L1,L2,L3**
Module -3		

(Transformers continued): Three-winding transformers. Cooling of transformers. **Three phase Induction motors:** Review of concept and generation of rotating magnetic field, Principle of operation, construction, classification and types; squirrel-cage, slip-ring. Slip, Torque equation, torque-slip characteristic covering motoring, generating and braking regions of operations, Maximum torque, significance of slip**.**	**10 Hours**	**L1,L2,L3**
Module -4		
Performance of three-phase Induction Motor: Phasor diagram of induction motor on no-load and on load, equivalent circuit, losses, efficiency, No-load and blocked rotor tests. Performance of the motor from the circle diagram and equivalent circuit. Cogging and crawling. High torque rotors-double cage and deep rotor bars. Equivalent circuit and performance evaluation of double cage induction motor. Induction motor working as induction generator. **Starting and speed Control of Three-phase Induction Motors:** Need for starter. Direct on line, Star-Delta and autotransformer starting. Rotor resistance starting. Speed control by voltage, frequency, and rotor resistance methods	**10 Hours**	**L1, L2,L3**
Module-5		
Single-phase Induction Motor: Double field revolving theory and principle of operation. Construction and operation of split-phase, capacitor start, capacitor run and shaded pole motors. Comparison of single phase motors and applications. **Synchronous motor:** Principle of operation, phasor diagrams, torque and torque angle, Blondel diagram, effect of change in load, effect of change in excitation, V and inverted V curves. Synchronous condenser, hunting and damping. Methods of starting synchronous motors.	**10 Hours**	**L1,L2,L3**

Text Book:

1 Electric Machines D. P. Kothari, et al McGraw Hill 4th Edition, 2011

2 Performance and Design of A.C. Machines M. G. Say CBS Publishers 3rd Edition, 2002

Reference Book:

1 Principles of Electric Machines P.C.Sen Wiley 2nd Edition, 2013

2 Electric Machines Mulukuntla S.Sarma,at el Cengage 1st Edition, 2009

3 Electrical Machines M.V. Deshpande PHI 1st Edition, 2013

4 Electrical Machines Abhijit Chakrabarti et al McGraw Hill 1st Edition, 2015

E-Books and Online course materials

Course Outcomes:

At the end of the course the student will be able to:

Course Code	CO#	Course Outcome
18EE33		**CO1:** Analyze in detail the construction, operating principles, and performance characteristics of single-phase and three-phase transformers. **CO2:** Evaluate the performance of transformers by conducting standard tests, such as load test, and configure multiple transformers in parallel for enhanced power capacity and load sharing. **CO3:** Analyze the operational characteristics of three-phase induction motors, including efficiency, power factor, torque-speed performance, and thermal

		behavior under various load conditions. **CO4:** Examine and compare various starting techniques and speed control methods for three-phase induction motors, ensuring optimal performance and energy efficiency in different industrial applications. **CO5:** Illustrate the working principles, construction, and operational characteristics of single-phase induction motors and synchronous motors, highlighting their practical applications and advantages in specific contexts.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	2	2				1						2	3		
2	CO2	3	3	2	2		1						2	3		
3	CO3	2	2				1						2	3		
4	CO4	3	3	2	2		1						2	3		
5	CO5	2	2				1						2	3		
CAM	AVERAGE	2.4	2.4	2	2		1						2	3		

Measurements and Digital Electronics
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-III

Subject Code	18EE34	CIE Marks	50
Number Lecture Hour/Week	3L + 1T	SEE Marks	50
Total Hours	48	Exam Hours	03

CREDITS-04

Course Objectives: This Course will enable students to:

- **Measure unknown resistance, inductance, and capacitance** using AC and DC bridge methods, and accurately determine earth resistance employing advanced testing techniques.
- **Analyze the construction and operational principles** of various electrical and electronic measuring instruments, focusing on their applications in measurement systems.
- **Simplify Boolean expressions** using Karnaugh Maps (K-maps) and the Quine-McCluskey algorithm to achieve optimized logic circuit designs.
- **Design and implement combinational logic circuits,** including decoders, encoders, digital multiplexers, adders, subtractors, and binary comparators, for diverse digital applications.
- **Explain the working principles of latches and flip-flops** and their applications in the design of registers and counters for sequential logic circuits.

Modules	**Teaching Hours.**	**Revised bloom's Taxonomy(RBT) Level**
Module -1		
Measurement of Resistance, Inductance, Capacitance and Frequency: Wheatstone's bridge, sensitivity, limitations. Kelvin's double bridge. Earth resistance measurement by fall of potential method and by using Meggar. Maxwell's inductance bridge, Schering bridge, Problems. Weston frequency meter and Phase Sequence Indicator. **Extension of Instrument Ranges:** Desirable features of ammeters and voltmeters. Shunts and multipliers. Construction of instrument transformers, Desirable characterizes, Errors of CT and PT. Turns compensation, Silsbee's method of testing CT. **Magnetic measurements:** Introduction, measurement of flux/flux density, magnetizing force and leakage factor	**10**	**L1,L2,L3**
Module -2		
Electronic and digital Instruments: Introduction. Essentials of electronic instruments, Advantages of electronic instruments. True RMS reading voltmeter, Electronic multimeters, Digital voltmeters (DVM) - Ramp type DVM, Integrating type DVM and Successive - approximation DVM, Q meter, Principle of working of electronic energy meter (with block diagram), extra features offered by present day meters and their significance in billing. **Display & Recording Devices:** Introduction, character formats, segment	**10**	**L1,L2,L3**

displays, Dot matrix displays. Cathode ray tubes, LED, Liquid crystal displays, Galvanometer recorders, Null balance recorders, Potentiometer type recorders, Bridge type recorders, LVDT type recorders, Circular chart and XY recorders, Digital tape recording, Ultraviolet recorders.		
Module – 3		
Principles of Combinational logic: Definition of Combinational logic, Canonical forms, Generation of switching equations from truth tables, K-Maps- 3, 4 & 5 variables. Incompletely specified functions (Don't care terms). Simplifying Max- term equations. Quine – Mc-Clusky minimization technique, Quine – Mc-Clusky using don't care terms, Reduced Prime Implicant tables.	**10**	**L1,L2,L3**
Module – 4		
Analysis and design of Combinational logic: General approach, Decoders-BCD decoders, Encoders. Digital multiplexers-using multiplexers as Boolean function generators, Adders and Sub tractors-Cascading full adders, Look ahead carry, Binary comparators. Design methods of building blocks of combinational logics.	**8**	**L1,L2,L3**
Module – 5		
Flip-flops and its applications: Basic Bistable element, Latches, SR latch, application of SR latch, A Switch debouncer, The gated SR latch. The gated D Latch, The Master-Slave Flip-Flops (pulse triggered). The Master- Slave SR Flip-Flops, The Master- Slave JK Flip-Flops. Characteristic equations, Registers, Counters- Binary Ripple Counter, Synchronous Binary counters, Counters based on Shift Registers, Design of A Synchronous counters, Design of A Synchronous Mod-6 counters using clocked JK Flip-Flops. Design of A Synchronous Mod-6 counter using clocked D, T, or SR Flip-Flops.	**10**	**L1,L2,L3**

Course Outcomes: At the end of the course the student will able to:

CO1: Perform detailed analysis and evaluation of various AC and DC bridge circuits for the precise measurement of unknown resistance, inductance, and capacitance, ensuring accuracy and reliability.

CO2: Examine and interpret the operational principles of advanced electronic instruments, display devices, and recording mechanisms, focusing on their applications in measurement and data visualization.

CO3: Derive optimized switching equations for digital circuits using Karnaugh Maps (K-Maps) and the Quine-McCluskey minimization technique to achieve reduced logic complexity.

CO4: Design and implement high-performance combinational logic circuits for specific applications by employing systematic design methodologies and Boolean logic principles.

CO5: Architect and construct synchronous and asynchronous counters, as well as shift registers, utilizing flip-flops for efficient sequential data processing and control.

Question Paper pattern:

- The Question paper will have ten questions.
- Each full question with sub questions will cover the contents under a module.

- Students will have to answer 5 full questions, selecting one full question from each module.

Text/ Reference Books

1	Electrical and electronics Measurements and Instrumentation	A.K. Sawhney	Dhanpat RaiAnd Co	10th Edition, SS
2	A Course in Electronics and Electrical Measurement and Instrumentation	J.B. Gupta	Katson Books	2013 Edition,
3	Electrical and electronic Measurement and instrumentation	Er.R.K Rajput	S Chand	5th Edition, 2012
4	Electrical Measuring Instruments and Measurements	S.C Bhargava	BS Publications	2013
5	Electronic Instrumentation and Measurements	David A Bell	Oxford University	3rd Edition, 2013
6	Digital logic Application	John Yarbrough	CengageLearn	2011
7	Logic and computer design Fundamentals	M. Morries and Charles Kime	Pearson Learning	4th Edition, 2014
8	Digital Circuits and Design	D.P.KothariJ.S. Dhillon	Pearson	First Print 2015
9	Fundamentals of Digital Circuits	A. Anand Kumar	PHI	3rd Edition, 2014

SL.NO	PO/CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3		2		1						2	3		
2	CO2	3	3		2	1	1						2	3		
3	CO3	3	3	3	2									3		
4	CO4	3	3	3	2	2							2	3		
5	CO5	3	3	3	2	2							2	3		
	AVERAGE	3	3	3	2	1.6	1						2	3		

ELECTRICAL MACHINES-I LAB

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-III

Subject Code	18EEL35	CIE Marks	50
Number Lecture Hour/Week	2	SEE Marks	50
Number of Lecture Hours	24	Exam Hours	03
CREDITS-1			

Course Objectives: This course will enable the students to:

- **Perform standardized tests** on transformers and induction machines, including open-circuit, short-circuit, and load tests, to evaluate their performance parameters such as efficiency, voltage regulation, and torque-speed characteristics.
- **Implement the parallel operation** of two single-phase transformers, ensuring proper load sharing and stability under varying operating conditions.
- **Examine the configuration and operation** of three single-phase transformers connected for three-phase operation, such as star-star, star-delta, and delta-delta arrangements.
- **Conduct load tests** on single-phase and three-phase induction motors to analyze parameters like power factor, efficiency, and torque-speed performance.
- **Perform tests on three-phase induction motors** to determine their complete performance characteristics using methods such as the circle diagram or equivalent circuit analysis.

SL NO	Experiments
1.	(a)Predetermination of efficiency and regulation by Open Circuit and Short circuit tests on single - phase transformer. (b)Calculation of parameters of equivalent circuit from the readings of the tests and determination of efficiency and regulation from the equivalent circuit to correlate results obtained earlier.
2.	Sumpner's test on similar transformers and determination of combined and individual transformer efficiency.
3.	Parallel operation of two dissimilar (different kVA) single-phase transformers and determination of load sharing and analytical verification-given the Open Circuit and Short circuit tests details.
4.	Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency and regulation under balanced resistive load.
5.	Scott connection with balanced and unbalanced resistive loads.
6.	Load test on 3-phase induction motor- and plot of Torque versus speed, output hp versus efficiency, power factor and slip.
7.	Predetermination of performance of 3-phase induction Motor from the Circle diagram.
8.	(a)Determination of parameters of the equivalent circuit of a 3-phase Induction Motor by conducting NO load and Blocked rotor tests. (b)Determination of performance parameters of the

	induction motor from the equivalent circuit to correlate the results obtained from the load test or circle diagram.
9.	Speed control of 3-phase induction motor by varying rotor resistance.
10.	Load test on- induction generator.
11.	Load test on single- phase induction motor.

Course outcomes:
At the end of the course the student will be able to:

Course Code	CO#	Course Outcomes
18EEL35		**CO1:** Analyze and evaluate the performance parameters of transformers using test data obtained from open-circuit and short-circuit tests. **CO2:** Configure and operate two single-phase transformers with different kVA ratings in parallel, ensuring proper load sharing and voltage regulation. **CO3:** Connect single-phase transformers in appropriate configurations, such as star-delta or delta-delta, to facilitate three-phase operation for balanced and unbalanced loads. **CO4:** Conduct load tests on single-phase and three-phase induction motors to assess performance characteristics, including efficiency, power factor, and torque-speed relationship. **CO5:** Determine and plot the performance characteristics of a three-phase induction motor under no-load conditions using the circle diagram method or equivalent techniques.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3		2		1			3	3	1	1		3	
2	CO2	3	3		2		1			3	1	1	1		3	
3	CO3	3	3		2		1			3	1	1	1		3	
4	CO4	3	3		2		1			3	1	1	1		3	
5	CO5	3	3		2		1			3	1	1	1		3	
	AVERAGE	3	3		2		1			3	1.4	1	1		3	

DIGITAL ELECTRONICS LAB

[As per Choice Based Credit System (CBCS) Scheme]

Semester III

Subject code	18EEL36	CIE Marks	50
Number of practical hours/week	02	SEE Marks	50
Total number practical hours	24	Exam Hours	03

CREDITS: 01

Course Objectives: This course will enable students to :

- **Understand the fundamental concepts and operations** of logic gates and their role in digital circuit design.
- **Design and implement arithmetic circuits**, including half adders, full adders, half subtractors, full subtractors, and binary-to-Grey code converters, for data computation and transformation.
- **Develop and construct combinational circuits** such as multiplexers (MUX), demultiplexers (DEMUX), encoders, and decoders for efficient signal routing and processing.
- **Design sequential circuits**, including shift registers and counters, by employing various flip-flop configurations to achieve desired functionality.
- **Design and implement digital comparators** for multi-bit data comparison and configure 7-segment displays for numeric data representation in embedded systems.

SL. NO	Experiments
1	Verification of basic gates: AND, OR, NAND, Ex-OR, Ex-NOR.
2	Design and implementation of Binary to Gray code converter and vice versa.
3	Design and implementation of Encoder/ Decoder.
4	Design and implementation of 8:1 MUX/ 1:8 DEMUX.
5	Realization of Half/Full adder and Half/Full subtractor.
6	Realization of 4-bit parallel adder/subtractor.
7	Design and implementation of 4-bit Binary comparator.
8	Design and implementation of Flip flops: SR, D, T, JK.
9	Design and implementation of SISO 8-bit shift register.
10	Design and implementation of synchronous up/down counter.
11	Design and implementation of Asynchronous up/down counter.
12	Design and implementation of 7 segment display.

Course outcomes:

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

CO1: Architect, analyze, and implement various types of flip-flops, including SR, JK, D, and T, to enable state-based operations in sequential logic systems.

CO2: Conceptualize and implement arithmetic logic units (ALUs) for designing half adders, full

adders, half subtractors, and full subtractors, along with binary-to-Grey code conversion systems for efficient data transformation.

CO3: Design and optimize combinational circuits such as multiplexers (MUX), demultiplexers (DEMUX), encoders, and decoders to enhance data processing and control flow in digital systems.

CO4: Engineer and implement advanced sequential circuits, including shift registers and counters, utilizing various flip-flop configurations to achieve efficient data manipulation and synchronous timing.

CO5: Develop and implement high-precision digital comparators for binary data evaluation and design 7-segment display controllers for effective visual representation of numeric data in embedded systems.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	2	2				3	3	1	1		3	
2	CO2	3	3	3	2	2				3	3	1	1		3	
3	CO3	3	3	3	2	2				3	3	1	1		3	
4	CO4	3	3	3	2	2				3	1	1	3		3	
5	CO5	3	3	3	2	2							3		3	
	AVERAGE	3	3	3	2	2				3	2.5	1	1.8		3	

ELECTRICAL AND ELECTRONIC MEASUREMENTS LAB

[As per choice-based credit system (CBCS) scheme]

SEMESTER - III

Subject Code	18EEL37	CIE Marks	50
Number of Practical Hours/Week	02	SEE marks	50
Total Number of Practical Hours	24	Exam hours	03

Credits – 01

Course Objectives: This course will enables the students to Understand:

- **Understand and apply measurement techniques** for accurately determining resistance, inductance, and capacitance across a wide range of values using appropriate bridge methods and instruments.
- **Explore and implement techniques** to extend the operational range of ammeters and voltmeters by using shunts, multipliers, and other circuit modifications.
- **Learn and perform the testing procedures** for current transformers, including ratio, polarity, and burden tests, to ensure accuracy and reliability in current measurement.
- **Measure resistance (R), inductance (L), and capacitance (C)** with high precision using a Q-meter, analyzing quality factors and resonant frequencies.
- **Conduct calibration procedures** for Linear Variable Differential Transformers (LVDTs) and low power factor (LPF) wattmeters to ensure optimal performance and accurate measurements.

Sl. No	Experiments
1	Measurement of unknown resistance using Wheatstone bridge.
2	Measurement of low resistance using kelvin's double bridge.
3	Measurement of inductance using Maxwell Inductance Bridge.
4	Measurement of capacitance using Schering Bridge.
5	Measurement of earth resistance using beggar.
6	Range extension of ammeter using shunt resistor.
7	Range extension of voltmeter using multiplier.
8	Testing of current transformer using Silsbee's method.
9	Measurement of Iron loss of magnetic material from B-H curve using CRO.
10	Measurement of R, L and C using Q- meter.
11	Calibration of dynamometer type power factor meter.

12	LVDT and capacitance pick up- characteristic and calibration.

Course Outcomes:

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

CO1: Analyze and quantify electrical resistance across diverse ranges, and determine inductance and capacitance values using advanced measurement techniques.

CO2: Perform precise measurement and assessment of earth resistance using specialized instrumentation and methodologies.

CO3: Enhance the measurement capabilities of voltmeters and ammeters by extending their operational range through appropriate circuit modifications and calibration.

CO4: Accurately determine resistance (R), inductance (L), and capacitance (C) parameters utilizing Q-meter for advanced circuit analysis and testing.

CO5: Conduct calibration of low power factor (LPF) wattmeter and linear variable differential transformers (LVDTs) to ensure accuracy and reliability in practical applications.

Graduate Attributes (As per NBA)

Engineering Knowledge
Individual and Team work
Communication

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be Strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure Part to be made zero.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	1	1					3	3	1	1		3	

2	CO2	3	3	1	1		1			3	3	1	1		3	
3	CO3	3	3	1	1					3	3	1	1		3	
4	CO4	3	3	1	1					3	3	1	1		3	
5	CO5	3	3	1	1					3	3	1	1		3	
	AVERAGE	3	3	1	1		1			3	3	1	1		3	

PROJECT - III
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER - III

Subject Code	18PRJ38	CIE Marks	50
No. of Practical Hours/Week	2	SEE Marks	50
		Exam Hours	3

CREDITS - 01

Course Objectives:
This Course will enable the students to:

- Independent Learning.
- Selection and Utilization of adequate information.
- Organization and presentation of information.
- Learn to work with team members.
- Expand one's intellectual capability and decision making
- Meeting the deadlines

Project - III
Students in consultation with the guide take up an updated topic on the subjects taught in third semester and search and collect the relative literature and then study. Students in a team should come with an idea as a result of literature studies and build a prototype to demonstrate the implementation of the idea.

Course Outcome:
At end of the course, students will be able to:
CO1: Exhibit a thorough understanding of the selected project topic, showcasing sound technical expertise and domain-specific knowledge.
CO2: Identify, formulate, and analyze engineering problems systematically to derive precise and actionable problem statements.
CO3: Develop and design innovative engineering solutions to address identified problems effectively and efficiently.
CO4: Implement and execute the project successfully, adhering to engineering standards, timelines, and resource constraints.
CO5: Effectively communicate project outcomes and solutions through professional presentations and reports to academic peers, industry professionals, and the broader society.

Graduate Attributes:
Engineering knowledge, Problem Analysis, Individual and team work, Communication.

