SCHEME 2022

III & IV Semester
Scheme and Syllabus

Electrical & Electronics Engineering

GLOBAL ACADEMY OF TECHNOLOGY
(Autonomous institution affiliated to VTU, Belagavi, Accredited by NAAC with 'A' grade, NBA Accredited CS, E&C, E&E, MECH and IS branches)Ideal Homes Township,

Department of Electrical and Electronics Engineering

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Scheme and Syllabus
of
UG Autonomous Program – 2022 batch

III SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22MAT31D	Transform Calculus and Numerical Methods	BS	MAT	2	2	0	50	50	100	3
2	22EEE32	Electrical Machines-I	IPC	Respective Department	3	0	2	50	50	100	4
3	22EEE33	Analog Electronic Circuits	IPC		3	0	2	50	50	100	4
4	22EEE34	Electric Circuits	PC		1	1	0	50	50	100	3
5	22EEE35	Measurements & Transducers	ESC/ETC/PLC		3	0	0	50	50	100	3
6	22EEE36	Ability Enhancement Course – I **(Theory)**	AEC		3	0	0	50	50	100	3
		OR			OR						
		Digital logic Design	AEC		2	0	2	50	50	100	3
				Total				**300**	**300**	**600**	**20**

SEMESTER-III

Course: Transform Calculus and Numerical Methods (For EEE)

Course Code	22MAT31D	CIE Marks	50
Hours/Week (L: T: P)	2:2:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: To enable students to apply the knowledge of Mathematics in variousfields of engineering by making them to learn:

CLO1	Laplace Transforms
CLO2	Fourier series of periodic functions
CLO3	Fourier and Z Transforms
CLO4	Numerical methods

Content	No. of Hours/ RBT levels
Module 1 Laplace transforms of elementary functions, Laplace transforms of Periodic functions, unit-step function and Dirac delta function. Inverse Laplace Transform, Convolution theorem (without Proof), Solution ofsecond order linear differential equations using Laplace transforms.	08 Hours L2, L3
Module 2 Fourier series of periodic functions, half range Fourier sine and cosine series. Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms.	08 Hours L2, L3
Module 3 Z-transform-definition, Standard z-transforms, Damping and shifting rules, initial value and final value theorems, Inverse z-transform and applications to solve difference equations.	08 Hours L2, L3
Module 4 Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson method. Finite differences: Newton's forward and backward difference formulae. Newton's divided difference formula and Lagrange's interpolation formula. Numerical integration: Simpson's 1/3rd,3/8th, Weddle's rule.	08 Hours L2, L3
Module 5 Numerical solution of ordinary differential equations of first order and first degree: Taylor's series methods, Runge-Kutta method of fourth order,Milne's and Adam-Bashforth predictor and corrector methods. Numericalsolution of second order ordinary differential equations: Runge-Kutta method and Milne's method.	08 Hours L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO31.1	Determine Laplace and inverse Laplace transforms of given functions and solve linear differentialequations
CO31.2	Determine Fourier series and Fourier Transform of given function.
CO31.3	Apply numerical techniques to solve algebraic and transcendental equations.
CO31.4	Apply numerical techniques for interpolation and to evaluate definite integrals.
CO31.5	Solve ordinary differential equations of first and second order using numerical methods

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006

Reference books:

1. E. Kreyszig , Advanced Engineering Mathematics, John Wiley & Sons 10th Edition, 2016
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, LaxmiPublications 6th Edition, 2014

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reducedto 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **onefull question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproductionof research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Assignments	10	
SEE	Semester End Examination	50	50
Grand Total			100

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO31.1	3	2	1									3				
CO31.2	3	2	1									3				
CO31.3	3	2	1									3				
CO31.4	3	2	1									3				
CO31.5	3	2	1									3				
Average	3	2	1									3				

Low-1: Medium-2: High-3

SEMESTER-III

Course: Electrical Machines – I (Integrated course)

Course Code	22EEE32	CIE Marks	50
Hours/Week (L: T: P)	3:0:2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Fundamentals of Electrical Engineering – 22ELE14/24

Course Objectives:

CLO1	Understand the principle of operation, constructional details, equivalent circuit andperformance of Single phase transformers by OC/SC and Sumpner's test
CLO2	Analyze the operation of Three phase transformers and other special purposetransformers
CLO3	Explain the constructional features of Three phase Induction motors and assess their performance.
CLO4	Compare the various methods of speed control of an Induction motor.
CLO5	Explain the operation of Single phase Induction motors and Fractional HP Motors.

Content	No. of Hours/ RBT levels
Module 1: Single Phase Transformers **Transformers:** Construction & Principle of operation, EMF equation, phasor diagrams- no load and on load, equivalent circuit, voltage regulation, losses, efficiency, Condition for maximum efficiency and voltage regulation, Power and distribution transformer, all day efficiency. Auto transformer.	08 Hours L3
Module 2: Testing of single-phase Transformers and Three phase Transformers **Testing of transformers:** Open circuit and short circuit, Sumpner's test, separation of hysteresis and eddy current losses. **Three phase transformers:** Construction & Principle of operation, groups, and connections, three phase connections with applications; Scott connection, open delta; Parallel operation of single phase and three phase transformers. Load sharing concept.	08 Hours L4
Module 3: Three Phase Induction Motors **Three Phase Induction Motors:** Construction & Principle of Operation, Types, Equivalent circuit, Slip-torque characteristics, Condition for maximum torque, Power flow equations ,losses and efficiency, No load and blocked rotor tests, Loadtest , Circle diagram.	09 Hours L2
Module 4: Starting and Speed Control of Three Phase Induction Motors **Starting and speed control of three phase induction motors:** slip control methods, control of supply frequency, control of stator poles. Cogging & Crawling, Double cage &Deep bar Induction Motor, Braking, and InductionGenerator. Applications	7 Hours L3
Module 5: Single Phase Induction Motors & Fractional H.P. Motors **Single Phase Induction Motors:** Construction & Principle of Operation, Double revolving field theory and operation, Equivalent circuit, No load and blocked rotor test, characteristics of single phase induction motors, Starting methods and applications of single-phase induction motors. **Fractional HP Motors:** Single phase A.C. series motor, Servo motors, Linear Induction Motor	8 hours L3

Laboratory Experiments:

Sl. No.	Experiments	No. of Hours/ RBT levels
1	Open Circuit and Short circuit tests on single phase transformer and pre- determination of (i) Efficiency and regulation (ii) Calculation of parameters of equivalent circuit.	2 hours L3
2	To perform Sumpner's test on transformers and determination of combined and individual transformer efficiency.	2 hours L3
3	Parallel operation of two single-phase transformers of different kVA ratings	2 hours L3
4	Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency and regulation under balanced resistive load.	2 hours L3
5	Load test on three phase induction motor.	2 hours L3
6	No-load and Blocked rotor test on three phase induction motor to draw (i) equivalent circuit and (ii) circle diagram. Determination of performance parameters at different load conditions	2 hours L3
7	Separation of hysteresis and eddy current losses in single phase transformer	2 hours L3
8	Scott connection with balanced and unbalanced loads.	2 hours L3
9	Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.	2 hours L3
10	Conduct suitable tests to draw the equivalent circuit of single-phase induction motor and determine performance parameters.	2 hours L3
	Simulation Experiments	
11	Testing of Induction Motor Using MATLAB/Simulink	2 hours L3
12	Testing of single phase transformer Using MATLAB/Simulink	2 hours L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO32.1	Understand the principle of operation, constructional details, equivalent circuit and testing of single-phase transformers.
CO32.2	Analyze the operation and different connections of Three phase transformers.
CO32.3	Analyze the operation and performance of Three phase induction motors.
CO32.4	Explain the various starting and speed control methods of a three-phase induction motor.
CO32.5	Explain the operation of Single-phase Induction motors and Fractional HP Motors.

Textbooks:

1. **P.S.Bimbhra,** Electrical Machines, Khanna Publishers, 7th Edition , 2011
2. **Nagrath and Kothari,** Electrical Machines , McGraw-Hill Education India, 2018

Reference books:

1. **A.E.Fitzgerald, Charles Kingsley, Stephen D Umans,** Electrical Machinery, 6th Edition, McGraw Hill Higher Education, 2014

2. **V.Del Toro,** Basic Electric Machines, Pearson Education India, 2016
3. **Ashfaq Hussain,** Electrical Machines, Dhanpat Rai & Co, 3rd Edition , 2020
4. **Samarajit Ghosh,** Electrical Machines, 2nd Edition, Pearson Education India, 2012

E-Books / Web References

1. https://ndl.iitkgp.ac.in/result?q={%22t%22:%22search%22,%22k%22:%22electrical%20machines%22,%22s%22:[],%22b%22:{%22filters%22:[]}}
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/course-notes
3. https://edisontechcenter.org/Transformers.html
4. https://edisontechcenter.org/inductionMotors.html

MOOCs

1. https://nptel.ac.in/courses/108/105/108105017/
2. https://www.classcentral.com/course/swayam-electrical-machines-iitd-14030
3. E-learning: www.vtu.ac.in

Scheme of Evaluation: (Integrated courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO/PSO Mapping

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO32.1	3	2	-	-	-	-	-	-	-	-	-	1	3	1	-
CO32.2	3	2	-	-	-	-	-	-	-	-	-	1	3	1	-
CO32.3	3	-	2	-	-	-	-	-	-	-	-	1	3	1	-
CO32.4	3	-	-	-	-	-	-	-	-	-	-	1	3	1	-
CO32.5	3	-	-	-	-	-	-	-	-	-	-	1	3	1	-
22EEE32	3	2	2	-	-	-	-	-	-	-	-	1	3	1	-

III SEMESTER

Course: Analog Electronic Circuits (Integrated course)

Subject Code	22EEE33	CIE Marks	50
Hours/Week (L:T:P)	3:0:2	SEE Marks	50
Credits	4	Examination Hours	03

Prerequisites: Course on Elements of Electronics Engineering

Objectives:

CLO1	Understand the various models used for transistor small signal analysis
CLO2	Classify various topologies of feedback and power amplifiers
CLO3	Design of Active filters and signal processing circuits using OPAMPS
CLO4	Understand the design of signal generators, comparators and converters
CLO5	Understand various ADCs/DACs , Timer and Voltage Regulators using OPAMPS

Content	No. of Hrs/ RBT levels
Module 1: BJT AC Analysis BJT analysis: Review of dc biasing circuits. BJT transistor modeling at low frequencies using: **r_e model:** r_e transistor model, common emitter fixed bias configuration, voltage divider bias, CE emitter bias and emitter follower configuration. **Hybrid model** Hybrid Equivalent Model, Approximate hybrid model – Fixed bias, voltage divider and emitter follower configuration.	08 Hours L2
Module 2: Feedback and Power amplifiers using BJT **Feedback Amplifiers:** Feedback concept, different feedback topologies, RC coupled amplifier, Darlington emitter follower, analysis and design. **Power Amplifiers:** Series fed class A amplifier, Transformer coupled class A amplifier, Class B amplifier operation and circuits, Amplifier distortion, Class AB and Class C amplifiers.	08 Hours L2
Module 3: Signal Processing circuits and Active filters **Basic OPAMP applications:** Inverting and non-inverting amplifier, summing and difference amplifier, voltage follower, integrator and differentiator circuits **Signal Processing Circuits:** Precision half wave rectifier, precision fullwave rectifiers, sample and hold circuit, peak detector. **Active Filters:** Introduction, First order low and high pass Butterworth filter, second order low and high pass Butterworth filter, band pass filter and band reject filter	08 Hours L2
Module 4: Signal Generators, Comparators & Converters **Signal Generators:** Triangular / rectangular wave generator, saw tooth generator, phase shift oscillator. **Comparators & Converters:** Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters.	8 Hours L2
Module 5: Analog/Digital Conversion, 555 Timer and Voltage Regulators **A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit8-bit D/A, successive approximation ADC **555 timers:** Functional diagram, Mono stable and Astable operation **Voltage regulators:** Voltage follower regulator, Precision voltage regulator, Fixed voltage regulators, Adjustable voltage regulators using OPAMPS.	8 hours L2

Laboratory Experiments:

Sl. No.	Experiments	No. of Hours/ RBT levels
1	Design a BJT Amplifier using Matlab/ Simscape Electrical and observe the voltage gain at a given frequency.	2 hours / L3
2.	Design a single stage BJT RC coupled amplifier and plot the frequency response, determine bandwidth, input, and output impedances.	2 hours / L3
3	Determination of gain, input and output impedance of BJT Darlington emitter follower circuit.	2 hours / L3
4	Verify the operation of an op – amp as (a) voltage comparator circuit and (b) zero crossing detector.	2 hours / L3
5	Design and verify the operation of op – amp as an (a) adder (b) subtractor	2 hours / L3
6	Design and verify the operation of op – amp as an (a) integrator and (b) differentiator	2 hours / L3
7	Design and verify the output waveform of an op – amp-based RC phase shift oscillator for a desired frequency.	2 hours / L3
8	Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass filters for a given cut off frequency to verify the frequency response characteristics	2 hours / L3
9	Design and realize an Inverting Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).	2 hours / L3
10	Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency	2 hours / L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO33.1	Develop r_e and hybrid models of transistors for various configurations
CO33.2	Classify different types of transistor amplifiers and its applications
CO33.3	Understand OPAMP based signal processing circuits and active filters
CO33.4	Demonstrate the applications of OPAMPS in signal generators, comparators, and converters.
CO33.5	Understand the operation of ADC/DAC, 555 Timer and voltage regulators using OPAMPS

Textbooks:

1. Electronic Devices and Circuit Theory Robert L Boylestad Louis Nashelsky Pearson 11thEdition, 2015
2. Op-Amps and Linear Integrated Circuits Ramakant A Gayakwad Pearson 4 th Edition 2015

Reference books:

1. Electronic Devices and Circuits David A Bell Oxford University Press 5th Edition, 2008
2. Operational Amplifiers and Linear ICs David A. Bell Oxford 3 rd Edition 2011
3. Operational Amplifiers and Linear Integrated Circuits K. Lal Kishore Pearson 1 st Edition, 2012
4. Linear Integrated Circuits, D. Roy Choudhury, Shail Jain, New Age International (P) Ltd., 2003.

E-Books / Web References

1. Electronic devices and circuit theory Robert L Boylestad Louis Nashelsky http://www.rtna.ac.th/departments/elect/Data/EE306/Electronic%20Devices%20and%20Circuit%20Theory.pdf
2. Op-Amps and Linear Integrated Circuits Ramakant A Gayakwad Pearson https://civildatas.com/download/op-amps-and-linear-integrated-circuit-technology-by-ramakant-a-gayakwad

Scheme of Evaluation: (Integrated courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO/PSO Mapping

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO33.1	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO33.2	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO33.3	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO33.4	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO33.5	3	-	2	1	-	-	1	-	-	-	-	2	1	2	2
22EEE33	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2

SEMESTER – III

Course: Electric Circuits (Program Core)

Course Code	22EEE34	CIE Marks	50
Hours/Week (L: T: P)	2: 2: 0	SEE marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Engineering Mathematics, Fundamentals of Electrical Engineering

Course Objectives:

CLO1	Illustrate various circuit reduction and analyzing techniques such for DC and AC circuits
CLO2	Apply different network theorems for solving complex networks
CLO3	Apply various techniques for solving circuits under transient conditions
CLO4	Computing different parameters for two port networks.
CLO5	Calculate the aftermath due unbalance nature in three phase circuits supplied by balanced three phase supply.

Content	No. of Hours/ RBT levels
Module 1: DC and AC Circuit Analysis – I Classification of circuit elements, Concept of Ideal and practical sources, **Network Reduction Techniques:** Source transformation, Source shifting and star – delta transformation techniques. **Circuit Analysis Methods:** Mesh and Node analysis with both independent and dependent sources (including Super-Mesh and Super node techniques).	8 hours L3
Module 2: DC and AC Circuit Analysis – II Network Theorems: Super Position, Reciprocity, Thevenin's, Norton's, Maximum power transfer, Millman's theorems. Analysis of DC and AC Circuits for both DC and AC excitations (independent sources only).	8 hours L3
Module 3: Transient Circuit Analysis Behaviour of circuit elements under switching action (t = 0 - and t = 0+), Initial conditions, Evaluation Response of RL and RC series circuits subjected to step excitation using time domain and Laplace transforms method.	8 hours L3
Module 4: Two-port Networks Definition and determination of Open circuit impedance, Short circuit admittance, Transmission (ABCD) parameters for simple DC, AC, and s-domain two-port networks, Inter relation among the above parameters.	8 hours L3
Module 5: Unbalanced Three Phase Systems and Coupled circuits **Unbalanced Three Phase Systems:** Analysis of three phase unbalanced systems supplied by balanced three phase supply. Evaluation of currents, voltages, real and reactive Powers. **Coupled circuits:** Self and Mutual Inductance, Concept of mutual coupling, Interrelations, Calculation of equivalent inductance in complex coupled circuit and Coupled impedance.	8 hours L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO34.1	Apply relevant network reduction techniques for solving DC and AC circuits.
CO34.2	Solve given network by adopting relevant theorem based on the circuit configuration.
CO34.3	Analyze behavior of circuit elements under switching condition.
CO34.4	Calculate various network parameters for given two port circuit.
CO34.5	Evaluate the effect of unbalance in three-phase circuit and mutual coupling in magnetically coupled circuits.

Textbooks:

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

Reference books:

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, Rich and C Dorf and James A Svoboda Wiley 9th Edition, 2015
4. Circuit Analysis; Theory and Practice, Allan H Robbins Wilhelm C Miller Cengage 5th Edition, 2013
5. Basic Electrical Engineering, V K Mehta, and Rohit Mehta S Chand 6th Edition 2015

E-Books / Web References

1. https://www.allaboutcircuits.com/textbook/
2. https://sites.pitt.edu/~qiw4/Academic/MEMS0031/Introduction%20to%20Electric%20Circui ts.pdf
3. https://www.ibiblio.org/kuphaldt/electricCircuits/
4. https://openpress.usask.ca/physics155/

MOOCs

1. https://nptel.ac.in/courses/108/105/108105159/
2. https://www.openlearning.com/courses/electric-circuit/?cl=1
3. https://www.edx.org/course/principles-of-electric-circuits-2

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO34.1	3	2	-	-	-	-	-	-	-	-	-	-		3	1
CO34.2	3	3	-	-	-	-	-	-	-	-	-	1		3	1
CO34.3	3	2	-	-	-	-	-	-	-	-	-	-		3	
CO34.4	3	2	-	-	-	-	-	-	-	-	-	-		3	1
CO34.5	3	2	-	-	-	-	-	-	-	-	-	-	2	3	
22EEE34	3	2	-	-	-	-	-	-	-	-	-	1	2	3	1