Examinations:

Continuous Internal Evaluation:
CIE marks for the project is 50 marks

1. Report 25 marks
2. Presentation 25 marks

Marks shall be awarded by a guide with one examiner (senior most faculty within the department) selected by the head of the department based on his/her performance.

Semester End Examination:
SEE marks for the project is 50 marks

1. Report 15 marks
2. Presentation 15 marks
3. Viva-Voce 20 marks

Marks shall be awarded by two examiners (one internal and one external) constituted by the head of the department/dean.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3								3	3	3				
2	CO2	3	3							3	3	3				
3	CO3	3	3	3	3	3				3	3	3		3	3	
4	CO4	3	3		3	3				3	3	3	3	3	3	
5	CO5						3	2	1	3	3	3	3			3
	AVERAGE	3	3	3	3	3	3	2	1	3	3	3	3	3	3	3

ENGINEERING MATHEMATICS –IV			
COMMON TO ALL BRANCHES			
Course Code	18MAT41	CIE Marks	50
Contact Hours/Week	04	SEE Marks	50
Total Hours	50	Exam Hours	03
Semester	IV	Credits	04

Course Learning Objectives:

This course viz., Engineering mathematics-IV (18MAT41) aims to prepare the students:

- Learn Fourier series and Fourier transforms.
- Conversant with numerical methods to solve ordinary differential equations, complex analysis, joint probability distribution and stochastic processes arising in science and engineering

Course Outcomes(COs):

After completion of course, the student will able to

CO#	Course Outcomes	Pos
CO1	Understanding the Periodic function and Fourier series expansion of different functions and its application to analyze circuits	1, 2,12
CO2	Apply the knowledge of Fourier transform and Understand the complex potentials in different engineering fields	1, 2,12
CO3	Solving the first order first degree ordinary differential equations arising in flow problems by numerical methods.	1, 2,12
CO4	Make the use of second order ordinary and partial differential equations arising in heat and wave equations by numerical methods.	1, 2,12
CO5	Learn to solve the problems on Joint probability distribution and to know the concept of stochastic processes and Markov's chains in discrete time.	1, 2,12

Bloom's level of the course outcomes:

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	√	√	√			
CO2	√	√	√			
CO3	√	√	√			
CO4	√	√	√			
CO5	√	√	√			

Course Articulation Matrix / Course mapping:

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

MODULE-1: FOURIER SERIES

Fourier Series: Periodic functions, Dirichlet's condition, Fourier Series of periodicfunctions with period 2 π and with arbitrary period 2c. Fourier series of even and odd functions
Half range Fourier Series, practical harmonic analysis .

(RBT Levels: L1, L2 and L3) **10 Hours**

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

MODULE-2: FOURIER TRANSFORMS

Fourier Transforms : Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier-transform
Complex line Integrals: Cauchy's Integration theorem, Cauchy integral formula, Laurent's Series, types of singularities. Residue, Poles, Cauchy's Residue theorem (without proof) and Problems.
Transformations: Bilinear transformations and problems

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

MODULE-3: NUMERICAL METHODS

Numerical Methods: Numerical solution of ordinary differential equations of first order andfirst degree, Taylor's series method, modified Euler's-method Runge -Kutta method of fourth order. Milne's and Adams - Bashforth predictor and corrector methods (No derivations of formulae).

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

MODULE-4: NUMERICAL METHODS

Numerical Methods: Numerical solution of second order ordinary differential equations, Runge- Kutta Method and Milne's Method, Numerical solution of P.D.E: Numerical solution of Heat equation, Wave equation, problems.

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

MODULE-5: JOINT PROBABILITY DISTRIBUTION

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.
Stochastic process: Stochastic processes, probability vector, stochastic matrices, fixed points, regular sto chastic matrices, Markov chains, higher transition probability-simple problems.

(RBT Levels: L1, L2 and L3) 10 Hours

Teaching – Learning Process	Chalk and talk method / Power Point Presentation

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question carries 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module .
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module .

CIE + Assignments: 15+35=50 Marks
There will be a 3 CIE's, the average of best of 2 CIE's will be considered and there will be a 35 marks for Assignments

Text Books:

1. B.S. Grewal : Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.
2. E. Kreyszig : Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed.(Reprint), 2016.

Reference books:

1. *N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers , 7th Ed., 2010.*
2. *B.V.Ramana: "Higher Engineering Mathematics" Tata McGraw-Hill, 2006.*
3. *H. K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics", S. Chand publishing, 1st edition, 2011.*

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org.

POWER GENERATION, TRANSMISSION AND DISTRIBUTION

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-IV

Subject Code	18EE42	CIE Marks	50
Number Lecture Hour/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-4

Course Objectives: This course will enable students to:

1. Understand the working of hydel, Nuclear, Thermal power generating stations.
2. Study the fundamentals of photovoltaic power conversion system.
3. Understand the basic concept of Co-generation.
4. Understand the short, long and medium line transmission system for different voltage levels and to study the different types of insulators for a given voltage level.
5. Study the different types of distribution systems.

Modules		**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Hydel Power Generation: Selection of site. Classification of hydro-electric plants. General arrangement and operation, structure and control, advantages and disadvantages. **Nuclear Power Generation:** Introduction, Advantages & disadvantages of nuclear power generation. Hazards, Environmental aspects for selecting the sites and locations of nuclear power stations. **Gas turbine power plant:** Schematic arrangement, advantages and disadvantages of Open, Closed and Combined cycle power plant.	**10 Hours**	**L1,L2**
Module -2		
Wind Power: Introduction to wind energy, basic principles of wind energy conversion, Site selection. Advantages and disadvantages. **Thermal Power Generation:** Introduction, Selection of site, Main parts of a thermal power plant and its Working, Plant layout, advantages and disadvantages. **Photovoltaic Power Conversion systems**: Solar Photovoltaic (SPV) systems, Operating principle, Types of solar cells, module, array (Series and parallel connections). Applications of Solar Photo voltaicsystems. **Concept of co-generation:** Combined heat and power distributed generation and distributed generation.	**10 Hours**	**L1,L2**
Module -3		
Overhead transmission lines: Typical transmission scheme: Standard voltages for transmission, advantages of high voltage transmission, Sag calculation in conductors, (a) Suspended on level supports (b) supports at different levels. Effect of wind, ice, tension and sag at erection. **Corona**: Phenomena, expression for disruptive and visual critical voltages and corona power loss. **Overhead line Insulators:** A brief introduction to types of insulators, String efficiency, Methods of increasing string efficiency.	**10 Hours**	**L1,L2,L3**

Module -4		
Line parameters: Introduction to line parameters. Calculation of inductance of single phase and three phase lines with equilateral spacing, Unsymmetrical spacing. Inductance of composite – conductors, Geometric mean radius (GMR) and geometric mean distance (GMD). Calculation of capacitance of single phase and three phase lines with equilateral spacing, Unsymmetrical spacing. Capacitance of composite – conductor, Geometric mean radius (GMR) and geometric mean distance (GMD). **Performance of transmission lines:** Classification of lines – Short, Medium and Long lines. Current and voltage relations, Line regulation and Ferranti effect inshort, Medium and long length lines. ABCD constants in all cases.	**10 Hours**	**L1, L2,L3**
Module-5		
Distribution: Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system. Secondary AC distribution systems – Three phase 4 wire system and single phase 2 wire distribution, AC distributors with concentrated and uniform loads. Effect of disconnection of neutral in a 3 phase four wire system. **Reliability and Quality of Distribution system:** Introduction, Definition of reliability, failure, Probability concepts. Limitations of distribution systems, Power quality and Reliability aids.	**10 Hours**	**L1,L2,L3**

Course Outcomes: At the end of the course, the student will be able to:

CO1: Describe the operational principles, energy conversion mechanisms, and efficiency aspects of hydroelectric, nuclear, and thermal power generating stations, including their environmental and economic impacts.

CO2: Explain the fundamental principles of photovoltaic power conversion systems, including solar cell operation, energy conversion efficiency, and the integration of solar power into electrical grids.

CO3: Analyze the performance of transmission lines, focusing on parameters such as efficiency, voltage regulation, power losses, and surge impedance, along with the impact of corona discharge and the role of overhead line insulators in maintaining system reliability.

CO4: Evaluate the operational characteristics of short, medium, and long transmission lines at different voltage levels and assess the selection and performance of various types of insulators suitable for specific voltage applications.

CO5: Explore the structure, configuration, and operational characteristics of various electrical distribution systems, including radial, ring, and interconnected networks, to ensure efficient power delivery to consumers.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	1		1	1					1	3		
2	CO2	3	3	3	1		1	1					1	3		
3	CO3	3	3	3	1		1						1	3		
4	CO4	3	3	2	1								1	3		
5	CO5	3	3	2	1								1	3		
	AVERAGE	3	3	2.6	1		1	1					1	3		

ELECTRICAL MACHINES – II

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-IV

Subject Code	18EE43	CIE Marks	50
Number Lecture Hour/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-04

Course Objectives: This course will enable the students to:

1. Understand the basics of DC motor and its performance characteristics.
2. Understand the different tests on DC motor and the basics of Synchronous generator.
3. Understand the calculation of equivalent circuit of Synchronous generator and the construction and operation of DC generator.
4. Understand the determination of voltage regulation of Synchronous generator.
5. Explain required conditions for the parallel operation of synchronous generator.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
DC Motors: Classification, Back emf, Torque equation, and significance of back emf, Characteristics of shunt, series & compound motors. Speed control of shunt, series and compound motors. Application of motors. DC motor starters – 3 point and 4 point. **Losses and efficiency-** Losses in DC motors, power flow diagram, efficiency, condition for maximum efficiency.	**10 Hours**	**L1**
Module -2		
Testing of dc motors: Direct & indirect methods of testing of DC motors-Brake test, Swinburne's test, Retardation test, Hopkinson's test, Field's test, merits and demerits of tests. **Synchronous Generators:** Basic principle of operation, advantages of stationary armature, constructional features and types of rotors, concept of winding factor- pitch factor and distribution factor, frequency of generated emf, EMF equation, problems.	**10 Hours**	**L1,L2**
Module -3		
Synchronous generators (continuation): Harmonics–causes, reduction and elimination. Armature reaction, Synchronous reactance, Equivalent circuit. **Direct current Generator:** Construction and working of DC generators, Types, EMF equations, Armature reaction, Commutation and associated problems.	**10 Hours**	**L1,L2,L3**
Module -4		
Synchronous generators (continuation): Alternator on load. Excitation control for constant terminal voltage. Voltage regulation. Open circuit and short circuit characteristics, Assessment of reactance-short circuit ratio, synchronous reactance, Voltage regulation by EMF, MMF, ZPF methods, Power angle characteristic	**10 Hours**	**L1, L2,L3**

(salient and non salient pole), power angle diagram, reluctance power.		
Module-5		
Synchronous generators (continuation):,Effects of saliency, two-reaction theory, V –curves Parallel operation of generators and load sharing. Methods of Synchronization, Synchronizing power, Determination of Xd & Xq– slip test **Performance of synchronous generators:** Capability curve for large turbo generators and salient pole generators. Hunting and damper windings.	**10 Hours**	**L1,L2,L3**
Course Outcomes: At the end of the course the student will be able to: **CO1:** Evaluate the performance characteristics of DC motors and analyze their operational behavior under varying conditions. **CO2:** Perform and analyze different tests on DC motors, including no-load, load, and efficiency tests, and gain a foundational understanding of the working principles of synchronous generators. **CO3:** Draw the equivalent circuit of synchronous generators and acquire a basic understanding of the construction and operation of DC generators. **CO4:** Examine and compare various methods of determining the voltage regulation of synchronous generators, such as the EMF, MMF, and Potier triangle methods. **CO5:** Analyze the principles and procedures for the parallel operation of synchronous generators, including load sharing and synchronization techniques, to ensure reliable power system operation.		
Text Book: 1. Electrical machinery, P.S Bhimbra, Khanna Publishers 2. Electrical machines, DP Kothari, I.J.Nagarath, TMH, 4th edition, 2010. 3. Electric Machines, Mulukuntla S.Sarma, MukeshK.Pathak, Cengage Learning, First.		
Reference Book: 1. Performance & Design of Alternating Current machines, M. G. Say, CBS publishers,3rd Edition,2002. 2. The Performance & Design of DC machines A.E Clayton & N.N.Hancock CBS Publication,3rd Edition,2004. 3. Electrical Machines, Ashfaq Hussain , Dhanpat Rai Publications.		

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	1								1	3		
2	CO2	3	3	3	1								1	3		
3	CO3	3	1		1								1	3		
4	CO4	3	3	3	1								1	3		
5	CO5	3	3	3									1	3		
	AVERAGE	3	2.6	3	1								1	3		

CONTROL SYSTEMS

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-IV

Subject Code	18EE44	CIE Marks	50
Number Lecture Hour/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-4

Course Objectives: This course will enable students to :

- Define a control system, feedback control system and to understand mathematical modeling of control systems.
- Obtain transfer function of a closed loop control system using block diagram reduction rules and signal flow graph methods.
- Understand transient and steady state response of a control system and to determine the stability of a system using Routh's stability criterion.
- Discuss the stability analysis using root locus techniques and Bode plot.
- Analyze stability of a control system using Nyquist plot and to understand the design of control systems.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Introduction to control systems: Introduction, classification of control systems. **Mathematical models of physical systems:** Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchronous, gear trains.	**10 Hours**	**L1**
Module -2		
Block diagram: Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function. **Signal flow graphs:** Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems.	**10 Hours**	**L1,L2**
Module -3		
Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems. **Routh Stability criterion:** BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis.	**10 Hours**	**L1,L2,L3**
Module -4		

Root locus technique: Introduction, root locus concepts, construction of root loci, rules for the construction of root locus. **Frequency Response analysis:** Co-relation between time and frequency response – 2nd order systems only. **Bode plots:** Basic factors G(iw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin.	**10 Hours**	**L1, L2,L3**
Module-5		
Nyquist plot: Principle of argument, Nyquist stability criterion, assessment of relative stability using Nyquist criterion. **Design of Control Systems:** Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller.	**10 Hours**	**L1,L2,L3**

Course Outcomes:

At the end of the course the student will be able to:

CO1: Analyze various types of control systems and develop mathematical models for physical systems using differential equations and analogous systems.

CO2: Design the transfer function of systems by employing block diagram reduction techniques and signal flow graph methods, ensuring accurate system representation.

CO3: Evaluate the time-domain response of control systems, including transient and steady-state behavior, and assess system stability using Routh's stability criterion.

CO4: Perform stability analysis using Root Locus and Bode Plot techniques to examine system dynamics and determine gain margins, phase margins, and system robustness.

CO5: Conduct stability analysis using the Nyquist plot and design appropriate controllers, such as PID controllers, to meet specified performance criteria and enhance system stability.

Text Book:

1 Control Systems ,Anand Kumar PHI 2nd Edition, 2014

Reference Book:

1 Automatic Control Systems Farid Golnaraghi, Benjamin C. Kuo Wiley 9th Edition, 2010.
2 Control Systems Engineering Norman S. Nise Wiley 4th Edition, 2004.
3 Modern Control Systems Richard C Dorf et al Pearson 11th Edition, 2008.
4 Control Systems, Principles and Design M.Gopal McGaw Hill 4th Edition, 2012.
5 Control Systems Engineering S. Salivahanan et al Pearson 1st Edition, 2015.
6 Modern Control Theory R. V. Parvatikar Prism Books Pvt. Ltd. 1st Edition, 2014.

Course Articulation Matrix for the Academic Year 2018-19

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	1	2	2	1						1	3		
2	CO2	3	3	1	2	3							1	3		
3	CO3	3	3	1	2	3	1						1	3		
4	CO4	3	3	1	2	3	1						1	3		
5	CO5	3	3	1	2	3	1						1	3		
	AVERAGE	3	3	1	2	2.8	1						1	3		

CONTROL SYSTEMS LAB

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-IV

Subject Code	18EEL45	CIE Marks	50
Number Lecture Hour/Week	2	SEE Marks	50
Number of Lecture Hours	24	Exam Hours	03

CREDITS-1

Course Objectives: This course will enable the students to:

- Determine the time and frequency domain responses of a given second order system.
- Design and analyze Lag, Lead and Lag-Lead compensators for given specifications.
- Draw the performance characteristics of ac and dc servomotors and synchro-transmitter receiver pair.
- Simulate the DC position and DC feedback control systems to study the effect of P,PI,PD and PID controller.
- Simulate root locus, bodeplot, Nyquistplot to study the stability of the system.

SL NO	Experiments
1.	Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor
2.	Experiment to draw synchro pair characteristics
3.	Experiment to determine frequency response of a second order system
4.	(a) To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response. (b) To determine experimentally the transfer function of the lead compensating network.
5.	(a) To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response. (b) To determine experimentally the transfer function of the lag compensating network
6.	Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function.
7.	(a) To simulate a typical second order system and determine step response and evaluate time response specifications. (b) To evaluate the effect of additional poles and zeros on time response of second order system. (c) To evaluate the effect of pole location on stability (d) To evaluate the effect of loop gain of a negative feedback system on stability.
8.	To simulate a second order system and study the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.
9.	(a) To simulate a D.C. Position control system and obtain its step response. (b) To verify the effect of input waveform, loop gain and system type on steady state errors. (c) To perform trade-off study for lead compensator. (d) To design PI controller and study its effect on steady state error.
10.	(a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response (b) To study the effect of open loop gain on transient response of closed loop system using root locus.

11.	(a) To study the effect of open loop poles and zeros on root locus contour (b) To estimate the effect of open loop gain on the transient response of closed loop system using root locus. (c) Comparative study of Bode, Nyquist and root locus with respect to stability.

Course outcomes:

At the end of the course the student will be able to:

CO1: Analyze the time-domain and frequency-domain responses of a given second-order system to evaluate system performance parameters.

CO2: Design and analyze **Lag, Lead, and Lag-Lead compensators** to meet specific system performance criteria and stability requirements.

CO3: Evaluate the performance characteristics of AC and DC servomotors and synchro-transmitter-receiver pairs through experimental analysis.

CO4: Simulate **DC position control and feedback control systems** to study the effects of proportional (P), proportional-integral (PI), proportional-derivative (PD), and proportional-integral-derivative (PID) controllers.

CO5: Simulate and interpret root locus, Bode plot, and Nyquist plot to perform stability analysis and enhance system robustness.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	1	3				3	3		1		3	
2	CO2	3	3	3	1	3				3	3		1		3	
3	CO3	3	3	3	1	1				3	3		1		3	
4	CO4	3	3	3	1	3				3	3		1		3	
5	CO5	3	3	3	1	3				3	3		1		3	
	AVERAGE	3	3	3	1	2.6				3	3		1		3	

ELECTRICAL MACHINES-II LAB

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-IV

Subject Code	18EEL46	CIE Marks	50
Number Lecture Hour/Week	2	SEE Marks	50
Number of Lecture Hours	24	Exam Hours	03

CREDITS-1

Course Objectives: This course will enable the students to:

- Perform tests on dc machines to determine their characteristics.
- Control the speed of a dc motor.
- Conduct test for pre-determination of the performance of dc machines.
- Conduct different tests on synchronous generator to evaluate its performance.
- Study of synchronous generator connected to infinite bus.

SL NO	Experiments
1.	Load test on a DC motor- determination of speed-torque and HP-efficiency characteristics.
2.	Load test on DC generator.
3.	Field's test on DC series Machines.
4.	Speed control of DC motor by armature voltage control and flux control.
5.	Swinburne's Test on DC motor.
6.	Retardation test on DC shunt motor.
7.	Regenerative test on DC Machines.
8.	Voltage regulation of an alternator by EMF and MMF method.
9.	Voltage regulation of an alternator by ZPF method.
10.	Slip test- measurement of direct and Quadrature axis reactance and predetermination regulation of salient pole synchronous machines.
11.	Study of synchronous generator connected to infinite bus, under constant power and variable excitation.
12.	Power angle curve of synchronous generator.