SEMESTER – III

Course: Measurements and Transducers (Program Core)

Course Code	22EEE35	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Fundamentals of Electrical Engineering

Course Objectives:

CLO1	Distinguish methods to measure resistance, inductance, and capacitance using bridges.
CLO2	Describe working of different electronic & digital instruments.
CLO3	Understand working of Electric Transducers, Potentiometers and Thermistor.
CLO4	Discuss various Inductive transducers and different Capacitive Transducers.
CLO5	Describe the Smart Sensors and its Applications

Content	No. of Hours/ RBT levels
Module 1: Measurement of Resistance, Inductance and Capacitance **Measurement of Resistance:** Classification of Resistance, Measurement of Resistance - Whetstone Bridge, High resistance measurement by Loss of Charge method. Measurement of Earth Resistance – Megger. **Measurement of Inductance:** Anderson Bridge **Measurement of Capacitance:** Schering Bridge.	08 Hours L2
Module 2: Electronic and Digital Instruments **Electronic Instruments:** Electronic Voltmeter and its advantages, True RMS reading Voltmeter. Cathode Ray Oscilloscope (CRO), **Digital Instruments:** Digital Voltmeter- Ramp Type, Digital LCR Meter, Digital Multimeter, Electronic Energy Meter. (Block Diagram Approach Only), smart meters.	08 Hours L2
Module 3: Transducers Introduction, Transducers, Electric Transducers, Advantages of Electrical Transducers, Classification of Transducers, Characteristics and Choice of Transducers. Resistive Transducers, Potentiometers – Loading Effect, Power Rating of Potentiometers, Disadvantages of Resistance Potentiometers, Theory of Strain Gauges, Resistance Thermometers, Thermistor.	08 Hours L2
Module 4: Inductive and Capacitive Transducers Integrated Circuit Temperature Transducers, Variable Inductance Transducers, Linear Variable Differential Transformer (LVDT), Advantage and Disadvantage of LVDTs, Uses of LVDTs, Rotary Variable Differential Transformer (RVDT). Capacitive Transducers – Differential Arrangement, Variation of Dielectric Constant for Measurement of Displacement, Variation of Dielectric Constant for Measurement of Liquid Level, Frequency Response of Capacitive Transducers, Advantages and Disadvantages of Capacitive Transducers, Uses of Capacitive Transducers, Piezo – Electric Transducers, Hall Effect Transducers, Applications of Hall Effect Transducer.	08 Hours L2

Module 5: Smart Sensors and its Applications **Smart Sensors:** Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing - Data Communication, Standards for Smart Sensor Interface, the Automation **Sensors –Applications:** Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing – Sensors for environmental Monitoring	08 Hours L2

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO35.1	Summarize the different methods used for measuring resistance, inductance and capacitance.
CO35.2	Explain the working of various types of digital & smart meters.
CO35.3	Describe the working of Electric Transducers, Potentiometers and Thermistor.
CO35.4	Distinguish the various Inductive, different Capacitive, Piezo – Electric and Hall-effect transducers.
CO35.5	Explain the Smart Sensors and its Applications

Textbooks:

1. A. K. Sawhney, Electrical & Electronic Measurement & Instruments, Dhanpat Rai & Co. Publications, 2007.
2. "Sensors and Transducers - D. Patranabis" –PHI Learning Private Limited., 2003
3. R. K. Rajput, Electrical & Electronic Measurement & Instruments, S. Chand. 5th Edition 2015.

Reference books:

1. G.K. Banerjee, Electrical & Electronic Measurements, PHI Learning Private Limited, 2012.
2. E.W. Golding and F.C. Widdis, Electrical Measurements and measuring Instruments, 5th Edition, Reem Publications, 2011.
3. J. B. Gupta, A Course in Electronics and Electrical Measurements and Instrumentation, Katson Books, 2013 Edition.
4. David A bell, Electronic Instrumentation and Measurements, 2nd Edition.
5. K. Lal Kishore, Electronic Measurements and Instrumentation 1st Edition, Pearson

E-Books / Web Reference

1. http://www.a-zshiksha.com/forum/viewtopic.php?f=147&t=61577
2. https://www.scribd.com/document/541458088/SENSORS-AND-TRANSDUCERS-nodrm
3. https://www.academia.edu/31325204/Text_book_Electronic_Instrumentation_and_Measurements_David_A_bell_2nd_edition_pdf

MOOCs

1. https://youtu.be/iUMoVcx2UNU
2. https://youtu.be/lqgUqOvd_os
3. https://youtu.be/e1T8CXLhUU8
4. https://youtu.be/RCs0Qlpi-rU
5. http://elearning.vtu.ac.in/econtent/courses/video/EEE/10EE55.html
6. https://nptel.ac.in/courses/108/105/108105153/

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module

carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO35.1	2	-	-	-	-	-	-	-	-	-	-	2	-	-	1
CO35.2	2	-	-	-	-	-	-	-	-	-	-	2	-	-	1
CO35.3	2	-	-	-	-	-	-	-	-	-	-	2	-	-	1
CO35.4	2	-	-	-	-	1	-	-	-	-	-	2	-	-	1
CO35.5	2	-	-	-	-	-	-	-	-	-	-	2	-	-	1
22EEE35	2	-	-	-	-	1	-	-	-	-	-	2	-	-	1

SEMESTER – III

Course: Digital Logic Design (Ability Enhancement course)

Course Code	22EEE36	CIE Marks	50
Hours/Week (L: T: P)	2:0:2	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Elements of Electronic Engineering (20ELN16/26)

Course Objectives:

CLO1	Use Karnaugh maps to simplify Boolean equations
CLO2	Design Decoders, Encoders, Digital Multiplexer, Adders, Subtractors and Binary Comparators
CLO3	Understand different types of Flip-flops and Registers
CLO4	Design the counters for given sequence
CLO5	Understand the different types of memory devices

Content	No. of Hours/ RBT levels
Module 1: Principles of Combinational Logic Definition of combinational logic, canonical forms, Simplification of Boolean function using Karnaugh maps-3,4,5 variables, incompletely specified functions (Don 't care terms), Simplifying Max term equations	6 hours L1, L2,L3
Module 2: Data-Processing Circuits General approach to combinational logic design, Decoders, Encoders, digital multiplexers, using multiplexers as Boolean function generators, Adders and subtractors, cascading full adders, Look ahead carry generator, Binary comparators.	6 hours L1, L2, L3
Module 3: Sequential Circuits SR latch, applications, Gated SR latch, D, T, JK flip flops, Characteristics equations, Master/Slave JK flip-flop, Edge triggered flip flop, Registers, Types of registers	5 hours L1, L2, L3
Module 4: Designing of Sequential circuits Counters, Conversion of one flip flop to another, Design of an asynchronous MOD-8, MOD-6, MOD-5 counter using JK, D, T flip flops, Design of a synchronous MOD-8, MOD-6, MOD-5 counter using JK, D, T flipflops. counter design with random sequence	7 hours L1, L2, L3
Module 5: Memory Devices Introduction to Programmable logic devices (PLD), Programmable Read Only Memory (PROM), Programmable Array Logic (PAL), Programmable Logic Array (PLA)	4 hours L1, L2

Sl. No.	Experiments	No. of Hours/ RBT levels
1.	Realize the given expression using a suitable decoder	
2.	Realization of Half/Full adder and Half/Full Subtractors using multiplexer	2 hours L3
3.	Design and implement two-bit magnitude comparator	2 hours L3
4.	Rig up and verify Decimal-to-BCD Encoder using IC 74147	2 hours L3
5.	To set up and test a 7 segment static display system to display numbers from 0 to 9 using BCD to 7 segment decoder/driver.	2 hours L3
6.	Realize the following flip-flops using NAND gates/IC 7476 (a) Master-Slave JK flip flops (b) D flip flop (c) T flip flop	2 hours L3

7.	Design and testing of Sequence generator	2 hours L3
8.	Realization of 3-bit counters as a sequential circuit and MOD – N counter design using 7490.	2 hours L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO36.1	Develop simplified Boolean expression using Karnaugh Maps
CO36.2	Design Multiplexer, Encoder, Decoder, Adder, Subtractors and Comparator as digital combinational circuits.
CO36.3	Describe different types of flip flops and shift registers
CO36.4	Develop counters for the given specifications
CO36.5	Understand the different memory devices

Textbooks:

1. Digital principles and applications ,Donal P leach,Albert Paul Malvino, Goutam Saha ,8th edition, McGraw Hill Education (India) Private Limited
2. Digital Design: With an introduction to Verilog HDL, VHDL and System Verilog 6th Edition by M.Morris Mano, Michel Giletti

Reference books:

1. Digital Principles and Design Donald D. Givone McGraw Hill 2002 ISBN 978-0- 07-052906-9.
2. Digital Circuits and Design D. P. Kothari and J. S Dhillon Pearson 2016, ISBN:9 789332 543539

E-Books / Web References

1. Digital Logic and Computer Design By M. Morris Mano

https://www.pdfdrive.com/digital-logic-and-computer-design-by-m-morris-mano-e34332016.html

2. Introduction to logic design and logic circuits with Verilog By Brock J.LaMeres, Springer

https://www.pdfdrive.com/introduction-to-logic-circuits-logic-design-with-verilog-d180988648.html

MOOCs

1 https://nptel.ac.in/courses/117/105/117105080/

2. https://www.khanacademy.org/

3. E-learning: www.vtu.ac.in

Scheme of Evaluation: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO36.1	3	1													
CO36.2	3	1	1		1							1			2
CO36.3	3	1			1							1			2
CO36.4	3	1	1		1							1			2
CO36.5	3	1	1									1			2
Average	3	1	1		1							1			2

Scheme and Syllabus
of
UG Autonomous Program – 2022 batch

IV SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22MAT41D	Complex Variables and Probability	BS	MAT	2	2	0	50	50	100	3
2	22EEE42	Electrical Machines-II	IPC	Respective Department	3	0	2	50	50	100	4
3	22EEE43	Control Systems	IPC		3	0	2	50	50	100	4
4	22EEE44	Power System –I	PC		2	2	0	50	50	100	3
5	22EEE45	Signal and Systems	ESC/ETC/PLC		2	2	0	50	50	100	3
6	22EEE46	Ability Enhancement Course – II **(Theory)**	AEC		3	0	0	50	50	100	3
		OR			**OR**						
		Data structures using C	AEC		2	0	2	50	50	100	3
							Total	**300**	**300**	**600**	**20**

SEMESTER IV

Course: Complex Variables and Probability

Course Code	22MAT41D	CIE Marks	50
Hours/Week (L: T: P)	2:2:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: To enable students to apply the knowledge of Mathematics in variousfields of engineering by making them to learn:

CLO1	Analytic functions and complex line integrals
CLO2	Probability distributions
CLO3	Sampling distributions and testing of hypothesis

Content	No. of Hours/ RBT levels
Module 1 Function of a complex variable, Analytic Functions-Cauchy-Riemann equations in Cartesian and polar forms. Construction of analytic functions using Milne Thomson method.	08 Hours L2, L3
Module 2 Conformal Transformations, Bilinear transformations. Complex lineintegrals, Cauchy's theorem, Cauchy's integral formula, Singularities, poles, residues, Cauchy's residue theorem.	08 Hours L2, L3
Module 3 Probability, Axioms of probability, Conditional probability, Bayes theorem,Discrete and continuous random variables, Moments, Moment generating functions, Binomial, Uniform, exponential, Poisson, Normal distributions.	08 Hours L2, L3
Module 4 Joint distributions (both discrete and continuous), Marginal and conditional distributions, Expectation and Covariance. Transformation of random variables, Central limit theorem and law of large numbers.	08 Hours L2, L3
Module 5 Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, student's t-distribution, chi-square distribution as a test of goodness of fit, F Test.	08 Hours L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO41.1	Apply Cauchy Riemann equations to study different properties of analytic functions
CO41.2	Evaluate complex line integrals
CO41.3	Solve problems associated with random variables using probability distributions
CO41.4	Solve problems related to testing of hypothesis

Textbooks:

1. T Veerarajan, Probability, Statistics and Random Processes for Engineers, Tata McGraw Hill,3rd Edition, 2008
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017

Reference books:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6thEdition, 2014
3. Richard H Williams, Probability, Statistics and Random Processes for Engineers, CengageLearning, 1st Edition, 2003

Scheme of Examination:

Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reducedto 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **onefull question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is addedto test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproductionof research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Assignments	10	
SEE	Semester End Examination	50	50
Grand Total			100

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO41.1	3	2	1									3				
CO41.2	3	2	1									3				
CO41.3	3	2	1									3				
CO41.4	3	2	1									3				
Average	3	2	1									3				

Low-1: Medium-2: High-3

SEMESTER IV

Course: Electrical Machines – II (Integrated Program Core)

Course Code	22EEE42	**CIE Marks**	50
Hours/Week (L: T: P)	3:0:2	**SEE Marks**	50
No. of Credits	4	**Examination Hours**	03

Prerequisites:

Fundamentals of Electrical Engineering – 22ELE14/24

Course Objectives:

CLO1	Understand the working principle, constructional details, and performance of DC Generators.
CLO2	Analyze the performance characteristics of DC Motors by conducting suitable tests and control the speed by suitable methods.
CLO3	Understand the working principle, construction and various excitation systems in Synchronous Generators.
CLO4	Analyze the performance of Synchronous Generators under various conditions.
CLO5	Explain the operation of Synchronous motors and its starting methods.

Content	No. of Hours/RBT levels
Module 1: DC Machine- I Construction & Principle of operation, method of excitation, types of DC machines, EMF equation, armature reaction and methods of limiting armature reaction, Commutation process and methods for improving commutation; Characteristics of DC Generators, Power flow diagram, losses and efficiency calculations, Parallel operation of DC Generators.	**8 Hours/ L2**
Module 2: DC Machine- II Principle of operation of DC motors, Concept of back EMF, Torque equation, operating characteristics of DC motors, Starting of DC motors- 3 point and 4 point starters, speed control of DC shunt and series motors, Efficiency Calculations. Testing of D.C. Machines: Direct Method, Indirect method – Swinburne, Hopkinson, Retardation and Field tests. Application of DC machines	**8 Hours/L4**
Module 3: Synchronous Generators- I Construction and principle of operation of Synchronous Machines; types of generators; excitation systems; Armature windings, winding factors, EMF equation. Harmonics–causes, reduction and elimination. Armature reaction, Synchronous reactance, Equivalent circuit, relation between generated voltage and terminal voltage, voltage regulation of alternators using synchronous impedance, MMF, ZPF method	**9 Hours/L2**
Module 4: Synchronous Generators-II Salient pole machines- two reaction theory, equivalent circuit model and phasor diagram; Slip test; regulation of salient pole alternator, Short Circuit Ratio and its significance; power angle characteristics; Synchronization & parallel operation and load sharing; synchronizing current, synchronizing power and synchronizing torque coefficient; effect of varying excitation and mechanical torque. Analysis of short circuit oscillogram, determination of various transient, sub transient and steady reactance and time constants.	**7 Hours/ L4**

Module 5: Synchronous Motors	
Principle of operation, Torque equation, V and inverted V curves, Power equations, Starting methods, effect of varying excitation, effect of load changes in a synchronous motor, Synchronous condenser, hunting and damping phenomena. Applications of synchronous motors.	**8 hours/ L2**

Laboratory Experiments

Sl. No.	Experiments	No. of Hours/ RBT levels
1	Magnetization and Load characteristics of DC shunt generator.	02 Hours/ L3
2	Speed control of DC shunt motor.	02 Hours/ L3
3	Swinburne s Test on DC shunt motor.	02 Hours/ L3
4	Performance characteristics of DC series motor.	02 Hours/ L3
5	Retardation test on DC shunt motor.	02 Hours/ L3
6	Regenerative test on DC shunt machines.	02 Hours/ L3
7	Voltage regulation of an alternator by EMF and MMF methods.	02 Hours/ L3
8	Voltage regulation of an alternator by ZPF method.	02 Hours/ L3
9	Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.	02 Hours/ L3
10	V and inverted V curves on synchronous motor.	02 Hours/ L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO42.1	Explain the working principle, constructional details, and performance of DC Generators.
CO42.2	Analyze the performance characteristics of DC Motors by conducting suitable tests and control the speed by suitable methods.
CO42.3	Explain the working principle, construction and various excitation systems in Synchronous Generators.
CO42.4	Analyze the performance of Synchronous Generators under various conditions.
CO42.5	Explain the operation of Synchronous motors and its starting methods.

Textbooks:

3. **P.S.Bimbhra,** Electrical Machines, Khanna Publishers, 7th Edition , 2011
4. **Nagrath and Kothari,** Electrical Machines , McGraw-Hill Education India, 2018

Reference books:

5. **A.E.Fitzgerald, Charles Kingsley, Stephen D Umans,** Electrical Machinery, 6th Edition, McGraw Hill Higher Education, 2014
6. **V.Del Toro,** Basic Electric Machines, Pearson Education India, 2016
7. **Ashfaq Hussain,** Electrical Machines, Dhanpat Rai & Co, 3rd Edition , 2020
8. **Samarajit Ghosh,** Electrical Machines, 2nd Edition, Pearson Education India, 2012

E-Books / Web References

1. https://ndl.iitkgp.ac.in/result?q={%22t%22:%22search%22,%22k%22:%22electrical%20mac hines%22,%22s%22:[],%22b%22:{%22filters%22:[]}}
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric- machines-fall-2013/course-notes
3. https://edisontechcenter.org/Transformers.html
4. https://edisontechcenter.org/inductionMotors.html

MOOCs

1. https://nptel.ac.in/courses/108/105/108105017/
4. https://www.classcentral.com/course/swayam-electrical-machines-iitd-14030
5. E-learning: www.vtu.ac.in

Scheme of Evaluation: (Integrated courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO42.1	3	2	-	-	-	-	-	-	-	-	-	1	3	1	-
CO42.2	3	2	-	-	-	-	-	-	-	-	-	1	3	1	-
CO42.3	3	-	2	-	-	-	-	-	-	-	-	1	3	1	-
CO42.4	3	-	-	-	-	-	-	-	-	-	-	1	3	1	-
CO42.5	3	-	-	-	-	-	-	-	-	-	-	1	3	1	-
22EEE42	3	2	2	-	-	-	-	-	-	-	-	1	3	1	-

SEMESTER IV

Course: Control Systems (Integrated Program Core)

Subject code	22EEE43	CIE Marks	50
Number of Lecture Hours/Week	3:0:2	SEE Marks	50
Credits	4	Exam Hours	03

Course Objectives: This course enables the students to

CLO1	Construct mathematical models of electrical and mechanical system.
CLO2	Apply Block Diagram reduction techniques and Signal Flow Graph to derive transfer function of linear systems.
CLO3	Calculate time response and frequency response specifications.
CLO4	Analyse a system in time domain and frequency domain with respect to stability.
CLO5	Understand the design procedure of PID controller, lag compensator and lead compensator.