Course outcomes:

At the end of the course the student will be able to:

CO1: Conduct experimental tests on DC machines to determine their performance characteristics, such as torque, efficiency, and speed regulation.

CO2: Implement various speed control techniques for DC motors, including armature control and field control methods, to meet specific operational requirements.

CO3: Perform pre-determination tests, such as the Swinburne's test and Hopkinson's test, to evaluate the efficiency and performance of DC machines under different load conditions.

CO4: Conduct comprehensive tests on synchronous generators, including open-circuit, short-circuit, and load tests, to analyze their operational performance and efficiency.

CO5: Examine the behavior of a synchronous generator connected to an infinite bus, focusing on load sharing, synchronization, and stability under varying operating conditions.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3							3	3		1		3	
2	CO2	3	3							3	3		1		3	
3	CO3	3	3							3	3		1		3	
4	CO4	3	3							3	3		1		3	
5	CO5	3	3	3	1					3	3		1		3	
	AVERAGE	3	3	3	1					3	3		1		3	

OP-AMP AND LINEAR IC'S LAB

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-IV

Subject Code	18EEL47	CIE Marks	50
Number Lecture Hour/Week	2	SEE Marks	50
Number of Lecture Hours	24	Exam Hours	03

CREDITS-1

Course Objectives: This course will enable the students :

• To conduct different experiments using OP-Amps

• To conduct experiments using Linear IC's

a) Study of pin details, specifications, application features of IC741 (LM741) and IC555 (Timer) through corresponding datasheets (Datasheets are instruction manuals for electronic components. They explain exactly what a component does and how to use it.).

b) Comparison of output performance quantity of an Operational Amplifier obtained by rigging up the circuit with the ideal value of

(i) A Non–Inverting Amplifier (Vout=AVin) (ii) An Inverting Amplifier (Vout=-AVin) (iii) A Difference Amplifier (Vout=-A(Vp-Vin)) (iv) A Difference Amplifier with floating inputs (Vout=AVin) (v) A Non – Inverting Amplifier with negative feedback (ii) An Inverting Amplifier with negative and output transfer characteristics to analyse and conclude that op-amps are rarely used in open-loop.

c) Plot of input and output transfer characteristics to analyse and conclude that op-amps are rarely used in open-loop.

d) Testing of op – amp.

SL NO	Experiments
1.	Design and verify a precision full wave rectifier. Determine the performance parameters.
2.	Design and realize to analyze the frequency response of an op – amp amplifier under inverting and non -inverting configuration for a given gain.
3.	Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.
4.	Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).
5.	Verify the operation of an op – amp as (a) voltage comparator circuit and (b) zero crossing detector.
6.	Design and verify the operation of op – amp as an (a) adder (b) subtractor (c) integrator and (d) differentiator.
7.	Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c) band pass filters for a given cut off frequency/frequencies to verify the frequency response characteristic.
8.	Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency.
9.	Design and realization of R-2R ladder DAC.
10.	Realization of Two bit Flash ADC

11.	Design and verify an IC 555 timer based pulse generator for the specified pulse.
12.	Designing of Fixed voltage power supply (voltage regulator) using IC regulators 78 series and 79 series.

Course outcomes:

At the end of the course the student will be able to:

CO1: Conduct experiments to determine the characteristic parameters of operational amplifiers (OP-Amps), including input offset voltage, input bias current, slew rate, and gain bandwidth product.

CO2: **Design and test OP-Amps** configured as amplifiers (inverting and non-inverting), adders, subtractors, differentiators, and integrators, and evaluate their performance for specified applications.

CO3: Design and test OP-Amps as oscillators (e.g., Wien bridge, phase-shift) and active filters (low-pass, high-pass, and band-pass) to achieve desired frequency characteristics.

CO4: Design and implement OP-Amp-based function generators to produce sine, square, and triangular waveforms of specified frequencies and amplitudes.

CO5: Design and analyze linear ICs configured as multivibrators (astable, monostable, and bistable) and regulated power supplies for various applications.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

SI. No.	**PO / CO**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	CO1	3	3							3	3		1		3	
2	CO2	3	3		1					3	3		1		3	
3	CO3	3	3							3	3		1		3	
4	CO4	3	3		1					3	3		1		3	
5	CO5	3	3							3	3		1		3	
	AVERAGE	3	3		1					3	3		1		3	

PROJECT - IV
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER – IV

Subject Code	18PRJ48	**CIE Marks**	50
No. of Practical Hours/Week	2	**SEE Marks**	50
		Exam Hours	3

CREDITS – 01

Course Objectives:
This Course will enable the students to:

- Independent Learning.
- Selection and Utilization of adequate information.
- Organization and presentation of information.
- Learn to work with team members.
- Expand one's intellectual capability and decision making
- Meeting the deadlines

Project - IV
Students in consultation with the guide take up an updated topic on the subjects taught in fourth semester and search and collect the relative literature and then study. Students in a team should come with an idea as a result of literature studies and build a prototype to demonstrate the implementation of the idea.

Course Outcome:
At end of the course, students will be able to:
CO1: Demonstrate Expertise in Project Topics: Exhibit a comprehensive understanding of the technical aspects related to the selected project area.
CO2: Identify and Formulate Problems: Undertake systematic problem identification and formulation to address key challenges effectively.
CO3: Develop Systematic Solutions: Generate and implement solutions using a structured and methodical approach.
CO4: Design Engineering Solutions: Create practical and innovative engineering solutions to address straightforward problems.
CO5: Communicate Effectively: Present project outcomes clearly and effectively to academic peers, industry professionals, and society at large.

Graduate Attributes:
Engineering knowledge, Problem Analysis, Individual and team work, Communication.

Examinations:

Continuous Internal Evaluation:
CIE marks for the project is 50 marks

1. Report 25 marks
2. Presentation 25 marks

Marks shall be awarded by a guide with one examiner (senior most faculty within the department) selected by the head of the department based on his/her performance.

Semester End Examination:
SEE marks for the project is 50 marks

1. Report 15 marks
2. Presentation 15 marks
3. Viva-Voce 20 marks

Marks shall be awarded by two examiners (one internal and one external) constituted by the head of the department/dean.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3								3	3	3				
2	CO2	3	3							3	3	3				
3	CO3	3	3	3	3	3				3	3	3		3	3	
4	CO4	3	3		3	3				3	3	3	3	3	3	
5	CO5						3	2	1	3	3	3	3			3
	AVERAGE	3	3	3	3	3	3	2	1	3	3	3	3	3	3	3

MANAGEMENT AND ENTREPRENEURSHIP

[As per Choice Based Credit System (CBCS)Scheme]

SEMESTER-V

Subject Code	18ES51	CIE Marks	50
Number Lecture Hour/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-04

Course Objectives: This course will enable students to:

- Understand the Nature and Characteristics of Management and importance of planning.
- Understand the Meaning, Nature and Characteristics of Organization its staffing, directing and controlling.
- Know the concepts of entrepreneurship, importance, Myth and problems associated with entrepreneurship and its social responsibilities.
- Discuss the concept and types of Small Scale Industries and their importance in economic development of a country and Institutional Support for Business Enterprises.
- Define the Meaning of Project, Project Objectives and Characteristics and Prerequisites for Successful Project Implementation.

Modules	**Teaching Hours**	**Revised Blooms Taxonomy (RBT) Level**
Module -1		
Management: Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art &Profession**.** **Planning:** Nature, Importance and Purpose Of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.	**10 Hours**	**L1**
Module -2		
Organizing and Staffing: Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees – meaning, Types of Committees, Centralization Versus Decentralization of Authority and Responsibility, Span of Control (Definition only), Nature and Importance of Staffing, Process of Selection and Recruitment. **Directing and Controlling:** Meaning and Nature of Directing-Leadership Styles, Motivation Theories Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling.	**10 Hours**	**L1,L2**
Module -3		

Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. **Entrepreneurship**: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship.	**10 Hours**	**L1,L2,L3**
Module -4		
Modern Small Business Enterprises: Role of Small Scale Industries, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry and Tiny Industry (Definition only). **Institutional Support for Business Enterprises:** Introduction, Policies & Schemes of Central–Level Institutions, State-Level Institutions.	**10 Hours**	**L1, L2,L3**
Module-5		
Project Management: Meaning of Project, Project Objectives & Characteristics, Project Identification- Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, Project Implementation Phase, Human & Administrative aspects of Project Management, Prerequisites for Successful Project Implementation. **New Control Techniques**- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM	**10 Hours**	**L1,L2,L3**

Course outcomes:

At the end of the course the student will be able to:

CO1: Explain the Nature and Characteristics of Management and importance of planning.

CO2: Discuss the Meaning, Nature and Characteristics of Organization its staffing, directing and controlling.

CO3: Explain the concepts of entrepreneurship, importance, Myth and problems associated with entrepreneurship and its social responsibilities.

CO4: Describe the concept and types of Small Scale Industries and their importance in economic development of a country and Institutional Support for Business Enterprises.

CO5: Explain the Meaning of Project, Project Objectives and Characteristics and Prerequisites for Successful Project Implementation.

Text Book:

1. Principles of Management, P.C.Tripathi, P.N.Reddy, McGraw Hill, 6th Edition,2017
2. Entrepreneurship Development And Small Business Enterprises PoornimaM. Charanthimath ,Pearson,2nd Edition,2014.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Management And Entrepreneurship
Course Code:18ES51

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1						2		2	2	1		2			1
2	CO2						2		2	2	2	2	2			1
3	CO3						2		3	3	3	2	3			3
4	CO4						2		2	2	3	2	3			1
5	CO5						2		2	1	3		3			1
	AVERAGE						2		2.2	2	2.4	2	2.6			1.4

POWER SYSTEM ANALYSIS – 1

[As per Choice Based Credit System (CBCS)Scheme]

SEMESTER-V

Subject Code	18EE52	CIE Marks	50
Number of Lecture Hours/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-04

Course Objectives: This course will enable the students to:

- Explain the power system components and construct per unit impedance diagram.
- Study and analyze three phase symmetrical faults on power system.
- Explain and compute unbalanced phases in terms of sequence components and develop sequence networks.
- Study and analyze various unsymmetrical faults on power system.
- Explain the dynamics of synchronous machine and determine the power system stability.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Representation of Power System Components: Introduction, Single-phase Representation of Balanced Three Phase Networks, One-Line Diagram and Impedance or Reactance Diagram, Per Unit (PU) System, Steady State Model of Synchronous Machine, Power Transformer, Transmission of electrical Power, Representation of Loads	**10 Hours**	**L1**
Module -2		
Symmetrical Fault Analysis: Introduction, Transient on a Transmission Line, Short Circuit of a Synchronous Machine(On No Load), Short Circuit of a Loaded Synchronous Machine, Selection of Circuit Breakers.	**10 Hours**	**L1,L2**
Module -3		
Symmetrical Components: Introduction, Symmetrical Component Transformation, Phase Shift in Star-Delta Transformers, Sequence Impedances of Transmission Lines, Sequence Impedances and Sequence Network of Power System, Sequence Impedances and Networks of Synchronous Machine, Sequence Impedances of Transmission Lines, Sequence Impedances and Networks of Transformers, Construction of Sequence Networks of a Power System, Measurement of sequence Impedance of Synchronous Generator.	**10 Hours**	**L1,L2,L3**
Module -4		

Unsymmetrical Fault Analysis: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double Line-To-Ground (LLG) Fault, Open Conductor Faults.	**10 Hours**	**L1, L2,L3**
Module -5		
Power System Stability: Introduction, Dynamics of a Synchronous Machine, Power Angle Equation, Salient and Non – Salient pole Synchronous Machines, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability.	**10 Hours**	**L1,L2,L3**

Course outcomes:

At the end of the course the student will be able to:

CO1: Model the power system components and construct per unit impedance diagram of power system.

CO2: Analyze three-phase symmetrical faults on power system.

CO3: Compute unbalanced phases in terms of sequence components and develop sequence networks.

CO4: Analyze various unsymmetrical faults on power system.

CO5: Analyze the dynamics of synchronous machine and determine the power system stability.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Power System Analysis-1
Course Code:18EE52

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO 2	PSO3
1	CO1	3	3	2	1								1	3		
2	CO2	3	3	3	1								1	3		
3	CO3	3	3	3	1								1	3		
4	CO4	3	3	3	1								1	3		
5	CO5	3	3	3	1								1	3		
	AVERAGE	3	3	2.8	1								1	3		

SIGNALS AND SYSTEMS

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-V

Subject Code	18EE53	CIE Marks	50
Number of Lecture Hours/Week	03	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS- 03

Course Objectives: This course will enable the students to:

1. Explain the classification, basic operations and properties of signals and systems.
2. Obtain and analyze the response of LTI system in time domain.
3. Obtain the solution for differential and difference equations of LTI systems and Fourier representation of periodic signals.
4. Obtain Fourier representations of a periodic signals.
5. Analyze the LTI system in Z-transform.

Module -1

Introduction and Classification of signals: Definition of signal and systems, communication and control systems as examples. Classification of signals. Basic Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration, time scaling, time shift and time reversal.

Elementary signals/Functions: Exponential, sinusoidal, step, impulse and ramp functions. Expression of triangular, rectangular and other waveforms interms of elementary signals.

10 Hours L1, L2, L3

Module -2

System Classification and properties: Linear-nonlinear, Time variant-invariant, causal-non causal, static-dynamic, stable-unstable, invertible systems.

Time domain representation of LTI System: Impulse response, convolution sum, convolution integral. Computation of convolution sum and convolution integral using graphical method for unit step and unit step, unit step and exponential, exponential and exponential, unit step and rectangular, and rectangular and rectangular.

LTI system Properties in terms of impulse response: System interconnection, Memory less, Causal, Stable, Invertible and De-convolution, and step response.

10 Hours L1,L2, L3

Module -3

Differential & Difference Equation representation of LTI systems: Solution for Differential & Difference equations.

Fourier Representation of Periodic Signals: Orthogonality of complex sinusoids, CTFS properties (No derivation)and basic problems.

08 Hours L1,L2,L3

Module -4

Fourier Representation of a periodic Signals: Introduction to Fourier Transform & DTFT, Definition and basic problems.

Properties of Fourier Transform: Periodicity, Linearity, Symmetry, Time shift, Frequency shift, Scaling, Differentiation and Integration, Convolution and Modulation, Parsevals relationships and Duality.

10 Hours L1, L2,L3

Module-5

The Z-Transforms: Z-transforms, properties of the region of convergence, properties of the Z-transform, Inverse Z-transform, Causality and stability, Transform analysis of LTI systems.

10 Hours L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

CO1: Classify the signals and perform basic operations on them.

CO2: Classify the systems and analyze the response of LTI system in time domain

CO3: Solve the differential and difference equations of LTI systems and Fourier representation of periodic signals

CO4: Solve by applying the properties of Fourier transform

CO5: Compute Z-transforms, inverse Z-transforms, and transfer functions of complex LTI systems

Text Book:

1. Simon Haykins and Barry Van Veen, "Signals and Systems", 2nd Edition, 2008, WileyIndia. ISBN 9971-51-239-4.

Reference Book:

1. Michael Roberts, "Fundamentals of Signals & Systems", 2nd edition, Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
2. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals and Systems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.
3. H. P Hsu, R. Ranjan, "Signals and Systems", Scham's outlines, TMH, 2006.
4. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2005.
5. Ganesh Rao and SatishTunga, "Signals and Systems", Pearson/Sanguine

Course Articulation Matrix for the Academic Year 2018-19
Course Name:Signals and Systems
Course Code:18EE53

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	2	1								1	3		
2	CO2	3	3	2	1								1	3		
3	CO3	3	3	2	1	1							1	3		
4	CO4	3	3	2	1	1							1	3		
5	CO5	3	3	2	1	1							1	3		
	AVERAGE	3	3	2	1	1							1	3		

POWER SYSTEM PROTECTION AND SWITCHGEAR(Professional Elective)

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER V

Subject Code	18EE541	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable the students to:

- Understand the essential qualities, construction and operating principles of different relays.
- Understand the protective schemes using over current and distance relays.
- Understand the pilot relaying scheme, differential protection and protection of generators, motors, transformers and bus zone.
- Understand the basic principle and different types of circuit breakers.
- Understand the principle of fuse and also protection against over voltages.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Relay: Faults, Types of Fault, Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Performance of Protective Relaying, Classification of Protective Relays, Automatic Reclosing, Current Transformers for protection, Voltage Transformers for Protection. **Relay Construction and Operating Principles:** Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays. **Overcurrent Protection:** Introduction, Time – current Characteristics, Current Setting, Time Setting.	**08 Hours**	**L1,L2**
Module -2		
Overcurrent Protection (continued): Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays. **Distance Protection:** Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays,	**08 Hours**	**L1,L2,L3**

Reach of Distance Relays. Effect of Power Surges (Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays.		
Module -3		
Pilot Relaying Schemes: Introduction, Wire Pilot Protection, And Carrier Current Protection. **Differential Protection**: Introduction, Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection. **Rotating Machines Protection:** Introduction, Protection of Generators. **Transformer and Bus zone Protection:** Introduction, Transformer Protection, Bus zone Protection, Frame Leakage Protection.	**08 Hours**	**L1,L2,L3**
Module -4		
Circuit Breakers: Introduction, Fault Clearing Time of a Ci Breaker, Arc Voltage, Arc Interruption, Prestriking Voltage Recovery Voltage, Current Chopping, Interruption of Capac Current, Classification of Circuit Breakers, Air – Break Ci Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, Circuit Breakers, Vacuum Circuit Breakers, High Voltage D Current Circuit Breakers, Rating of Circuit Breakers, Testin Circuit Breakers.	**08 Hours**	**L1, L2,L3**
Module-5		
Fuses: Introductions, Definitions, Fuse Characteristics, Types of Fuses, Application Fuses, Selection of Fuses, Discrimination. **Protection against Overvoltage:** Causes of Overvoltage, Lightning phenomena, Wave Shape Voltage of due to Lightning, Over Voltage due to Lightning, Klydonograph and Magnetic Link Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub-Stations from Direct Strokes, Protection against Travelling Waves, Insulation Coordination, Basic Impulse Insulation Level (BIL). **Modern Trends in Power System Protection:** Introduction, gas insulated substation/switchgear (GIS).	**08 Hours**	**L1, L2**
CO1: Analyze and evaluate the essential qualities, construction, and operating principles of different types of relays. **CO2:** Analyze and implement protective schemes using overcurrent and distance relays to ensure efficient fault detection and isolation**.** **CO3:** Develop and critically assess pilot relaying schemes, differential protection strategies,		

and advanced protection mechanisms for generators, motors, transformers, and bus zones.

CO4: Analyze and compare the operating principles, performance, and application of various circuit breakers to optimize system protection.

CO5: Evaluate the principles and applications of fuses, and design effective overvoltage protection strategies to enhance system reliability and safety.