CONTENT	No. of Hours/ RBT levels
Module 1: Mathematical Modeling of Physical Systems **Introduction to Control Systems:** Introduction, Open loop and Closed loop control system. **Mathematical Modelling of physical systems**: Transfer functions, poles and zeros. Mathematical modelling of electrical systems, mechanical systems, procedure for deriving transfer functions. Electrical analogy of mechanical system. Servomechanism. AC and DC servomotors.	8 hours L5
Module 2: Block Diagram and Signal Flow Graph **Block Diagram**: Block diagram representation of closed loop system, block diagram reductions techniques to derive transfer function. **Signal Flow Graph**: Construction of signal flow graph for a given electrical network from system equations. Mason's Gain formula.	8 hours L3
Module 3: Time Domain Analysis and Stability **Time Domain Analysis**: Standard test signals, time response of first order and second order systems [unit step input only], time domain specifications, steady state errors and error constants. **Concept of Stability**: BIBO stability, Routh-Hurwitz criterion, relative stability analysis.	8 hours L3, L4
Module 4: Stability Analysis using Root locus and Bode Plot **Root Locus Technique:** Introduction, Construction of Root loci, Stability analysis using root loci. **Frequency Domain Analysis**: Frequency domain specifications. **Bode Plots:** General procedure for construction of bode plots, computation of gain margin and phase margin, Stability Analysis using Bode Plot.	8 hours L3,L4
Module 5: Stability Analysis using Nyquist Plot, Controllers, Compensators **Nyquist plot**: Nyquist stability criterion, assessment of relative stability using Nyquist criterion. **PID controller:** Effect of P, PI, PD and PID controller. [elementary statements only] **Design of Compensators**: Need of compensators, design Steps of lag and lead compensators. [elementary statements only]	8 hours L3

Sl. No.	Experiments	No. of Hours/ RBT levels
1	Conduct a load test to draw Speed-Torque characteristics of AC and DC Servomotor.	02 hours/**L2**
2	**a.** Experiment to Determine Frequency Response specifications of a second order system. **b.** Determine the effect of damping ratio on frequency response.	02 hours/**L3**
3	Design a passive phase lead compensator for a given maximum phase lead and determine the transfer function experimentally.	02 hours/**L3**
4	Design a passive phase lag compensator for a given maximum phase lag and determine the transfer function experimentally.	02 hours/**L3**
5	Study the effect of P, PI, PD and PID controller on the step response of a second order feedback control system.	02 hours/**L2**
6	(a) Determine the step response of a second order system and determine. The time domain specifications. (b) Evaluate the effect of addition of poles and zeros on time response of 2^{nd} order system.	02 hours/**L3**
7	Verify the effect of input waveform (step, ramp and parabolic) and system type on steady state error.	02 hours/**L2**
8	Design a lead compensator using simulation for a given system to obtain required frequency domain specification.	02 hours/**L3**
9	Obtain the root locus plot of a given open loop transfer function and determine: **a)** The range of open loop gain K for which the closed loop system is stable. **b)** The breakaway and/or break-in points and the corresponding gain. **c)** Determine the effect of addition of poles and zeros on stability of system.	02 hours/**L3**
10	Judge the stability of a given system using Bode plot and Nyquist plot and compare the result.	02 hours/**L4**

Course Outcomes:

Upon successful completion of this course, the student shall be able to:

CO1	Construct models of electrical and mechanical systems using mathematical modelling.
CO2	Apply block diagram reduction techniques and Mason's Gain Formula to obtain the transfer function of the given system.
CO3	Calculate time response and frequency response specifications of the given System.
CO4	Analyze linear systems with respect to stability using different methods in time and frequency domain.
CO5	Apply the standard design procedure to design passive lead compensator, lag compensator and PD, PI, PID controller for a given specifications and obtain the frequency responses.

Text books:

1. Control Systems Engineering by I.J Nagrath, M Gopal, New Age International Publishers; 6th edition 2017.
2. Control System Engineering by Norman S. Nise, Wiley India Edition 2018

Reference books:

3. Modern Control Engineering by Ogata, Pearson Education India; 5th edition 2015
4. Control Systems by Anand Kumar, PHI, 2nd Edition 2014
5. Control Systems (Schaum's Outline Series) by Joseph Distefano et al. McGraw Hill Education; 3rd edition 2017.
6. Control Systems, by Jairath A, Ane Books Pvt Ltd, 2008.
7. Ramesh Babu P Anandanatarajan R, Control Systems Engineering, Scitech Publications (India) Pvt Ltd, December 2018.
8. A.Nagoor kani, Control Systems Engineering, RBA Publications, January 2014.

E-Books / Web References

1. Vincent Del Toro, Principles of Control Systems Engineering, Mc Graw Hill, https://babel.hathitrust.org/cgi/pt?id=mdp.39015000451032&view=1up&seq=9&skin=2021
2. https://en.wikibooks.org/wiki/Control_Systems
3. https://www.youtube.com/watch?v=HcLYoCmWOjI&list=PLBlnK6fEyqRhqzJT87LsdQKYZBC93ezDo

MOOCs

1. https://nptel.ac.in/courses/108/106/108106098/
2. https://nptel.ac.in/courses/108/102/108102043/
3. http://elearning.vtu.ac.in/econtent/courses/web/EEE/17EE61.html

Scheme of Evaluation: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO43.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO43.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO43.3	3	2	-	2	3	-	-	2	2	2	-	2	-	-	2
CO43.4	3	2	2	2	3	-	-	2	2	2	-	2	-	-	2
CO43.5	3	2	2	2	3	-	-	2	2	2	-	2	-	-	3
22EEE43	**3**	**2**	**2**	**2**	**3**	**-**	**-**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**2**

SEMESTER – IV

Course: Power System – I (Program Core)