Text Book:

1. Power System Protection and Switchgear, Badri Ram D.N Vishwakarma, McGrawHill,2ndEdition
2. Power System Protection and Switchgear,BhuvaneshOza et al,McGraw Hill, 1st Edition,2010

Reference Book:

1. Protection and Switchgear, Bhaveshetal,Oxford ,1st Edition,2011
2. Power System Switchgear and Protection,N. Veerappan,S.R. Krishnamurthy,S. Chand ,1st Edition, 2009.
3. Fundamentals of Power System Protection, Y.G.Paithankar,S.R. Bhide ,PHI ,1st Edition,2009.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Power System Protection And Switchgear
Course Code:18EE541

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3					2						1	3		
2	CO2	3	1				2						1	3		
3	CO3	3	3				2						1	3		
4	CO4	3	3				2						1	3		
5	CO5	3	3				3						1	3		
	AVERAGE	3	2.5				2.2						1	3		

ELECTRIC CIRCUIT ANALYSISLAB

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-V

Subject Code	18EEL55	**CIE Marks**	50
Number of Practical Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	**SEE Marks**	50
RBT Level	L1, L2, L3	**Exam Hours**	03

CREDITS 01

Course Objectives: This course will enable students to:

- Determine currents in DC circuits.
- Verify Mesh and Nodal analysis of DC circuits.
- Verify Superposition, Reciprocity, Thevenin's, Norton's and Maximum power transfer theorems.
- Analyze series and parallel Resonant circuits and also determine transient response of RL, RC and RLC series circuits.
- Determine Z and Y parameters of two port networks.

List of Experiments:

1. Determination of current and voltage in DC circuits.
2. Verification of Mesh Analysis & Nodal Analysis.
3. Verification of Superposition theorem.
4. Verification of Reciprocity theorem.
5. Verification of Thevenin 's & Norton's theorems.
6. Verification of Maximum power transfer theorem.
7. Analysis of series resonant circuit.
8. Analysis of parallel resonant circuit.
9. Determination transient response of RC series circuit.
10. Determination transient response of RL series circuit.
11. Determination of transient response of RLC series circuit.
12. Determination of Z & Y parameters of two port networks.

Course Outcomes: At the end of the course the student will be able to:

CO1: Analyze and compute current, voltage, and power in DC circuits using fundamental electrical laws.

CO2: Apply Mesh and Nodal analysis techniques to systematically analyze complex DC circuits.

CO3: Evaluate and solve complex electric circuits using advanced network theorems,

including Thevenin's, Norton's, and Superposition theorems.

CO4: Analyze and interpret the behavior of series and parallel resonant circuits, and compute the transient response of RL, RC, and RLC series circuits under various conditions.

CO5: Compute and interpret Z and Y parameters of two-port networks to model and analyze interconnected systems.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Electric Circuit Analysis Lab
Course Code:18EEL55

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	**CO1**	3	1			2				3	3		1		3	
2	**CO2**	3	1			2				3	3		1		3	
3	**CO3**	3	2			2				3	3		1		3	
4	**CO4**	3	3	1	2	2	2			3	3		1		3	
5	**CO5**	3	3	1	2	2	2			3	3		1		3	
	AVERAGE	3	2	1	2	2	2			3	3		1		3	

SIGNALS AND SYSTEMS LAB

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-V

Subject Code	18EEL56	CIE Marks	50
Number Lecture Hour/Week	02 Hours	SEE Marks	50
RBT Level	L1, L2, L3	Exam Hours	03

CREDITS–01

Course Objectives: This laboratory course will enable students to:

- Simulate basic signals impulse, unit step, unit ramp, sinusoidal, cosine and exponential.
- Find the Even and Odd components of the signal and Computation of Energy and Power of the signal.
- Find solution to the difference equations and computation of convolution
- Compute the DFT for a discrete signal
- Evaluate Sampling theorem.

Note:

•The experiments are to be carried using Matlab /Scilab / Octave or equivalent.

List of Experiments:

1. Representation of basic signals impulse, unit step, unit ramp, sinusoidal, cosine and exponential.
2. Finding Energy and power of signals.
3. Finding Even and Odd components of the signal.
4. Write a program to perform Operations on signal time scaling, amplitude scaling.
5. Write a program to linear convolution of two sequences.
6. Find the Fourier transform, plot magnitude and phase.
7. Find the Inverse Fourier transform, plot magnitude and phase.
8. Find the solution of difference equation.
9. Evaluate Sampling Theorem.
10. Write a program to perform up sampling.
11. Write a program to perform down sampling.
12. Finding frequency response of LTI system.

L1,L2,L3

Course Outcomes: On the completion of this laboratory course, the students will be able to:

CO1: Analyze and apply time scaling and amplitude scaling techniques to modify and interpret signals in continuous and discrete domains.

CO2: Perform convolution operations on given sequences to determine the response of linear time-invariant (LTI) systems.

CO3: Interpret and analyze signals using frequency domain representation to uncover their spectral characteristics.

CO4: Solve and analyze difference equations to evaluate the behavior and response of discrete-

time systems.

CO5: Apply the principles of frequency domain sampling to reconstruct signals and avoid aliasing.

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO 2	PSO3
1	CO1	3	3	1	1	3				3	3		1		3	
2	CO2	3	3	1	1	3				3	3		1		3	
3	CO3	3	3	1	1	3				3	3		1		3	
4	CO4	3	3	1	1	1				3	3		1		3	
5	CO5	3	3	1	1	3				3	3		1		3	
CAM	AVERAGE	3	3	1	1	2.6				3	3		1		3	

POWER SYSTEM PROTECTION AND SWITCHGEAR LAB

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-V

Subject Code	18EEL57	CIE Marks	50
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	SEE Marks	50
		Exam Hours	03

CREDITS-1

Course Objectives: This laboratory course will enable students to:

- Conduct an experiment to verify the characteristics off use.
- Conduct experiments to verify the characteristics of electromagnetic relays.
- Conduct experiments to verify the characteristics of static relays.
- Conduct experiments to verify the characteristics of microprocessor based over current, over voltage, under voltage relays.
- Conduct experiments on transformer, motor and feeder protection.

Laboratory Experiments:

1. Current-time characteristics off use.
2. Over current relay**:**
   (a) IDMT non-directional characteristics
3. IDMT characteristics of over voltage or under voltage relay.
4. Operation of negative sequence relay.
5. Operating characteristics of microprocessor based (numeric) over –current relay.
6. Operating characteristics of microprocessor based (numeric) over/under voltage relay.
7. To study the characteristics of the operation of Buchholz relay
8. Feeder protection scheme-fault studies.
9. Motor protection scheme-fault studies.
10. Directional over current relay

Course Outcomes: On the completion of this laboratory course, the students will be able to:

CO1: Analyze and evaluate the operating characteristics of fuses under varying load and fault conditions.

CO2: Test and interpret the operating characteristics of electromagnetic relays to ensure proper fault detection and protection.

CO3: Examine and validate the characteristics and operational behavior of static relays under different fault scenarios.

CO4: Test and assess the performance of microprocessor-based relays for overcurrent, overvoltage, and under voltage protection**.**

CO5: Conduct experiments to design and implement protection schemes for transformers, motors,

and feeders under fault conditions.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Power System Protection And Switchgear Lab
Course Code:18EEL57

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	1	1	1		1			3	3		1		3	
2	CO2	3	3	1	1		1			3	3		1		3	
3	CO3	3		1	1		1			3	3		1		3	
4	CO4	3		1	1	3	1			3	3		1		3	
5	CO5	3		1	1		1			3	3		1		3	
	AVERAGE	3	2	1	1	3	1			3	3		1		3	

PROJECT - V
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER - V

Subject Code	18PRJ58	CIE Marks	50
No. of Practical Hours/Week	2	SEE Marks	50
		Exam Hours	3

CREDITS - 01

Course Objectives:
This Course will enable the students to:

- Independent Learning.
- Selection and Utilization of adequate information.
- Organization and presentation of information.
- Learn to work with team members.
- Expand one's intellectual capability and decision making
- Meeting the deadlines

Project - V
Students in consultation with the guide take up an updated topic on the subjects taught in fifth semester and search and collect the relative literature and then study. Students in a team should come with an idea as a result of literature studies and build a prototype to demonstrate the implementation of the idea.

Course Outcome:
At end of the course, students will be able to:
CO1: Exhibit a thorough understanding of the selected project topic, showcasing sound technical expertise and domain-specific knowledge.
CO2: Identify, formulate, and analyze engineering problems systematically to derive precise and actionable problem statements.
CO3: Develop and design innovative engineering solutions to address identified problems effectively and efficiently.
CO4: Implement and execute the project successfully, adhering to engineering standards, timelines, and resource constraints.
CO5: Effectively communicate project outcomes and solutions through professional presentations and reports to academic peers, industry professionals, and the broader society.

Graduate Attributes:
Engineering knowledge, Problem Analysis, Individual and team work, Communication.

Examinations:

Continuous Internal Evaluation:
CIE marks for the project is 50 marks

1. Report 25 marks
2. Presentation 25 marks

Marks shall be awarded by a guide with one examiner (senior most faculty within the

department) selected by the head of the department based on his/her performance.

Semester End Examination:
SEE marks for the project is 50 marks

1. Report 15 marks
2. Presentation 15 marks
3. Viva-Voce 20 marks

Marks shall be awarded by two examiners (one internal and one external) constituted by the head of the department/dean.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3								3	3	3				
2	CO2	3	3							3	3	3				
3	CO3	3	3	3	3	3				3	3	3		3	3	
4	CO4	3	3		3	3				3	3	3	3	3	3	
5	CO5						3	2	1	3	3	3	3			3
	AVERAGE	3	3	3	3	3	3	2	1	3	3	3	3	3	3	3

SOFT SKILLS

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-V

Course Code	18HSM59	CIE Marks	50
Number of Lecture Hours/Week	01	SEE Marks	50
Total Number of Lecture Hours	28	Exam Hours	03hrs

CREDITS– 03

Course Learning Objectives:

- To enable the students to obtain the basic knowledge about Communication Skills: Meaning, definition, importance, purpose, process, types, barriers and Essential of communication.
- Develop reading and understanding ability
- Learn effective writing.
- Learn how to write different types of letter.
- Case method of learning.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
INTRODUCTION TO COMMUNICATION: Meaning, Definition, Importance & Purpose of Communication, Process of Communication, Types of Communication, Communication network in an organization, 7c's of communication, Barriers to Communication and Essential of good Communication.	**06 Hours**	**L1,L2,L3**
Module -2		
READING AND UNDERSTANDING – Reading Comprehension – Reading rate and reading comprehension, Paraphrasing, Interpretations of graphical information, Book reading and summarizing it.	**06 Hours**	**L1,L2,L3**
Module -3		
EFFECTIVE WRITING: Purpose of Writing, Clarity in Writing, Principle of Effective Writing. Better writing using personal Experiences – Describing a person, situation, memorable events etc….	**05 Hours**	**L1,L2,L3**
Module –4		
DRAFTING OF LETTERS: Writing different types of letters – writing for employment, joining letter, complaints & follows up , Enquiries, representation etc. Official Communication – e-mail & Social Media.	**06 Hours**	**L1,L2,L3**
Module -5		
CASE METHOD OF LEARNING: Understand Case method of learning, different type of cases, overcoming the difficulties of the case method, analyzing the case. Do's & Don'ts for case preparation.	**05 Hours**	**L1,L2,L3**

Course Outcomes: At the end of this course, students should be able to

CO 1- Describe the process, types and importance of communication in various contexts .

CO 2- Develop the ability to read books or lengthy texts with critical comprehension, effectively identifying and analyzing key themes, arguments, and main ideas.

CO 3- Develop writing skills by effectively describing people, situations, and memorable events and demonstrate responsibility, self-management, self-confidence and ethical behavior.

CO 4- Develop the ability to draft various professional letters such as employment application, joining letters, complaints, follow ups and representations.

CO 5- Foster teamwork abilities through collaborative case study discussion and problem solving exercises.

Text Book:

1. Scotofer, contemporary business communication, Biztant ra
2. Chaturvedi P D & Mukesh chaturvedi - Business communication:Concepts, cases & applications- 2/e, pearson education.
3. Essential of Business communication – Rajendra Pal and J.S Korlhall – Sultan Chand & Sons, New Delhi

Reference Books:

1. Business correspondence & report writing – R.C.Sharma, Krishna Mohan – Tata Megraww Hill Publishing Company Ltd, New Delhi.
2. Business Communication – K.K. Sinha – Galgotio Publishing Company, New Delhi.

COURSE OUTCOME AND PROGRAMME OUTCOME MAPPING (1/2/3):

Note: 1-Low, 2-Medium, 3-High

CO/PO	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	PSO.3
CO1	-	-	-	-	-		-	-	-	3	-	2	-	-	3
CO2	-	-	-	-	-	-	-	-	-	3	-	2	-	-	2
CO3	-	-	-	-	-	3	-	3	-	3	-	2	-	-	3
CO4	-	-	-	-	-	3	-	3	-	3	-	2	-	-	2
CO5	-	-	-	-	-	3	-	3	3	3	-	2	-	-	3

MICROCONTROLLER

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-VI

Subject Code	18EE61	CIE Marks	50
Number of Lecture Hours/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-04

Course Objectives: This course will enable the students to understand:

- The basics of 8051 Microcontroller.
- The execution of assembly programming of 8051 Microcontroller.
- The execution of 8051 C programming and also the usage of timers.
- The serial port and Interrupt programming in assembly and 8051 C.
- The interfacing of various devices with 8051 Microcontroller.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
8051 Microcontroller Basics: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051,Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing with External ROM And RAM.8051 Addressing Modes.	**10 Hours**	**L1**
Module -2		
Assembly Programming and Instruction of 8051: Introduction to 8051p assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming.	**10 Hours**	**L1,L2**
Module -3		
8051 Programming in C: Data types and time delay in 8051C, IO programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C, Accessing code ROM space in 8051C, Data serialization using 8051C. **8051 Timer Programming in Assembly and C:** Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C.	**10 Hours**	**L1,L2,L3**
Module -4		
8051 Serial Port Programming in Assembly and C: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051 C. **8051 Interrupt Programming in Assembly and C:** 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C.	**10 Hours**	**L1, L2,L3**
Module-5		
Interfacing: LCD interfacing, Keyboard interfacing. **ADC, DAC and Sensor Interfacing:** ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning. **Motor Control: Relay, PWM, DC and Stepper Motor:** Relays and optisolators, stepper motor interfacing, DC motor interfacing and	**10 Hours**	**L1,L2,L3**

PWM.		

8051 Interfacing with 8255: Programming the 8255, 8255 interfacing, C programming for 8255.		

Course Outcomes: At the end of the course the student will be able to:
CO1:Understand and explain the architecture, instruction set, and basic operation of the 8051 Microcontroller.

CO2: Write, execute, and debug assembly language programs for the 8051 Microcontroller to perform specific tasks.

CO3: Develop and implement programs for timers and counters using both assembly language and C programming for the 8051 Microcontroller.

CO4: Design and implement programs to handle serial communication and interrupts using assembly language and C programming for the 8051 Microcontroller.

CO5: Interface peripheral devices (e.g., LEDs, LCDs, motors, sensors) with the 8051 Microcontroller to develop embedded system applications.

Text Book:
1. The 8051 Microcontroller and Embedded Systems Using Assembly and C, Muhammad Ali Mazadi Pearson 2 nd Edition, 2008.

Reference Book:
1. The 8051 Microcontroller, Kenneth Ayala Cengage Learning 3 rd Edition,2005.
2. The 8051 Microcontroller and Embedded Systems, Manish K Patel McGraw Hill2014.
3. Microcontrollers: Architecture, Programming, Interfacing and System Design, Raj Kamal Pearson 1 st Edition, 2012.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Microcontroller
Course Code:18EE61

S.NO	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	**CO1**	3	2	1		3	2						2	3		
2	**CO2**	3	3	3	1	3	2						2	3		
3	**CO3**	3	3	3	1	3	2						2	3		
4	**CO4**	3	3	3	1	3	2						2	3		
5	**CO5**	3	3	3	3	3	2						2	3		
	AVERAGE	3	2.8	2.6	1.5	3	2						2	3		

POWER ELECTRONICS

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-VI

Subject Code	18EE62	CIE Marks	50
Number of Lecture Hours/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-04

Course Objectives: This course will enable the students to:

- Understand different types of power semiconductor devices and their switching characteristics.
- Understand the characteristics of MOSFET, IGBT and BJT.
- Understand the basics of Thyristor.
- Understand the analysis of controlled rectifiers and AC voltage controllers.
- Understand basics of DC-DC and DC-AC converters.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Introduction: Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches. **Power Diodes:** Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Freewheeling diodes ,Freewheeling diodes with RL load. **Diode Rectifiers:** Introduction, Diode Circuits with DC Source connected to R and RL load, Single-Phase Full-Wave Rectifiers with R load ,Single-Phase Full-Wave Rectifier with RL Load .	**10 Hours**	**L1**
Module -2		
Power Transistors: Introduction, Power MOSFETs – Steady State Characteristics, Switching Characteristics Bipolar Junction Transistors – Steady State Characteristics, Switching Characteristics, Switching Limits, IGBTs, MOSFET Gate Drive, BJT Base Drive, Isolation of Gate and Base Drives, Pulse transformers and Opto-couplers.	**10 Hours**	**L1,L2**
Module -3		
Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dt Protection, dv/dt Protection, DIACs, Thyristor Firing Circuits, Unijunction Transistor	**10 Hours**	**L1,L2,L3**
Module -4		
Controlled Rectifiers: Introduction, Single phase half wave circuit with RL Load, Single phase half wave circuit with RL Load and Freewheeling Diode, Single phase half wave circuit with RLE Load, Single-Phase Full Converters with RLE Load, Single-Phase Dual Converters, Principle of operation of Three- Phase duel Converters. **AC Voltage Controllers:** Introduction, Principle of phase control & Integral cycle control, Single-Phase Full-Wave Controllers with Resistive Loads, Single- Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers.	**10 Hours**	**L1, L2,L3**
Module-5		

DC-DC Converters: Introduction, principle of step down and step up chopper with RL load, performance parameters, DC-DC converter classification. **DC-AC Converters:** Introduction, principle of operation single phase bridge inverters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters.	**10 Hours**	**L1,L2,L3**

Course Outcomes: At the end of the course the student will be able to:

CO1: Analyze and explain the types of power semiconductor devices along with their construction, operation, and switching characteristics.

CO2: Evaluate and compare the performance and switching characteristics of MOSFETs, IGBTs, and BJTs in power electronic applications.

CO3: Explain and analyze the basic concepts of thyristors its characteristics and applications.

CO4: Analyze and design-controlled rectifiers and AC voltage controllers for various power control applications.

CO5: Analyze DC-DC converters and DC-AC inverters for efficient power conversion.

Text Book:

1. Power Electronics: Circuits Devices and Applications, Mohammad H Rashid, Pearson 4th Edition, 2014

Reference Book:

1. Power Electronics, P.S. Bimbhra ,Khanna Publishers, 5th Edition,2012.
2. Power Electronics: Converters, Applications and Design, Ned Mohan et al, Wiley,3rd Edition,2014.
3. Power Electronics,Daniel W Hart, McGraw Hill, 1 st Edition,2011.
4. Elements of Power Electronics, Philip T Krein, Oxford Indian Edition,2008.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Power Electronics
Course Code:18EE62

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2										1	3		
2	CO2	3	3	1									1	3		
3	CO3	3	3	1									1	3		
4	CO4	3	3	2	2								1	3		
5	CO5	3	3	2	2								1	3		
	AVERAGE	3	2.8	1.5	2								1	3		

DIGITAL SIGNAL PROCESSING
(Professional Elective)
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-VI

Subject Code	18EE631	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: course will enable the students to:

- Understand the fundamentals of Discrete Fourier transform.
- Understand the algorithms of fast Fourier transform.
- Design analog Butterworth & Chebyshev IIR filters and also digital Butterworth filter.
- Design digital Chebyshev IIR filters.
- Design and Realize FIR Digital filters.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Discrete Fourier Transforms: Definitions, properties-linearity, shift, symmetry Properties- circular convolution – periodic convolution, use of tabular arrays, circular arrays, Stock ham's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlapadd and save methods.	**08 Hours**	**L1**
Module -2		
Fast Fourier Transforms Algorithms: Introduction, decimation in time algorithm, first decomposition, number of computations, continuation of decomposition, number of multiplications, computational efficiency, decimation in frequency algorithms, Inverse radix – 2 algorithms.	**08 Hours**	**L1,L2**
Module -3		
Design of IIR Digital Filters: Introduction, impulse invariant transformation, bilinear transformations, All pole analog filters-Butterworth & Chebyshev filters, design of digital Butterworth filter by impulse invariant transformation and bilinear transformation, Frequency transformations.	**08 Hours**	**L1,L2,L3**
Module -4		
Design of IIR Digital Filters (Continued): Design of digital Chebyshev – type 1filter by impulse invariant transformation and bilinear transformation, Frequency transformations. Realization of IIR digital systems: direct form, cascade form and parallel form, Ladder structures for equal degree polynomial.	**08 Hours**	**L1, L2,L3**
Module-5		
Design of FIR Digital Filters: Introduction, windowing, rectangular, modified rectangular. Hamming, Hanning, Blackman window, design of FIR digital filters by use of windows, Design of FIR digital filters- frequency sampling techniques. **Realization of FIR systems**: direct form, cascade form, linear phase form	**08 Hours**	**L1,L2,L3**

Course Outcomes: At the end of the course the student will be able to:

CO1: Understand and explain the fundamentals of the Discrete Fourier Transform (DFT) and its applications in signal analysis.

CO2: Analyze and implement Fast Fourier Transform (FFT) algorithms for efficient computation of the DFT.

CO3: Design and analyze analog Butterworth and Chebyshev IIR filters, and convert them into digital Butterworth filters for signal processing applications.

CO4: Design and implement digital Chebyshev IIR filters to meet specific frequency response requirements.

CO5: Design and realize FIR digital filters using windowing techniques and other advanced methods.

Text Book:

1. Introduction to Digital Signal Processing, Jhonny R. Jhonson, Pearson ,1 st Edition, 2016.

Reference Book:

1. Digital Signal Processing – Principles, Algorithms, and Applications, Jhon G. Proakis Dimitris G. Manolakis, Pearson ,4 th Edition,2007.
2. Applications Jhon G. Proakis Dimitris G. Manolakis ,Pearson, 4 th Edition,2007.
3. Digital Signal Processing ,A.NagoorKani ,McGraw Hill ,2 nd Edition,2012.
4. Digital Signal Processing, Shaila D. Apte, Wiley ,2 nd Edition,2009.
5. Digital Signal Processing ,AshokAmberdar, Cengage, 1 stEdition,2007.
6. Digital Signal Processing ,Tarun Kumar Rawat, Oxford 1 st Edition,2015.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Digital Signal Processing
Course Code:18EE631

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	2	2	1	1						2	3		
2	CO2	3	3	2	2	1	1						2	3		
3	CO3	3	3	3	2	1	1						2	3		
4	CO4	3	3	3	2	1	1						2	3		
5	CO5	3	3	3	2	1	1						2	3		
	AVERAGE	3	3	2.6	2	1	1						2	3		

ELECTROMAGNETIC FIELD THEORY (Open Elective)

[As per Choice Based Credit System (CBCS)Scheme]

SEMESTER-VI

Subject Code	18EE642	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable the students to:

- Study the vector analysis and the basics of electrostatics.
- Study the concept of energy and potential and also about conductors and dielectrics.
- Analyze Poisson's and Laplace equations and also steady magnetic fields.
- Analyze magnetic forces and magnetic materials.
- Analyze the time varying fields and uniform plane waves.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Vector Analysis: Scalars and Vectors, Vector algebra, Cartesian co-ordinate system, Vector Components and unit vectors. Scalar field and Vector field. Dot product and Cross product, Gradient of a scalar field. Divergence and Curl of a vector field. Co – ordinate systems: cylindrical and spherical, relation between different coordinate systems. Expression for gradient, divergence and curl in rectangular, cylindrical and spherical co-ordinate systems, Numericals. **Electrostatics:** Coulomb's law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions. Electric flux density, Gauss law and its applications. Maxwell's first equation (Electrostatics). Divergence theorem. Numerical.	**08 Hours**	**L1**
Module -2		
Energy and Potential: Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential. The potential field of a point charge and of a system of charges. Potential gradient. The dipole. Energy density in the electrostatic field. Numerical. **Conductor and Dielectrics:** Current and current density. Continuity of current. Metallic conductors, conductor's properties and boundary conditions. Perfect dielectric materials, capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates. Numerical.	**08 Hours**	**L1,L2**
Module -3		
Poisson's and Laplace Equations: Derivations and problems, Uniqueness theorem. **Steady magnetic fields:** Biot - Savart's law, Ampere's circuital law. The Curl. Stokes theorem. Magnetic flux and flux density. Scalar and vector magnetic potentials. Numerical.	**08 Hours**	**L1,L2,L3**
Module -4		
Magnetic forces: Force on a moving charge and differential current element. Force between differential current elements. Force and torque on	**08 Hours**	**L1, L2,L3**

a closed circuit. Numerical. **Magnetic Materials and Magnetism:** Nature of magnetic materials, magnetization and permeability. Magnetic boundary conditions. Magnetic circuit, inductance and mutual inductance. Numerical.		
Module-5		
Time Varying Fields and Maxwell's Equations: Faraday's laws, Displacement current. Maxwell's equations in point form and integral form.Numericals. **Uniform plane wave:** Wave propagation in free space and in dielectrics.Poynting theorem. Propagation in good conductors, skin effect. Numericals.	**08 Hours**	**L1,L2,L3**

Course Outcomes: At the end of the course the student will be able to:

CO1: Analyze vector analysis concepts, including scalars, vectors, coordinate systems, and vector operations, and apply them to electrostatics by evaluating electric field intensity, flux density, Gauss's law, Maxwell's first equation, and the divergence theorem

CO2: Evaluate energy and potential in an electric field, including potential difference, potential gradients, dipoles, and energy density, and analyze conductors and dielectrics by examining current density, boundary conditions, and capacitance calculations for dielectric materials and parallel plate capacitors.

CO3: Analyze Poisson's and Laplace equations for electrostatic potential, and apply the concepts to steady-state magnetic fields.

CO4: Examine and analyze the forces on charged particles in magnetic fields, and investigate the properties of magnetic materials.

CO5: Analyze time-varying fields and the propagation of uniform plane waves in free space and various media.

Text Book:

1. Engineering Electromagnetic, William H Hayt et al, McGraw Hill ,8 thEdition,2014.
2. Principles of Electromagnetics, Matthew N. O. Sadiku, Oxford, 6 th Edition,2015.

Reference Book:

1. Fundamentals of Engineering Electromagnetics, David K. Cheng, Pearson,2014.
2. Electromagnetism -Theory (Volume -1) -Applications (Volume-2), AshutoshPramanik, PHI Learning, 2014.
3. Electromagnetic Field Theory Fundamentals, Bhag Guru et al, Cambridge,2005.
4. Electromagnetic Field Theory,RohitKhurana, Vikas Publishing, 1 stEdition,2014.
5. Electromagnetics, J. A. Edminister, McGraw Hill, 3 rd Edition,2010.
6. Electromagnetic Field Theory and Transmission Lines, GottapuSasibhushanaRao ,Wiley, 1st Edition,2013.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Electromagnetic Field Theory
Course Code:18EE642

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	2								1	3		
2	CO2	3	3	3	2								1	3		
3	CO3	3	3	3	2								1	3		
4	CO4	3	3	3	2								1	3		
5	CO5	3	3	3	2								1	3		
	AVERAGE	3	3	3	2								1	3		

PLC AND SCADA (open elective)
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-VI

Subject Code	18EE643	CIE Marks	50
Number of Lecture Hours/Week	03	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-4

Course Objectives: This course will enable students to:

- Understand Architecture of PLC and its programming.
- Develop Fundamental PLC Wiring Diagrams, Ladder Logic Programs and programming of Timers.
- Program counter and control instructions.
- Understand fundamentals of SCADA and its architecture.
- Understand Human Machine Interface (HMI) and SCADA Applications.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, Modifying the operation, PLCs versus Computers, PLC size and Application. PLC Hardware Components , The I/O Section, Discrete I/O Modules ,Analog I/O Modules , Special I/O Modules I/O Specifications, Typical Discrete I/O Module Specifications, Typical Analog I/O Module Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs) .	**10 Hours**	**L1, L2, L3**
Module -2		
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs, Electromagnetic Control Relays , Contactors, Motor Starters, Manually Operated Switches , Mechanically Operated Switches, Sensors, Output Control Devices , Seal-In Circuits , Latching Relays, Converting Relay Schematics into PLC, Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. Programming Timers Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers.	**10 Hours**	**L1,L2, L3**

Module -3		
Programming Counters, Counter Instructions, Up-Counter, One-Shot Instruction, Down-Counter, Cascading Counters , Incremental Encoder-Counter, Applications ,Combining Counter and Timer Functions.	**08 Hours**	**L1,L2,L3**
Module -4		
SCADA fundamentals: Introduction, Open system: Need and advantages, Building blocks of SCADA systems. **Remote terminal unit (RTU):**Evolution of RTUs, Components of RTU, Communication subsystem, Communication protocols, Message security, Multi-port Communication, Logic subsystem, Time keeping, Data acquisition and processing, Digital data acquisition, Analog data acquisition, Analog outputs, Digital (contact) output, Pulse inputs, Pulse outputs, Termination subsystem, Digital terminations, Analog terminations, Testing and human-machine interface (HMI) subsystem Power supplies, Advanced RTU functionalities, Multi-port and multi-protocol Operation, Digital interface to other electronic devices, Closed-loop control, computation, and optimization at the RTU level, Interface to application functions, Advanced data processing, Other functions, **Intelligent electronic devices (IEDs):**Evolution of IEDs, IED functional block diagram. Data concentrators and merging units, RTUs, IEDs, and data concentrator, Merging units and IEDs, SCADA communication systems, **Master station**: Master station software components, Basic SCADA software, Advanced SCADA application functions, Master station hardware components, Server systems in the master station, SCADA server, Application server, ISR or HIM server, Development server, Network management server, Video projection system, CFE (communication front end) and FEP (front-end processor, ICCP server, Dispatcher training simulator (DTS) server, Small, medium, and large master stations, Global positioning systems (GPS), Master station performance.	10 Hours	L1, L2,L3
Module-5		
Human-machine interface (HMI) HMI components, Operator console, Operator dialogue, Mimic diagram, Peripheral devices, HM*I software functionalities, Situational awareness, Intelligent alarm filtering: Need and technique, Alarm suppression techniques, Area of responsibility (AOR) alarm filtering, Alarm point priority filtering, Timed alarm suppression, Knowledge-based alarm suppression, Operator needs and requirements. SCADA Systems: Building the SCADA systems, legacy hybrid and new systems, SCADA implementation: A laboratory, system hardware, System software, SCADA lab	10 Hours	L1,L2,L3

field design.		

Course Outcomes: After studying this course, students will be able to:

CO1: Understand Architecture of PLC and its programming.

CO2: Develop Fundamental PLC Wiring Diagrams, Ladder Logic Programs and programming of Timers.

CO3: Program counter and control instructions.

CO4: Understand fundamentals of SCADA and its architecture.

CO5: Understand Human Machine Interface (HMI) and SCADA Applications.

Text Book:

1, Petruzella, Frank D. 'Programmable logic controllers'4th ed., ISBN-13: 978-0-07-351088, McGraw-Hill.

2. M i n i S . T h o m a s, and J o h n D . M c D o n a l d, 'Power sytems and SMART Grids. CRC PressTaylor & Francis Group.**

3. Stuart A. Boyer: "SCADA- Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, The Instrumentation system and Automation Society, 4th Edition, 2010.

Reference Book:

1. Gordon Clarke, Deon Reynders" Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes An imprint of Elsevier Publications, 1st Edition, 2004
2. Batten G. L., "Programmable Controllers", McGraw Hill Inc., Second Edition
3. Gordon Clark, Deem Reynders, "Practical Modern SCADA Protocols", ELSEVIER.
4. P. K. Srivstava, "Programmable Logic Controllers with Applications", BPB Publications
5. Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 2nd Edition.
6. John R. Hackworth, Frederick D., Hackworth Jr., "Programmable Logic Controllers Programming Methods and Applications", PHI Publishers.
7. John W. Webb, Ronald A. Reis, "Programmable Logic Controllers: Principles and Application", PHI Learning, New Delhi, 5th Edition.
8. L.A. Bryan, E. A. Bryan, "Programmable Controllers Theory and Implementation" Industrial Text Company Publication, Second Edition.

CO-PO -PSO Mapping:

CO/PO	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	PSO 3
CO 1	3		-	-	-	-	-	-	1			2	1	2	-
CO 2	3		1	3	2	-	-	-	1	1	-	2	3	3	-
CO 3	3		1	3	2	-	-	-	1	1	-	2	3	3	-
CO 4	3		2	3	2	-	-	-	1	1	-	2	3	3	-
CO 5									1						-

MICROCONTROLLER LABORATORY

[As per Choice Based Credit System (CBCS) Scheme]

Semester VI

Subject code	18EEL65	CIE Marks	50
Number of practical hours/week	02	SEE Marks	50
Total number practical hours	24	Exam Hours	03

CREDITS: 01

Course Objectives: This course will enable students to:

- Write assembly language programs for data transfer, arithmetic and logical operations.
- Write and execute assembly language programs for code conversions.
- Write and execute assembly language programs using subroutines.
- Perform interfacing of stepper motor and DC motor to control the speed.
- Generation of different waveforms using DAC interface.

SL. NO	Experiments
	Note: For the experiments 1 to 6, 8051 assembly programming is to be used
1.	Data transfer – Program for block data movement, sorting, exchanging, finding largest element in an array
2.	Arithmetic instructions: Addition, subtraction, multiplication and division. Square and cube operations.
3.	Counters.
4.	Boolean and logical instructions (bit manipulation).
5.	Conditional call and return instructions.
6.	Code conversion programs – BCD to ASCII, ASCII to BCD, ASCII to decimal, Decimal to ASCII, Hexadecimal.
7.	Programs to generate delay, programs using serial port and on-chip timer/counters
	Note: Single chip solution for interfacing 8051 is to be with C Programs for the following experiments.
8.	Stepper motor interface.
9.	DC motor interface for direction and speed control using PWM.
10.	Alphanumerical LCD panel interface.
11.	Generate different waveforms: Sine, Square, Triangular, Ramp using DAC interface.
12.	External ADC and Temperature control interface.
13.	Elevator interface.

Course outcomes: At the end of the course the student will be able to:

CO1: Write and execute assembly language programs for data transfer, arithmetic and logical operations.

CO2: Write and execute assembly language programs for code conversions.

CO3: Write and execute assembly language programs using subroutines.

CO4: Perform interfacing of stepper motor and DC motor to control the speed.

CO5: Generate different waveforms using DAC interface.

Graduate Attributes (As per NBA)

Engineering knowledge, Problem Analysis, Individual Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Course Articulation Matrix for the Academic Year 2018-19
Course Name: Microcontroller Lab
Course Code:18EEL65

SI. No.	**PO / CO**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	CO1	3	2	1		3	2			3	3		2		3	
2	CO2	3	2	1		3	2			3	3		2		3	
3	CO3	3	2	1		3	2			3	3		2		3	
4	CO4	3	2	1	2	3	2			3	3		2		3	
5	CO5	3	2	1	2	3	2			3	3		2		3	
	AVERAGE	3	2	1	2	3	2			3	3		2		3	

POWER ELECTRONICS LABORATORY

[As per Choice Based Credit System (CBCS) Scheme]

Semester VI

Subject code	18EEL66	CIE Marks	50
Number of practical hours/week	02	SEE Marks	50
Total number practical hours	24	Exam Hours	03

CREDITS: 01

Course Objectives: This course will enable students to:

- Conduct experiments on semiconductor devices to obtain their static characteristics.
- Conduct experiments for the triggering of SCR.
- Perform experiments on single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
- Control the speed of a DC, Universal and Stepper motors.
- Perform experiment on single phase full bridge inverter connected to resistive load.

SL. NO	Experiments
1	Static Characteristics of SCR.
2	Static Characteristics of MOSFET and IGBT.
3	Characteristic of TRIAC.
4	SCR turn on circuit using synchronized UJT relaxation oscillator.
5	SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.
6	Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without free wheeling diode.
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.
8	Speed control of DC motor using single semi converter.
9	Speed control of stepper motor.
10	Speed control of universal motor using ac voltage regulator.
11	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.
12	Single phase MOSFET/IGBT based PWM inverter.

Course outcomes:

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

CO1: Conduct experiments on semiconductor devices to obtain their static characteristics.
CO2: Conduct experiments for the triggering of SCR.
CO3: Perform experiments on single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
CO4: Control the speed of a DC, Universal and Stepper motors.
CO5: Perform experiment on single phase full bridge inverter connected to resistive load.

Graduate Attributes (As per NBA)

Engineering knowledge, Problem Analysis, Individual Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2				1			3	3		1		3	
2	CO2	3	2	2	2	1	1			3	3		1		3	
3	CO3	3	3	3	2	1	1			3	3		1		3	
4	CO4	3	3	3	2	1	1			3	3		1		3	
5	CO5	3	3	3	2	1	1			3	3		1		3	
	AVERAGE	3	2.6	2.6	2	1	1			3	3		1		3	

DIGITAL SIGNAL PROCESSING LABORATORY

[As per Choice Based Credit System (CBCS) Scheme]

Semester VI

Subject code	18EEL67	CIE Marks	50
Number of practical hours/week	02	SEE Marks	50
Total number practical hours	24	Exam Hours	03

CREDITS: 01

Course Objectives: This course will enable students to:

- Simulate DFT and IDFT of a given sequence.
- Verify the convolution property of the DFT
- Design and implement IIR filters.
- Design and implement FIR filters using window function.
- Design and implement FIR filters using frequency sampling technique.

SL. NO	**Experiments**
1	Verification of Sampling Theorem both in time and frequency domains.
2	Evaluation of impulse response of a system.
3	To perform linear convolution of given sequences.
4	To perform circular convolution of given sequences using (a) the convolution summation formula (b).
5	Computation of N-point DFT and plot the magnitude and phase spectrum.
6	Linear and circular convolution by DFT and IDFT method.
7	Solution of a given difference equation.
8	Calculation of DFT and IDFT by FFT.
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters).
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions.
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.
12	Realization of IIR and FIR filters.

Course outcomes:

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

CO1: Simulate DFT and IDFT of a given sequence.

CO2: Verify the convolution property of the DFT

CO3: Design and implement IIR filters.

CO4: Design and implement FIR filters using window function.

CO5: Design and implement FIR filters using frequency sampling technique.

Graduate Attributes (As per NBA)

Engineering knowledge, Problem Analysis, Individual or Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	2	3	1			3	3		1		3	
2	CO2	3	3	3	2	3	1			3	3		1		3	
3	CO3	3	3	3	2	3	1			2	3		1		3	
4	CO4	3	3	3	2	3	1			2	3		1		3	
5	CO5	3	3	3	2	3	1			2	3		1		3	
	AVERAGE	3	3	3	2	3	1			2.5	3		1		3	

PROJECT - VI
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER - VI

Subject Code	18PRJ68	**CIE Marks**	50
No. of Practical Hours/Week	2	**SEE Marks**	50
		Exam Hours	3

CREDITS - 01

Course Objectives:
This Course will enable the students to:

- Independent Learning.
- Selection and Utilization of adequate information.
- Organization and presentation of information.
- Learn to work with team members.
- Expand one's intellectual capability and decision making
- Meeting the deadlines

Project - VI
Students in consultation with the guide take up an updated topic on the subjects taught in sixth semester and search and collect the relative literature and then study. Students in a team should come with an idea as a result of literature studies and build a prototype to demonstrate the implementation of the idea.

Course Outcome:
At end of the course, students will be able to:
CO1: Exhibit a thorough understanding of the selected project topic, showcasing sound technical expertise and domain-specific knowledge.
CO2: Identify, formulate, and analyze engineering problems systematically to derive precise and actionable problem statements.
CO3: Develop and design innovative engineering solutions to address identified problems effectively and efficiently.
CO4: Implement and execute the project successfully, adhering to engineering standards, timelines, and resource constraints.
CO5: Effectively communicate project outcomes and solutions through professional presentations and reports to academic peers, industry professionals, and the broader society.

Graduate Attributes:
Engineering knowledge, Problem Analysis, Individual and team work, Communication.

Examinations:

Continuous Internal Evaluation:
CIE marks for the project is 50 marks

1. Report 25 marks
2. Presentation 25 marks

Marks shall be awarded by a guide with one examiner (senior most faculty within the

department) selected by the head of the department based on his/her performance.

Semester End Examination:
SEE marks for the project is 50 marks

1. Report 15 marks
2. Presentation 15 marks
3. Viva-Voce 20 marks

Marks shall be awarded by two examiners (one internal and one external) constituted by the head of the department/dean.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3								3	3	3				
2	CO2	3	3							3	3	3				
3	CO3	3	3	3	3	3				3	3	3		3	3	
4	CO4	3	3		3	3				3	3	3	3	3	3	
5	CO5						3	2	1	3	3	3	3			3
	AVERAGE	3	3	3	3	3	3	2	1	3	3	3	3	3	3	3

PROFESSIONAL ETHICS

Course	Code	Credits	Total Hours – 10		Assessment		Exam Duration in hours
			Hours /Week				
			Lecture	Tutorial	SEE	CIE	

PROFESSIONAL ETHICS	18HSM69	01	01	00	50	50	03

OBJECTIVES:

- To enable the students to create an awareness on Engineering Ethics and Human Values,
- To instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT V GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003. 2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009

3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003 .
4. Edmund G Seebauer and Robert L Barry, “Fundametals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.
6. World Community Service Centre, " Value Education", Vethathiri publications, Erode, 2011.

POWER SYSTEM ANALYSIS – 2(Core Course) [As per Choice Based Credit System (CBCS) Scheme] SEMESTER-VII			
Subject Code	18EE71	CIE Marks	50
Number of Lecture Hours/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03
CREDITS-04			

Course Objectives: This course will enable the students to:

- Understand basics of Network Topology.
- Understand basics of load flow studies.
- Analyze different methods of load flow studies.
- Understand economic operation of power system.
- Understand Symmetrical fault analysis and also stability of power system.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Network Topology: Introduction and basic definitions of Elementary graph theory Tree, cut-set, loop analysis. Formation of Incidence Matrices. Primitive network- Impedance form and admittance form, Formation of Y Bus by Singular Transformation. Ybus by Inspection Method. Illustrative examples	**10 Hours**	**L1, L2,L3**
Module -2		
Load Flow Studies: Introduction, Classification of buses. Power flow equation, Operating Constraints, Data for Load flow, Gauss Seidal iterative method. Illustrative examples.	**10 Hours**	**L1,L2,L3**
Module -3		
Load Flow Studies(continued) Newton-Raphson method derivation in Polar form, Fast decoupled load flow method, Flow charts of LFS methods. Comparison of Load Flow Methods. Illustrative examples.	**10 Hours**	**L1,L2,L3**
Module -4		
Economic Operation of Power System: Introduction and Performance curves Economic generation scheduling neglecting losses and generator limits Economic generation scheduling including generator limits and neglecting losses Economic dispatch including transmission losses Derivation of transmission loss formula. Illustrative examples. **Unit Commitment**: Introduction, Constraints and unit commitment solution by prior list method and dynamic forward DP approach (Flow chart and Algorithm only).	**10 Hours**	**L1,L2,L3**
Module-5		
Symmetrical Fault Analysis: Z Bus Formulation by Step by step	**10 Hours**	**L1,L2,L3,L4**

building algorithm without mutual coupling between the elements by addition of link and addition of branch. Illustrative examples bus Algorithm for Short Circuit Studies excluding numerical.T1 **Power System Stability**: Numerical Solution of Swing Equation by Point by Point method and RungeKutta Method. Illustrative examples.		

Course Outcomes: At the end of the course the student will be able to: .

CO1: Develop a model power system network using graph theory.

CO2: Analyze bus voltage profiles and power flows by the formulation and solution of power flow equations to ensure system reliability and stability.

CO3: Analyze different methods of load flow studies for enhancing computational accuracy and speed.

CO4: Formulate and solve economic dispatch problems, by minimizing generation costs and enhancing decision-making capabilities in real-time operation to maximize system efficiency and economic benefits.

CO5: Analyze symmetrical faults on a power system ensures it to remain in synchronism under disturbances. Ensures system security, reliability, and resilience under normal and faulted conditions.

Text Book:

1. Modern Power System Analysis D. P. Kothari McGraw Hill 4 th Edition, 2011\
2. Computer Methods in Power Systems Analysis Glenn W. Stagg Ahmed H Ei - Abiad Scientific International Pvt. Ltd. 1 st Edition, 2019\
3. Power Generation Operation and Control Allen J Wood etal Wiley 2 nd Edition,2016

Reference Book

1. Computer Methods in Power Systems Analysis Glenn W Stagg Ahmed H Ei - Abiad McGraw Hill 1stEdition, 1968
2. Computer Techniques in Power System Analysis M.A. Pai McGraw Hill 2ndEdition, 2006
3. Power System Analysis HadiSaadat McGraw Hill 2ndEdition, 2002

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	**CO1**	3	3	3		3							1	3		
2	**CO2**	3	3	3		3							1	3		
3	**CO3**	3	3	3		3							1	3		
4	**CO4**	3	3	3		3							1	3		
5	**CO5**	3	3	3		3							1	3		
	AVERAGE	3	3	3		3							1	3		

HIGH VOLTAGE ENGINEERING (Professional Elective)
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-VII

Subject Code	18EE721	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable the students to:

- Understand conduction and breakdown in gases, liquid and solid dielectrics.
- Understand generation of high voltages and currents.
- Understand Measurement of high voltages and currents.
- Understand overvoltage phenomenon and insulation coordination.
- Understand non-destructive testing of materials.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Conduction and Breakdown in Gases: Gases as Insulating Media, Collision Process, Ionization Processes, Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown, Experimental Determination of Coefficients α and γ, Breakdown in Electronegative Gases, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges. **Conduction and Breakdown in Liquid Dielectrics**: Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids. **Breakdown in Solid Dielectrics:** Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.	**08 Hours**	**L1, L2,L3**
Module -2		
Generation of High Voltages and Currents: Generation of High Direct Current Voltages, Generation of High Alternating Voltages, Generation of Impulse Voltages, Generation of Impulse Currents, Tripping and Control of Impulse Generators.	**08 Hours**	**L1,L2,L3**
Module -3		
Measurement of High Voltages and Currents: Measurement of High Direct Current Voltages, Measurement of High AC and Impulse Voltages, Measurement of High Currents – Direct, Alternating and Impulse, Cathode Ray Oscillographs for Impulse Voltage and Current Measurements.	**08 Hours**	**L1,L2,L3**
Module -4		

Overvoltage Phenomenon and Insulation Coordination in Electric Power Systems: Natural Causes for Overvoltages - Lightning Phenomenon, Overvoltage due to Switching Surges, System Faults and Other Abnormal, Principles of Insulation Coordination on High Voltage and Extra High Voltage Power Systems.	**08 Hours**	**L1, L2,L3**
Module-5		
Non-Destructive Testing of Materials and Electrical Apparatus: Introduction, Measurement of Dielectric Constant and Loss Factor, Partial Discharge Measurements. **High Voltage Testing of Electrical Apparatus**: Testing of Insulators and Bushings, Testing of Isolators and Circuit Breakers, Testing of Cables, Testing of Transformers, Testing of Surge Arrestors, Radio Interference Measurements, Testing of HVDC Valves and Equipment.	**08 Hours**	**L1,L2,L3**

Course Outcomes: At the end of the course the student will be able to:

CO1: Analyze the physical mechanisms of conduction and breakdown in gaseous, liquid, and solid dielectrics under various electrical stresses and environmental conditions.

CO2: Demonstrate the principles and techniques for generating high voltages and high currents, including both AC, DC, and impulse waveforms, and their applications in high-voltage engineering.

CO3: Apply advanced measurement methodologies and instrumentation for accurate quantification of high voltages and currents, ensuring compliance with international standards and calibration protocols.

CO4: Evaluate overvoltage phenomena in electric power systems caused by switching operations, lightning, and insulation failures, and design effective insulation coordination strategies to enhance system reliability and protection.

CO5: Assess non-destructive testing techniques for material characterization and performance evaluation, and conduct high-voltage testing of electrical apparatus to ensure operational safety, durability, and compliance with industry standards.

Text Book:

1 High Voltage Engineering M.S. Naidu, V.Kamaraju McGraw Hill 5 th Edition, 2013.

1. High Voltage Engineering Fundamentals E. Kuffel, W.S. Zaengl, J. KuffelNewnes 2 nd Edition, 2000
2. High Voltage Engineering Wadhwa C.L. New Age International 3 rd Edition, 2012
3. High-Voltage Test and Measuring Techniques Wolfgang Hauschild , Eberhard Lemke Springer 1 st Edition2014
4. High Voltage Engineering Farouk A.M. Rizk CRC Press 1 st Edition2014

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2				2	1					1	3		
2	CO2	3	2				2	1					1	3		
3	CO3	3	2	1			2	1					1	3		
4	CO4	3	3	3	2		3	1					1	3		
5	CO5	3	3	3	2		3	1					1	3		
	AVERAGE	3	2.4	2.33	2		2.4	1					1	3		

SENSORS AND TRANSDUCERS(Professional Elective)
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER- VII

Subject Code	18EE722	CIE Marks	50
Number of Lecture Hours/Week	3L+1T	SEE Marks	50
Number of Lecture Hours	50	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable the students tounderstand:

- About sensors and transducers, their classification, advantages and disadvantages.
- The working of different types of transducers and sensors.
- Different amplifiers for signal conditioning and also Data Acquisition System.
- The basics of Data transmission and telemetry.
- Methods to measure various non-electrical quantities.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Sensors and Transducers: Introduction, Classification of Transducers**,** Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers.	**8Hours**	**L1,L2**
Module -2		
Sensors and Transducers (continued): Stain Gages, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems.	**8 Hours**	**L1,L2**
Module -3		

Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers. **Data Acquisition Systems and Conversion:** Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.	**8 Hours**	**L1,L2**
Module -4		
Data Transmission and Telemetry: Data/Signal Transmission, Telemetry. **Measurement of Non – Electrical Quantities:** Pressure Measurement	**8 Hours**	**L1, L2**
Module-5		
Measurement of Non – Electrical Quantities: Temperature Measurement, Flow Measurement- Introduction, Electromagnetic Flow Measurement, Ultrasonic Flow Meters, Thermal Meters, Wire Anemometer. Measurement of Displacement, Measurement of Velocity/Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level, Measurement of Viscosity.	**8 Hours**	**L1,L2**

Course Outcomes At the end of the course the student will be able to:

CO1: Classify various sensors and transducers based on their operating principles, functions, and characteristics, and critically evaluate their advantages and limitations in measurement systems.

CO2: Analyze the working principles and applications of different types of sensors and transducers, emphasizing their role in accurate and reliable data acquisition.

CO3: Demonstrate the operation of signal conditioning circuits, including various amplifiers, and design efficient Data Acquisition Systems (DAS) for diverse measurement and control applications.

CO4: Explain the fundamental concepts of data transmission techniques and telemetry systems, focusing on their importance in remote monitoring and control systems.

CO5: Illustrate advanced techniques for measuring non-electrical quantities such as temperature, pressure, displacement, and flow, emphasizing precision and real-world applications.

Text Book:

1. Electrical and Electronic Measurements and instrumentation R.K Rajput S. Chand 3rd Edition, 2013.

Reference Books

1.A Course in Electronics and Electrical Measurements and Instruments J.B. Gupta Katson Books 13th Edition, 2008

2.A Course in Electrical and Electronic Measurements and Instrumentation A. K. SawhenyDhanpatRai 2015

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3					2	1	1				1	1	3	
2	CO2	3					2	1	1				1	1	3	
3	CO3	3					2	1	1				1	1	3	
4	CO4	3					2	1	1				1	1	3	
5	CO5	3					2	1	1				1	1	3	
	AVERAGE	3					2	1	1				1	1	3	

SMART GRID (Professional Elective)
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-VII

Subject Code	18EE723	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable the students to Understand:

- The design, communications and measurement Technology.
- Stability analysis tools for smart grid.
- Computational tools for the analysis of smart grid and design, operation and performance.
- Renewable energy and storage and interoperability ,standards and cybersecurity of smart Grid.
- Research, Education and Trainingfor smart Grids.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Smart Grid Architectural Designs: Introduction, Today's Grid versus the Smart Grid, Energy Independence and Security Act of 2007: Rationale for the Smart Grid, Computational Intelligence, Power System Enhancement, Communication and Standards, Environment and Economics, General View of the Smart Grid Market Drivers, Stakeholder Roles and Function, Working Definition of the Smart Grid Based on Performance Measures, Representative Architecture, Functions of Smart Grid Components. **Smart Grid Communications and Measurement Technology:** Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Micro grid and Smart Grid Comparison. **Performance Analysis Tools for Smart Grid Design:** Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, DSOPF Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingencies and Their Classification, Contingency Studies for the Smart Grid.	**08 Hours**	**L1,L2,L3**
Module -2		

Stability Analysis Tools for Smart Grid: Introduction to Stability, Strengths and Weaknesses of Existing Voltage Stability Analysis Tools, Voltage Stability Assessment, Voltage Stability Assessment Techniques, Voltage Stability Indexing, Analysis Techniques for Steady-State Voltage Stability Studies, Application and Implementation Plan of Voltage Stability, Optimizing Stability Constraint through Preventive Control of Voltage Stability, Angle Stability Assessment, State Estimation.	**08 Hours**	**L1,L2,L3,L4**
Module -3		
Computational Tools for Smart Grid Design: Introduction to Computational Tools, Decision Support Tools, Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Pareto Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges. **Pathway for Designing Smart Grid:** Introduction to Smart Grid Pathway Design, Barriers and Solutions to Smart Grid Development, Solution Pathways for Designing Smart Grid Using Advanced Optimization and Control Techniques for Selection Functions, General Level Automation, Bulk Power Systems Automation of the Smart Grid at Transmission Level, Distribution System Automation Requirement of the Power Grid, End User/Appliance Level of the Smart Grid, Applications for Adaptive Control and Optimization.	**08 Hours**	**L1,L2,L3,L4**
Module -4		
Renewable Energy and Storage: Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Penetration and Variability Issues Associated with Sustainable Energy Technology, Demand Response Issues, Electric Vehicles and Plug-in Hybrids, PHEV Technology, Environmental Implications, Storage Technologies, Tax Credits. **Interoperability, Standards, and Cyber Security:** Introduction, Interoperability, Standards, Smart Grid Cyber Security, Cyber Security and Possible Operation for Improving Methodology for Other Users.	**08 Hours**	**L1, L2**
Module-5		
Research, Education, and Training for the Smart Grid: Introduction, Research Areas for Smart Grid Development, Research Activities in the Smart Grid, Multidisciplinary Research Activities, Smart Grid Education, Training and Professional Development. **Case Studies and Test beds for the Smart Grid:** Introduction, Demonstration Projects, Advanced Metering, Microgrid with	**08 Hours**	**L1,L2**

Renewable Energy, Power System Unit Commitment (UC) Problem,ADP for Optimal Network Reconfiguration in Distribution Automation, Case Study of RER Integration,Testbeds and Benchmark Systems, Challenges of Smart Transmission,Benefits of Smart Transmission.		

Course Outcomes: At the end of the course the student will be able to:

CO1: Develop and evaluate smart grid designs, focusing on advanced communication systems and precise measurement technologies.

CO2: Apply and explain tools and techniques for stability analysis in smart grid systems, ensuring reliable and secure operation.

CO3: Utilize computational tools to analyze, design, operate, and evaluate the performance of smart grid systems.

CO4: Explain the integration of renewable energy sources, energy storage systems, interoperability standards, and cybersecurity measures in smart grid infrastructure.

CO5: Emphasize the importance of research, education, and training initiatives to advance smart grid technologies and practices.

Text Book:

1. "Smart grid, Fundamentals of Design and Analysis" by James Momoh, Wiley. 1st Edition, 2012.

POWER SYSTEM PLANNING (Professional Elective)
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-VII

Subject Code	18EE724	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable the students to:

- Understand the primary components of power system planning and also forecasting of Electricity.
- Understand Financial Planning and Analysis of power system and also Renovation and Modernization of Power Plants.
- Understand Transmission Planning and Energy Storage.
- Understand principles of planning in distribution and also reliability criteria for generation, transmission, distribution systems.
- Understand Demand side planning and principles of electricity market.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Power System: Power Systems, Planning Principles, Planning Process, Project Planning, Power Development, Power Growth, National and Regional Planning, Enterprise Resources Planning, Structure of a Power System, Power Resources, Planning Tools, Power Planning Organization, Regulation, Scenario Planning. **Electricity Forecasting**: Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modeling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.	**08 Hours**	**L1, L2**
Module -2		
Power-System Economics: Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Economic Characteristics – Generation Units, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment. **Generation Expansion:** Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies, Distributed Power Generation, Renovation and Modernization of Power Plants.	**08 Hours**	**L1,L2,L3**
Module -3		
Transmission Planning: Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy	**08 Hours**	**L1,L2,L3**

Storage.		
Module -4		
Distribution: Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity, Up gradation of Network Development, System Studies, Urban Distribution, Rural Electrification. **Reliability and Quality:** Reliability Models, System Reliability, Reliability and Quality Planning, Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid .	**08 Hours**	**L1, L2**
Module-5		
Demand-Side Planning: Demand Response, Demand – Response Programmes, Demand– Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit. **Electricity Market**: Market Principles, Power Pool, Independent System Operator, Distribution System Operator, Power Balancing, Market Participants, Power Markets, Market Rules, Bidding, Trading, Settlement System, Merchant Power, Differential Electricity, Congestion Management, Ancillary Services, Hedging, Smart Power Market.	**08 Hours**	**L1,L2**
Course Outcomes: At the end of the course the student will be able to: **CO1**: Explain about the primary components of power system planning and also forecasting of Electricity. **CO2**: Explain Financial Planning and Analysis of power system and also Renovation and Modernization of Power Plants. **CO3**: Explain Transmission Planning and Energy Storage. **CO4**: Explain principles of planning in distribution and also reliability criteria for generation, transmission, distribution systems. **CO5**: Explain Demand side planning and principles of electricity market.		
Text Book: 1 Electric Power Planning A. S. Pabla McGraw Hill, 2 nd Edition, 2016		

SI. No.	**PO / CO**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	CO1	3	3	3	1	1	1	1					1	3		
2	CO2	3	3	3	1	1	1	1					1	3		
3	CO3	3	3	3	1	1	1	1					1	3		
4	CO4	3	3	3	1	1	1	1					1	3		
5	CO5	3	3	3	1	1	1	1					1	3		
	AVERAGE	3	3	3	1	1	1	1					1	3		

ADVANCED CONTROL SYSTEMS(Professional Elective)
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-VII

Subject Code	18EE731	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable the students to:

- Understand state variable approach for linear time invariant systems.
- Understand controllability and observability in state variable analysis
- Design pole placement techniques for the stability improvement of the system.
- Analyze nonlinear systems.
- Analyze nonlinear systems using Lyapunov Stability Theorem.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
State Variable Analysis and Design: Introduction, Concept of State, State Variables and State Model, State Modelsfor Linear Continuous – Time Systems, State Variables and Linear Discrete – Time Systems.	**08 Hours**	**L1,L2,L3**
Module -2		
State Variable Analysis and Design (continued): Diagonalization, Solution of State Equations, Concepts of Controllability and Observability.	**08 Hours**	**L1,L2 ,L3**
Module -3		
Pole Placement Design and State Observers: Introduction, Stability Improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement, State Regulator Design, Design of State Observer, Compensator Design by the Separation Principle.	**08Hours**	**L1,L2,L3**
Module -4		
Non-linear systems Analysis: Introduction, Common Nonlinear System Behaviors, Common Nonlinearities in Control Systems, Fundamentals, Describing Functions of Common Nonlinearities, Stability Analysis by Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane.	**08Hours**	**L1, L2,L3**

Module-5		
Non-linear systems Analysis (continued): Impulse Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorem, Lyapunov Function for Nonlinear Systems.	**08 Hours**	**L1,L2,L3**

Course Outcomes: At the end of the course the student will be able to:

- Explain state variable approach for linear time invariant systems.
- Explain controllability and observability in state variable analysis
- Design pole placement techniques for the stability improvement of the system.
- Analyze nonlinear systems.
- Analyze nonlinear systems using Lyapunov Stability Theorem.

Text Book:

1. Control Systems Engineering (For the Modules 1 and 2) I.J. Nagarath and M.Gopal New Age 5th Edition, 2007 .
2. Digital Control and State Variable Methods: Conventional and Intelligent Control Systems (For the Modules 3,4 and 5) M.Gopal McGraw Hill 3rdEdition, 2008.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	1	1							1	1		
2	CO2	3	3	3	1	1							1	1		
3	CO3	3	3	3	1	1							1	1		
4	CO4	3	3	3	1	1							1	3		
5	CO5	3	3	3	1	1							1	3		
	AVERAGE	3	3	3	1	1							1	2.4		

FACTS AND HVDC TRANSMISSION(Professional Elective) [As per Choice Based Credit System (CBCS) Scheme] SEMESTER-VII			
Subject Code	18EE732	CIE Marks	50
Number of Lecture Hours/Week	03	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03
CREDITS-03			

Course Objectives: This course will enable students to:

- Understand basics of FACTS and types of FACTS controllers.
- Understand the basics of various static shunt compensators and Static Var Compensators.
- Understand the basics of various static series compensators.
- Understand the basics of HVDC systems and also power conversion schemes.
- Understand control of HVDC converter systems.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
FACTS Concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What Limits the Loading Capability? Power Flow and DynamicStabilityConsiderationsofaTransmissionInterconnection ,Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Brief Description and Definitions of FACTS Controllers, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.	**08Hours**	**L1,L2,L3**
Module-2		
Static Shunt Compensators: Objectives of Shunt Compensation -Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability. Methods of Controllable Var Generation –Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC).Operation of Single Phase TSC – TSR. Switching Converter Type Var Generators, Basic Operating Principles, Basic Control Approaches. **Static VAR Compensators** :SVC and STATCOM, the Regulation.	**08Hours**	**L1,L2,L3**

Slope. Comparison between STATCOM and SVC, V– I and V– Characteristics, Transient stability, Response Time.		
Module-3		
Static Series Compensators: Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability. GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor, The Static synchronous Series Compensator, Transmitted Power Versus Transmission ,Angle Characteristic.	**08Hours**	**L1,L2,L3**
Module-4		
Development of HVDC Technology: Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, HVDC Characteristics and Economic Aspects. **PowerConversion:**3-Phase Converter,3-Phase Full Bridge Converter,12-Pulse Converter.	**08Hours**	**L1,L2,L3**
Module-5		
Control of HVDC Converter and System: Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.	**08Hours**	**L1,L2,L3**
Course Outcomes: After studying this course, students will be able to: **CO1:** Explain basics of FACTS and types of FACTS controllers. **CO2:**Explain the basics of various static shunt compensators and Static Var Compensators. **CO3:**Explain the basics of various static series compensators. **CO4:**Explain the basics of HVDC systems and also power conversion schemes. **CO5:**Explain control of HVDC converter systems.		
Text Book: 1. UnderstandingFACTS:ConceptsandTechnologyofFlexibleACTransmissionSystemsbyNarainG Hingorani,LaszloGyugyi, Wiley publication, Firstedition 2000. 2.HVDCTransmission:PowerConversionApplicationsinPowerSystemsby Chan-KiKimetal, Wiley publication,Firstedition2009.		
ReferenceBook:1ThyristorBasedFACTSControllersforElectricalTransmissionSystemsbyR.Mohan Mathur, Rajiv K.Varma, Wiley publication,Firstedition 2002.		

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2				1						1	3		
2	CO2	3	2				1						1	3		
3	CO3	3	2				1						1	3		
4	CO4	3	2				1						1	3		
5	CO5	3	2				1						1	3		
	AVERAGE	3	2				1						1	3		

UTILIZATION OF ELECTRICAL POWER AND ELECTRICAL VEHICLES(Professional Elective)

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-VII

Subject Code	18EE733	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03
	CREDITS-03		

Course Objectives: This course will enable the students to:

- Understand the basics of illumination.
- Understand the speed control methods of the motors used in electric traction.
- Understand the braking methods in different electric motors and also power supply used in electric traction.
- Understand basics of Electric and Hybrid electric vehicles.
- Understand various Energy storage systems for EV and HEV.

Module	**Teaching Hours**	**Revised bloom's Taxonomy (RBT) Level**
Module -1		
Illumination: Introduction, Radiant Energy, Definitions, Laws of Illumination, Polar Curves, Photometry, Measurement of Mean Spherical Candle Power by Integrating Sphere, Illumination Photometer, Energy Radiation and luminous Efficiency, electric Lamps, Cold Cathode Lamp, Lighting Fittings, Illumination for Different Purposes, Requirements of Good Lighting.	**8 Hours**	**L1,L2,L3,**
Module -2		
Electric Traction Speed - Time Curves and Mechanics of Train Movement: Introduction, Systems of Traction, Systems of electric Traction, Speed - Time Curves for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion. **Motors for Electric traction:** Introduction, Series and Shunt Motors for Traction Services, Two Similar Motors (Series Type) are used to drive a Motor Car, Tractive Effort and Horse Power, AC Series Motor, Three Phase Induction Motor. **Control of motors:** Control of DC Motors, Tapped Field Control or Control by Field Weakening, Multiple Unit Control, Control of Single Phase Motors, Control of Three Phase Motors.	**8 Hours**	**L1,L2,L3,**
Module -3		
Braking: Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical Drum Brakes. **Electric Traction Systems and Power Supply:** System of Electric Traction, AC Electrification, Transmission Lines to Sub - Stations, Sub – Stations, Feeding and Distribution System of AC Traction Feeding and Distribution System for DC	**8 Hours**	**L1,L2**

Tramways, Electrolysis by Currents through Earth, Negative Booster, System of Current Collection, Trolley Wires. **Trams, Trolley Buses and Diesel – Electric Traction:** Tramways, The Trolley – Bus, Diesel Electric Traction.		
Module -4		
Electric and Hybrid Electric Vehicles: Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.	**8 Hours**	**L1,L2,L3**
Module-5		
Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Super capacitors.	**8 Hours**	**L1,L2,L3**
Course Outcomes: At the end of the course the student will be able to: **CO1:**Explain the basics of illumination. **CO2:**Explain the speed control methods of the motors used in electric traction. **CO3:**Explain the braking methods in different electric motorsand also power supply used in electric traction. **CO4:**Explain basics of Electric and Hybrid electric vehicles. **CO5:**Explain various Energy storage systems for EV and HEV.		
Text Book: 1.A Text Book on Power System Engineering A. Chakrabarti et al, DhanpatRai and Co ,2nd Edition, 2010. 2.Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, And Design Mehrdad Ehsani et al,CRC Press 1st Edition, 2005. 3.Electric and Hybrid Vehicles: Design Fundamentals Iqbal Husain CRC Press 2003		
Reference Book: 1. Utilization, Generation and Conservation of Electrical Energy,Sunil S Rao ,Khanna Publishers ,1st Edition, 2011. 2. Utilization of Electric Power and Electric Traction,G.C. Garg, Khanna Publishers ,9th Edition, 2014. 3. Modern Electric Vehicle Technology C.C. Chan and K.T. Chau Oxford University 2001		

SI. No.	**PO / CO**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	CO1	3	3	3	1		3	1					1	3		
2	CO2	3	3	3	1		3	1					1	3		
3	CO3	3	3	3	1		3	1					1	3		
4	CO4	3	1	1			3	2					1	3		
5	CO5	3	1	1			3	2					1	3		
	AVERAGE	3	2.2	2.2	0.6		3	1.4					1	3		

INDUSTRIAL DRIVES AND APPLICATIONS (Professional Elective)
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-VII

Subject Code	18EE734	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable the students to:

- Understand the basics, its Dynamics and also control of electric drives.
- Understand analysis of various control methods of DC motor drives.
- Understand analysis of performance of three phase induction motor.
- Understand the analysis of various control methods of three phase induction motor and basics of synchronous motor drives.
- Analyze starting of synchronous motor and also basics of stepper motor drives and drives used for various Industrial applications.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Electrical Drives: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of dc and ac Drives. **Dynamics of Electrical Drives:** Fundamental Torque Equations, Speed Torque Conventions and Multiquadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization. **Control Electrical Drives:** Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives.	**08 Hours**	L1,L2,L3
Module -2		
Direct Current Motor Drives: Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Single Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Multi-quadrant Operation of dc Separately Excited Motor Fed from Fully Controlled Rectifier, Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor.	**08 Hours**	L1,L2,L3

Module -3		
Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Analysis of Induction Motor fed from Non-Sinusoidal Voltage Supply, Starting, Braking and Transient Analysis.	**08 Hours**	L1,L2,L3
Module -4		
Induction Motor Drives (continued): Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control and Converter Rating for VSI and Cycloconverter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control. **Synchronous Motor Drives:** Operation from fixed frequency supply-starting and pull-in,Synchronous motor variable speed drives, Variable frequency control of multiple synchronous motors.	**08 Hours**	L1,L2,L3
Module-5		
Synchronous Motor Drives (continued): Self-controlled synchronous motor drive employing load commutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives. **Stepper Motor Drives:** Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.	**08 Hours**	L1,L2,L3

Course Outcomes: At the end of the course the student will be able to:

CO1: Describe the fundamental concepts, dynamic behavior, and control strategies of electric drives.

CO2: Evaluate and compare various control techniques for DC motor drives, including their performance under different operating conditions.

CO3: Analyze the operational characteristics and performance metrics of three-phase induction motors.

CO4: Assess advanced control methods for three-phase induction motors and elucidate the fundamental principles of synchronous motor drives.

CO5: Control a stepper motor drive and suggest a suitable electrical drive for specific application in industry.

Text Book:

1.	Fundamentals of Electrical Drives	Gopal K. Dubey	Narosa Publishing House,	2nd Edition, 2001.
2.	Electrical Drives: Concepts and Applications (Refer to chapter 07 for Industrial Drives under module 5.)	VedumSubrahmanyam	McGraw Hill	2nd Edition, 2011.

Reference Books

1.	Electric Drives	N.K De, P.K. Sen	PHI Learning	1st Edition, 2009.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	1	1								1	3		
2	CO2	3	3	1	1								1	3		
3	CO3	3	3	1	1								1	3		
4	CO4	3	3	1	1								1	3		
5	CO5	3	3	1	1			2					1	3		
	AVERAGE	3	3	1	1			2					1	3		

RENEWABLE ENERGY RESOURCES(Open Elective)

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER- VII

Subject Code	18EE741	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course objectives: This course will enable the students to understand:

- The causes of energy scarcity and basics of solar energy systems and its applications.
- Different types of solar Energy collectors, their configurations and applications.
- The basics of hydrogen energy, wind mills and geothermal Energy.
- The basics of biomass energy and tidal energy.
- The basics of sea wave energy and ocean thermal energy.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		
Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. **Solar Cells**: Components of Solar Cell System, Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic Panels, Applications of Solar Cell Systems.	08 Hours	L1, L2,L3
Module -2		
Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Solar Dryers, Solar Cookers, Solar pond.	08 Hours	L1,L2,L3
Module -3		
Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy. **Wind Energy:** Windmills, Wind Turbines, Wind Resources, Considerations and guidelines for Wind Site Selection. **Geothermal Energy:** Geothermal Systems, Classifications, Geothermal Based Electric Power Generation, Associated problems, environmental Effects.	08 Hours	L1,L2,L3
Module -4		
Biomass Energy: Biomass Production, Energy Plantation, Gasification, Gasifier and Their Classifications, Chemistry of Reaction Process in Gasification, Updraft, Downdraft and Cross-draft Gasifier, Fluidized Bed Gasification, Applications of Biomass Gasifier. **Tidal Energy:** Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal	08 Hours	L1, L2,L3

Energy.		
Module-5		
Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. **Ocean Thermal Energy:** Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Application of OTEC in Addition to Produce Electricity, Advantages, Disadvantages and Benefits of OTEC.	08 Hours	L1,L2,L3

Course outcomes:

At the end of the course the student will be able to:

CO1: Analyze the factors contributing to energy scarcity and outline the fundamental principles of solar energy systems along with their industrial and domestic applications.

CO2: Describe various types of solar energy collectors, their structural configurations, working principles, and potential applications.

CO3: Analyze the principles, benefits, applications, and challenges of hydrogen, wind, and geothermal energy, including energy storage, site selection considerations, power generation methods, and environmental impacts.

CO4: Evaluate the production, classification, and applications of biomass gasification and tidal energy, including energy plantations, gasifier types, reaction processes, tidal power generation, turbine technologies, and associated challenges.

CO5: Analyze the principles, technologies, and applications of sea wave and ocean thermal energy, including wave motion, power generation, OTEC systems, cycle types, advantages, disadvantages, and associated challenges.

Text Book:

1. Nonconventional Energy Resources. Shobh Nath Singh, Pearson, 1st Edition, 2015 .

Reference Book

1. Nonconventional Energy Resources , B.H. Khan McGraw Hill, 3rd Edition
2. Renewable Energy Power for a sustainable Future, Godfrey Boyle, Oxford, 3rd Edition, 2012
3. Renewable Energy Sources Their Impact on global Warming and Pollution,TasneemAbbasi , S.A. Abbasi, PHI ,1st Edition, 2011.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	1	1			2	2					1	3		
2	CO2	3		2			2	2					1	3		
3	CO3	3	1	1			2	2					1	3		
4	CO4	3	1	2			2	2					1	3		
5	CO5	3	1	2			2	2					1	3		
	AVERAGE	3	1	1.6			2	2					1	3		

OPERATION AND MAINTENANCE OF SOLAR ELECTRICSYSTEMS(Open Elective)

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-VII

Subject Code	18EE742	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Total Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This Course will enable students to:

1. Understand the basics of solar resource data, PV technology and also PV cells, modules and arrays.
2. Understand inverters, system components and mounting methods of the PV system..
3 Understand site assessment, design process of the grid connected system and its sizing.
4 Understand installation, commissioning, operation and maintenance of PV systems.
5 Understand the types of financial incentives available and calculation of payback time.

Module	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Solar Resource and Radiation: Solar resources, Quantifying solar radiation, The effect of the Earth's atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays. **PV Industry and Technology:** Semiconductor devices, Mainstream technologies, Monocrystalline silicon, Multicrystalline/polycrystalline silicon, Thin film solar cells, Contacts, Buying solar modules, Standards, Certifications, Warranties, Emerging technologies, Dye-sensitized solar cells, Sliver cells, Hetero-junction with intrinsic thin layer (HIT) photovoltaic cells, III-V Semiconductors, Solar concentrators. **PV Cells, Modules and Arrays:** Characteristics of PV cells, Graphic representations of PV cell performance, Connecting PV cells to create a module, Specification sheets, Creating a string of modules, Creating an array, Photovoltaic array performance, Irradiance, Temperature, Shading.	**8 Hours**	**L1, L2, L3.**
Module-2		
Inverters and Other System Components: Introduction, Inverters, Battery inverters, Grid interactive inverters, Transformers, Mainstream inverter technologies, String inverters, Multi-string inverter, Central inverter, Modular inverters, Inverter protection systems, Self-protection, Grid protection, Balance of system equipment: System equipment excluding the PV array and inverter, Cabling, PV combiner box, Module junction box, Circuit breakers and fuses ,PV main disconnects/isolators, Lightning and surge protection, System monitoring, Metering, Net metering, Gross metering. **Mounting Systems:** Roof mounting systems, Pitched roof mounts, Pitched roof mounts for tiled roofs, Pitched roof mounts for metal roofs, Rack mounts, Direct mounts, Building-integrated systems, Ground mounting systems, Ground rack mounts, Pole mounts, Sun-tracking systems, Wind	**8 Hours**	**L1, L2, L3, L4.**

loading, Lightning protection.		
Module – 3		
Site Assessment: Location of the PV array, Roof specifications, Is the site shade-free?, Solar Pathfinder, Solmetric Sun eye, HORI catcher, iPhone apps, Software packages, Available area, Portrait installation, Landscape installation, Energy efficiency initiatives, Health, safety and environment (HSE) risks, Local environment, Locating balance of system equipment, Site plan. **Designing Grid-connected PV Systems:** Design brief, Existing system evaluation, choosing system components, Modules, Mounting structure, Inverters, Cabling, Voltage sizing, Current sizing, Monitoring, System protection, Over-current protection, Fault-current protection, Lightning and surge protection, Grounding/earthing, Mechanical protection, Array protection, Sub array protection, Extra low voltage (ELV) segmentation. **Sizing a PV System:** Introduction, Matching voltage specifications, Calculating maximum voltage, Calculating minimum voltage, Calculating the minimum number of modules in a string, Calculating the maximum voltage, Calculating the maximum number of modules in a string, Calculating the minimum voltage, Calculating the minimum number of modules in a string, Matching current specifications, Matching modules to the inverter's power rating, Losses in utility-interactive PV systems, Temperature of the PV module, Dirt and soiling, Manufacturer's tolerance, Shading, Orientation and module tilt angle, Voltage drop, Inverter efficiency, Calculating system yield.	**8 Hours**	**L1, L2.**
Module – 4		
Installing Grid-connected PV Systems: PV array installation, DC wiring, Cabling routes and required lengths, Cable sizing, PV combiner box, System grounding/earthing, Inverter installation, Installation checklist, ,Interconnection with the utility grid, Required information for installation, Safety. **System Commissioning:** Introduction, Final inspection of system installation, Testing, Commissioning, System documentation. **System Operation and Maintenance:** System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, Other common problems.	**8 Hours**	**L1, L2.**
Module – 5		
Marketing and Economics of Grid-connected PV Systems: Introduction, PV system costing, Valuing a PV system, Simple payback and financial incentives, Simple payback, Feed-in tariffs, Rebates, Tax incentives, Loans, Renewable portfolio standards and renewable energy certificates, Marketing, Insurance. **Case Studies:** Case studies A to G.	**8 Hours**	**L1, L2.**
Course Outcomes: At the end of the course the student will be able to: **CO1: Describe** the fundamentals of solar resource data, **explain** PV technology, and **analyze** the structure and function of PV cells, modules, and arrays. **CO2: Describe** the function of inverters, **analyze** various system components, and **explain** different mounting methods used in PV systems.		

CO3: Assess the site for PV system installation and design a grid connected system and compute its size.
CO4: **Analyze** the procedures for installation and commissioning and **apply** maintenance practices for efficient performance of PV systems.
CO5: Identify different types of financial incentives for PV systems and **calculate** the payback time to assess economic feasibility.

Question Paper pattern:

- The Question paper will have ten questions.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text/ Reference Books

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											1	3		
2	CO2	3		3		1	2	2					1	3		
3	CO3	3	3	2		1	2	2					1	3		
4	CO4	3											1	3		
5	CO5	3	1			2	2						1	3		
	AVERAGE	3	0.8	1		0.8	1.2	0.8					1	3		

1	Grid-connected Solar Electric Systems, The Earthscan Expert Handbook for Planning, Design and Installation	Geoff Stapleton and Susan Neill	Earthscan	1st Edition, 2012

ELECTRICAL ENERGY CONSERVATION AND AUDITING (Open Elective) [As per Choice Based Credit System (CBCS) Scheme] SEMESTER-VII			
Subject Code	18EE743	CIE Marks	50
Number of Lecture Hours/Week	3L	SEE Marks	50
Total Hours	40	Exam Hours	03
CREDITS-03			

Course Objectives: This Course will enable students to:

1. Understand the current energy scenario and importance of energy conservation.
2. Understand developing cash flow models, payback analysis and depreciation.
3. Understand Energy Auditing and also survey Instrumentation.
4. Understand Energy Audit of motors and lighting systems.
5. Understand Energy Audit applied to buildings and also demand side management.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Global and Indian Energy Scenarios: Energy Conservation, Energy Audit, Energy Scenario of India, Present Nonrenewable Energy Scenario, Present energy Consumption, Energy Security, Energy Strategy for Future, Clean Development Mechanism, Energy Conservation Act-2001.	**8 Hours**	**L1, L2, L3**
Module-2		
Energy Economic Analysis: This time value of money concept, developing cash flow models, payback analysis and depreciation, taxes and taxes credit- numerical problems.	**8 Hours**	**L1, L2, L3**
Module – 3		
Energy Auditing: Types of Energy Audits and Energy-Audit Methodology: Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training. **Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data – Acquisition System, Thermal Basis.	**8 Hours**	**L1, L2, L3**
Module – 4		
Energy Audit of Motors: Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling. **Energy Audit of Lighting Systems:** Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities.	**8 Hours**	**L1, L2, L3**
Module – 5		
Energy Audit Applied to Buildings: Energy – Saving Measures in New	**8 Hours**	**L1, L2, L3**

Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings. **Demand side Management:** Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM.		

Course Outcomes: At the end of the course the student will able to:

CO1: Explain the current energy scenario and importance of energy conservation.

CO2: Explain payback analysis and depreciation.

CO3: Explain the Energy Auditing and also measurement of various quantities

CO4: Conduct Energy Audit of motors and lighting systems.

CO5: Conduct Energy Audit applied to buildings and also Explain demand side management.

Question Paper pattern:

- The Question paper will have ten questions.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text/ Reference Books

1	Energy Management Handbook	W.C. Turner	John Wiley and Sons	
2	Energy Efficient Electric Motors and Applications	H.E. Jordan	Plenum Pub. Corp	
3	Energy Management	W. R. Murphy, G. Mckay	Butterworths	
4	Energy Science Principles, Technologies and Impact	J. Andrews, N. Jelley	Oxford University Press.	
5	Market operations in power systems: Forecasting, Scheduling, and Risk Management	ShahedepourM.,Yamin H., Zuyi Li.	John Wiely& Sons, New York	
6	Energy Conservation	Diwan, P.	Pentagon Press (2008)	
7	Handbook on Energy Audit	Sonal Desai	McGraw Hill	1st Edition, 2015
8	Generation of Electrical Energy	B R Gupta	S. Chand	1stEdition, 1983

SI. No.	**PO / CO**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	CO1	3											1	1	3	
2	CO2	3		3		1	2	2					1	3	3	
3	CO3	3	3	2		1	2	2					1	3	3	
4	CO4	3											1	3	3	
5	CO5	3	1			2	2						1	3	3	
	AVERAGE	3	0.8	1		0.8	1.2	0.8					1	3	3	

POWER SYSTEM SIMULATION LABORATORY

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-VII

Subject Code	18EEL75	CIE Marks	50
Number of Lecture Hours/Week	02	SEE Marks	50
Total Number of Lecture Hours	24	Exam Hours	03

CREDITS-01

Course Objectives This Course will enable students to:

- Conduct experiment to determine voltage regulation and efficiency for a short, medium and long transmission lines.
- Conduct experiment to determine Y-Bus for Power Systems by Singular Transformation method.
- Conduct experiment to determine Z-Bus for Power Systems using Z-Bus Building Algorithm.
- Conduct Load Flow analysis using Newton Raphson method.
- Conduct Fault Analysis of a given network.

SL NO	Experiments
1.	Performance of short transmission line, determination of voltage regulation and efficiency.
2.	Performance of medium transmission line (nominal π-network, nominal T-network), determination of voltage regulation and efficiency.
3.	Formation of Y-Bus for Power Systems without Mutual Coupling, by Singular Transformation method.
4.	Formation of Y-Bus for Power Systems by Inspection Method.
5.	Formation of Z Bus(without mutual coupling) using Z-Bus Building Algorithm.
6.	To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus
7.	using Z-Bus Building Algorithm.
8.	Load Flow Analysis using Newton Raphson Method.
9.	Economic dispatch in power system neglecting losses.
10.	Optimal Generation Scheduling for Thermal power plants.
11.	Symmetrical Fault analysis to find out fault current, post-fault voltage and line flow of a given network.
12.	Unsymmetrical fault analysis to find out the fault current of a given network.

Course outcomes:

At the end of the course the student will be able to:

CO1: Conduct experiments to determine voltage regulation and efficiency of short, medium and long transmission lines.

CO2: Determine Y-Bus for Power System using Singular Transformation method.

CO3: Determine Z-Bus for Power System using Z-Bus Building Algorithm.

CO4: Conduct Load Flow analysis using Newton Raphson method.

CO5: Analyze the Faults on a given network.

Graduate Attributes (As per NBA)
Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

SI. No.	**PO / CO**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	CO1	3	3	3	2	3				3	3		1		3	
2	CO2	3	3	3	2	3				3	3		1		3	
3	CO3	3	3	3	2	3				3	3		1		3	
4	CO4	3	3	3	2	3				3	3		1		3	
5	CO5	3	3	3	2	3				3	3		1		3	
	AVERAGE	3	3	3	2	3				3	3		1		3	

HIGH VOLTAGE LABORATORY
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-VII

Subject Code	18EEL76	CIE Marks	50
Number of Lecture Hour/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	SEE Marks	50
Total Number of Lecture Hours	36	Exam Hours	03

CREDITS-01

Course Objectives: This laboratory course will enable students to:

- Conduct experiments to study the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages.
- Conduct experiment to measure the breakdown strength of transformer oil
- Conduct experiment to measure capacitance of different electrode configuration models using Electrolytic Tank.
- Conduct experiment to determine Surface Flashover on the surface of polymer and porcelain insulating materials
- Conduct experiment to determine audible and visible corona inception and extinction voltage under the non- uniform field.

SL NO	Experiments
1.	Measurement of Breakdown Strength of Transformer Oil.
2.	Field Mapping using Electrolytic test kit.
3.	Measurement of HVAC using sphere gap equipment
4.	Measurement of HVDC using sphere gap equipment
5.	Finding of flash over voltages of uniform and non-uniform field electrodes subjected to HVAC
6.	Finding of flash over voltages of uniform and non-uniform field electrodes subjected to HVDC
7.	To perform experiment on the horn gap arrestor and understand the arc quenching phenomenon
8.	Surface Flashover on the surface of polymer insulator materials
9.	Surface Flashover on corrugated porcelain insulator material
10.	To understand the basic principle of corona and obtain audible and visible corona inception and extinction voltage under the non- uniform field
11.	Study of Solid Dielectrics used in power apparatus
12.	Study application of insulating materials

Course outcomes: On the completion of this laboratory course, the student will be able to:
CO1: Conduct experiments to determine the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages.
CO2: Conduct experiment to determine the breakdown strength of transformer oil.
CO3:Conduct experiment to determine the capacitance of different electrode configuration models using Electrolytic Tank.
CO4: Conduct experiment to determine Surface Flashover on the surface of polymer and porcelain insulating materials

CO5: Conduct experiment to determine audible and visible corona inception and extinction voltage under the non- uniform field.
Graduate Attributes (As per NBA) Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.
Conduct of Practical Examination: 1. All laboratory experiments are to be included for practical examination. 2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners. 3. Students can pick one experiment from the questions lot prepared by the examiners. 4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

SI. No.	**PO / CO**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	CO1	3	2	3	1		1			3	3		1		3	
2	CO2	3	2	3	1		1			3	3		1		3	
3	CO3	3	2	3	1		1			3	3		1		3	
4	CO4	3	2	3	1		1			3	3		1		3	
5	CO5	3	2	3	1		1			3	3		1		3	
	AVERAGE	3	2	3	1		1			3	3		1		3	

COMPUTER AIDED ELECTRICAL DRAWING LAB

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-VII

Subject Code	18EEL77	CIE Marks	50
Number of Lecture Hours/Week	2	SEE Marks	50
Total Number of Lecture Hours	24	Exam Hours	03

CREDITS-1

Course Objectives: This course will enable students to:

- Develop single layer Lap and Wave winding diagrams of DC machines.
- Develop double layer Lap and Wave winding diagrams of DC machines.
- Develop three phase Lap and Wave winding diagrams of AC machines.
- Draw sectional view of single and three phase core and shell type transformer.
- Draw sectional view of transformers, DC machine and its parts and alternator and its parts.

SL NO	List of Experiments
1.	Develop single layer Lap and Wave winding diagram of DC machines.
2.	Develop double layer Lap and Wave winding diagram of DC machines.
3.	Develop winding diagram of AC Machines a) Three phase lap winding b) Three phase wave winding
4.	Draw sectional view of single-phase core and shell type transformer.
5.	Draw sectional view of three phase core and shell type transformer.
6.	Draw sectional view of DC machine yoke with poles.
7.	Draw sectional view of DC machine armature .
8.	Draw sectional view of DC machine commutator.
9.	Draw sectional view of alternator stator.
10.	Draw sectional view of alternator Rotor.
11.	Draw single line diagram of a Substation.
12	Draw single line diagram of a Generating Station.

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

CO1: Develop single layer Lap and Wave winding diagrams of DC machines.

CO2: Develop double layer Lap and Wave winding diagrams of DC machines.

CO3: Develop three phase Lap and Wave winding diagrams of AC machines.

CO4: Draw sectional view of single and three phase core and shell type transformers.

CO5: Draw sectional views of transformers, DC machine and its parts and alternator and its parts

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.

4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

SI. No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2	3		3				3	3		1		3	
2	CO2	3	2	3		3				3	3		1		3	
3	CO3	3	2	3		3				3	3		1		3	
4	CO4	3	2	3		3				3	3		1		3	
5	CO5	3	2	3		3				3	3		1		3	
	AVERAGE	3	2	3		3				3	3		1		3	

PROJECT - VII
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER - VII

Subject Code	18PRJ78	**CIE Marks**	50
No. of Practical Hours/Week	2	**SEE Marks**	50
		Exam Hours	3

CREDITS - 01

Course Objectives:
This Course will enable the students to:

- Independent Learning.
- Selection and Utilization of adequate information.
- Organization and presentation of information.
- Learn to work with team members.
- Expand one's intellectual capability and decision making.
- Meeting the deadlines

Project - VII
Students in consultation with the guide take up an updated topic on the subjects taught in sixth semester and search and collect the relative literature and then study. Students in a team should come with an idea as a result of literature studies and build a prototype to demonstrate the implementation of the idea.

Course Outcome:
At end of the course, students will be able to:

CO1:Exhibit a thorough understanding of the selected project topic, showcasing sound technical expertise and domain-specific knowledge.

CO2: Identify, formulate, and analyze engineering problems systematically to derive precise and actionable problem statements.

CO3: Develop and design innovative engineering solutions to address identified problems effectively and efficiently.

CO4:Implement and execute the project successfully, adhering to engineering standards, timelines, and resource constraints.

CO5:**Effectively communicate project outcomes and solutions** through professional presentations and reports to academic peers, industry professionals, and the broader society.

Graduate Attributes:
Engineering knowledge, Problem Analysis, Individual and teamwork, Communication.

Examinations:

Continuous Internal Evaluation:
CIE marks for the project is 50 marks.

1. Report 25 marks
2. Presentation 25 marks

Marks shall be awarded by a guide with one examiner (senior most faculty within the department) selected by the head of the department based on his/her performance.

Semester End Examination:
SEE marks for the project is 50 marks.

1. Report 15 marks
2. Presentation 15 marks
3. Viva-Voce 20 marks.

Marks shall be awarded by two examiners (one internal and one external) constituted by the head of the department/dean.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3								3	3	3				
2	CO2	3	3							3	3	3				
3	CO3	3	3	3	3	3				3	3	3		3	3	
4	CO4	3	3		3	3				3	3	3	3	3	3	
5	CO5						3	2	1	3	3	3	3			3
	AVERAGE	3	3	3	3	3	3	2	1	3	3	3	3	3	3	3

INDUSTRIAL PSYCHOLOGY AND ORGANISATIONAL BEHAVIOUR [As per Choice Based Credit System (CBCS) scheme] SEMESTER-VII			
Subject Code	18HSM79	CIE Marks	50
Number of Lecture Hours/Week	01	SEE Marks	50
Total Number of Lecture Hours	20	Exam Hours	03
CREDITS-01			

Course Objectives: This course will enable students to:

1. Relating human psychology to science
2. Understand the human psychology
3. Understand the nature of organization and organization models
4. Understand the human social communication
5. Understand the leadership qualities

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Introduction to I/O psychology: Major fields of I/O psychology, brief history of I/O psychology, employment of I/O psychology, ethics in I/O psychology. (Chapter-1)	**3 Hours**	**L1,L2**
Module -2		
Organizational Communication: Types of organizational communication, interpersonal communication, improving employee communication skills. (Chapter-11)	**3 Hours**	**L1,L2**
Module -3		
Leadership: Introduction, personal characteristics associated with leadership, interaction between the leadership and the situation specific leader skills, leadership where we are today. (Chapter-12)	**3 Hours**	**L1,L2**
Module -4		
Group behavior- teams and conflicts Group dynamics, factor affecting group performance, individual versus group performance, group conflicts. (Chapter-13)	**5 Hours**	**L1, L2**
Module-5		
Stress Management: Dealing with the demands of life and work, stress defined, predisposition to stress, sources of stress, consequences of	**4 Hours**	**L1,L2**

stress, stress reduction intervention related to life/work issues. (Chapter-15)		
Course Outcomes: At the end of this course, students would be able to CO1: Comprehend the knowledge and concepts of human psychology. CO2: Know the importance of psychology. CO3: Have insight into individual and group behavior. CO4: Deal with people in better way. CO5:Motivate groups and build groups.		
Text Books: "Michael G.Amodt, Industril/Organizational Psychology: An Applied Approach, 6th Edition, Wadsworth Cengage Learning,ISBN:978-0-495-60106-7.		
Reference Books: 1. Blum M.L. Naylor J.C., Horper& Row, Industrial Psychology, CBS Publisher, 1968. 2. Luthans, Organizational Behaviour, McGraw Hill, International, 1997. 3. Morgan C.t.,KingR.A.,JohnRweisz&John Schoples, Introduction to Psychology, McHraw Hill, 1966. 4. Schermerhorn J.R.Jr., Hunt J.G &Osborn R.N., Managing, Organizational Behaviour, John Willy.		

SI. No.	**PO / CO**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	CO1	1		1			2	2	2	3	2		2			2
2	CO2	1		1			2	2	2	3	3		2			2
3	CO3	1		1			2	2	2	3	3	3	2			2
4	CO4	1		1			2	2	2	3	3	3	2			2
5	CO5	1	1	1			2	2	2	3	2		2			2
	AVERAGE	1	0.2	1			2	2	2	3	2.6	1.2	2			2

PROJECT - VIII
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER - VIII

Subject Code	18PRJ81	**CIE Marks**	50
No. of Practical Hours/Week	4	**SEE Marks**	50
		Exam Hours	3

CREDITS - 08

Course Objectives:
This Course will enable the students to:

- Independent Learning.
- Selection and Utilization of adequate information.
- Organization and presentation of information.
- Learn to work with team members.
- Expand one's intellectual capability and decision making.
- Meeting the deadlines

Project - VIII
Students in consultation with the guide take up an updated topic on the subjects taught in eighth semester and search and collect the relative literature and then study. Students in a team should come with an idea as a result of literature studies and build a prototype to demonstrate the implementation of the idea.

Course Outcome:
At end of the course, students will be able to:
CO1: Exhibit a thorough understanding of the selected project topic, showcasing sound technical expertise and domain-specific knowledge.
CO2: Identify, formulate, and analyze engineering problems systematically to derive precise and actionable problem statements.
CO3: Develop and design innovative engineering solutions to address identified problems effectively and efficiently.
CO4: Implement and execute the project successfully, adhering to engineering standards, timelines, and resource constraints.
CO5: Effectively communicate project outcomes and solutions through professional presentations and reports to academic peers, industry professionals, and the broader society.

Graduate Attributes:
Engineering knowledge, Problem Analysis, Individual and teamwork, Communication.

Examinations:

Continuous Internal Evaluation:
CIE marks for the project is 50 marks.

1. Report 25 marks
2. Presentation 25 marks

Marks shall be awarded by a guide with one examiner (senior most faculty within the department) selected by the head of the department based on his/her performance.

Semester End Examination:
SEE marks for the project is 50 marks.

1. Report 15 marks
2. Presentation 15 marks
3. Viva-Voce 20 marks.

Marks shall be awarded by two examiners (one internal and one external) constituted by the head of the department/dean.

Sl.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3								3	3	3				
2	CO2	3	3							3	3	3				
3	CO3	3	3	3	3	3				3	3	3		3	3	
4	CO4	3	3		3	3				3	3	3	3	3	3	
5	CO5						3	2	1	3	3	3	3			3
	AVERAGE	3	3	3	3	3	3	2	1	3	3	3	3	3	3	3

INTERNSHIP

[As per Outcome Based Education (OBE) and Choice Based Credit System (CBCS) Scheme]

SEMESTER-IV

Subject Code	18EEI82	CIE Marks	50
Total No. of implementation/training weeks	12P	SEE Marks	50
		Exam Hours	03

CREDITS-06

Course Objectives: Students will be taught to:

1. Learn to appreciate work and its function in the economy.
2. Develop work habits and attitudes necessary for job success.
3. Develop communication, interpersonal and other critical skills in the job interview process.
4. Build a record of work experience.
5. Acquire employment contacts leading directly to a full-time job following graduation from college.

Students has to carry out the internship OF 12 weeks in the industry.

Course outcomes: After studying this course, students will be able to:

CO1. Apply the knowledge of electronics hardware and software components to solve the real time problems of the society.

CO2. Analyze the various existing solutions available to solve the real time problem and propose the best solution.

CO3. Design and implement the system to solve the real time problem of the society.

CO4.Conduct investigations on the output and prepare the technical documentation of the designed system in a team.

CO5.Use the modern tool available like advanced hardware and software tools.

COURSE OUTCOME AND PROGRAMME OUTCOME MAPPING (1/2/3):

Note: 1-Low, 2-Medium, 3-High

CO/PO	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	PSO.3
CO1	3	-	-	-	3	3	2	-	-	-	-	3	-	3	-
CO2	2	3	2	2	-	2	2	-	-	-	-	3	-	3	-

CO3	**2**	**2**	**3**	**2**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**-**
CO4	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**2**	**3**	**-**	**3**	**-**
CO5	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	-	-	-	**3**	**-**	**3**	**-**