Course Code	22EEE44	CIE Marks	50
Hours/Week (L: T: P)	2:2:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Electric Circuits, Fundamentals of Electrical EngineeringCourse Objectives:

CLO1	Understand the Structure of Power Systems and other Economic Aspects
CLO2	Explain the modelling of transmission line with passive elements
CLO3	Analyze the performance of transmission system under given loading condition
CLO4	Describe the factors affecting overhead Insulator design of Transmission lines along with mechanical aspects
CLO5	Compare the distribution systems with overhead transmission system

Content	No. of Hours/ RBT levels
Module 1: Structure of Power Systems and other economic aspects: Introduction, Typical Power Systems Structure, definitions of commonly used terms-connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve etc. Load characteristics, relation between load factor and loss factor, power factor of various equipment, causes and disadvantages of low power factor Cost of electrical energy-fixed cost, running cost, Tariff on charge to customer.	8 hours L2
Module 2: Transmission line parameters Introduction to line parameters- resistance, inductance, and capacitance – Calculation of inductance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines – Inductance of composite conductors, Advantages of single circuit and double circuit lines. Calculation of capacitance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines – Capacitance of composite conductor.	8 hours L3
Module 3: Performance evaluation of Transmission line Classification of lines, Current and voltage interrelations, Calculation of line regulation and efficiency – Nominal T and nominal Pi circuits – Long lines considering hyperbolic form equations. Equivalent circuit of a long line with T and Pi configurations, ABCD constants – Ferranti, Ferro resonance and proximity effects.	8 hours L3
Module 4: Overhead Transmission line aspects Line Insulators: Types of insulators, Potential distribution over a string of suspension insulators, String efficiency, Methods of increasing string efficiency. Sag: Importance of sag, Sag calculation – supports at same and different levels, effect of wind and ice, Line vibration and dampers. Corona: Phenomena, disruptive and visual critical voltages, corona loss. Advantages and disadvantages of corona. Methods of reducing corona.	8 hours L3
Module 5: Distribution Systems AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system, AC distribution calculations, AC distributors with concentrated loads. DC distribution systems – Classification, DC distributor Fed at one end, DC distributor Fed at both ends, parallel feeders, Stepped or Tapered Distributor, Ring Main Distributor.	8 hours L2

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO44.1	Explain the structure of power systems and other economic aspects
CO44.2	Analyze the transmission line parameters for given transmission line configuration
CO44.3	Analyze the performance of given power transmission system
CO44.4	Interpret the mechanical aspects involved in design of overhead transmission lines
CO44.5	Distinguish the distribution with transmission system

Textbooks:

1. A Textbook on Power System Engineering; By A. Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, Dhanpat Rai & Co. (P) Limited, 2016.
2. Electrical Power Systems; By D. Das, New Age International Publishers, 2006.
3. Power System Analysis and Design; By B.R. Gupta, S Chand & Company; Re-Issue Edition,2005
4. Principles of Power System; By V.K.Mehta and Rohit Mehta, S Chand & Company;

Reference books:

1. Electrical Power Systems, By C.L Wadhwa, New Age Internationals; 7th Edition, 2016.
2. Power System Analysis, By John Grainger and William Stevenson Jr., Mcgraw Hill Education,2017.
3. Electrical Power Transmission System Engineering: Analysis and Design, By Turan Gonen, CRCpress; 2nd Edition, 2009.
4. Power System Engineering, By D. P. Kothari And I.J. Nagrath , Mcgraw-Hill; 3rd Edition, 2019.

E-Books / Web References

1. https://engineeringonline.ucr.edu/blog/power-systems-engineering-a-career-on-the-grid/
2. https://pserc.wisc.edu/
3. https://cusp.umn.edu/power-systems/advanced-power-systems-1-2

MOOCs

1. https://www.cousera.org/learn/electric-power-systems
2. https://nptel.ac.in/courses/108/105/108105104/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-061-introduction-to-electric-power-systems-spring-2011/

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-

thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO44.1	3	2	-	-	-	-	-	-	-	-	-	1	-	3	-
CO44.2	3	2	-	-	-	-	-	-	-	-	-	1	-	3	-
CO44.3	3	2	-	-	-	-	-	-	-	-	-	1	-	3	-
CO44.4	3	2	-	-	-	-	-	-	-	-	-	1	-	3	-
CO44.5	3	2	-	-	-	-	-	-	-	-	-	1	-	3	-
22EEE44	3	2	-	-	-	-	-	-	-	-	-	1	-	3	-

SEMESTER – IV

Course: Signals and Systems

Course Code	22EEE45	CIE Marks	50
Hours/Week (L: T: P)	2:2:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Fourier Transforms, Z transforms, complex variables

Course Objectives:

CLO1	Understand generation of signals, elementary signals and properties of systems.
CLO2	Apply convolution in both continuous and discrete domain for the analysis of systems given impulse response of a system.
CLO3	Perform Fourier analysis for continuous and discrete time, linear time invariant systems.
CLO4	Apply Z-transform and properties of Z transform for the analysis of discrete time systems.

Content	No. of Hours/ RBT levels
Module 1 – Introduction **Introduction:** Definitions of signals and a system, classification of signals, **Basic operations on signals**: Amplitude Scaling, addition, multiplication, differentiation, integration, time scaling, time shifting and time reversal. **Elementary Signals and functions**: Exponential, sinusoidal, step, impulse and ramp functions.	08 hours L2
Module 2: Properties of systems and Time domain representation of LTI system **Properties of systems** – Linear, nonlinear, Time variant, time invariant, causal, non-causal, static, dynamic, stable, unstable, invertible. **Time – Domain Representations for LTI Systems:** Convolution sum, convolution integral, impulse response, Computation of convolution sum and convolution integral using graphical method.	08 hours L3
Module 3: Fourier Representation of signals and LTI systems Discrete time periodic signals, Discrete Time Fourier series (DTFS), Continuous Time periodic signals, Continuous Time Fourier Series (CTFS), Properties of CTFS and DTFS – Linearity, time shift, frequency shift, convolution, Perseval's theorem, symmetry.	08 hours L4
Module 4: Fourier Transforms Discrete time aperiodic signals, Discrete-time Fourier transform (DTFT), continuous time aperiodic signal, continuous time Fourier transform (FT). Properties of continuous and discrete time Fourier transform.	08 hours L4
Module 5: Z Transform Introduction, Z-transform, properties of region of convergence, properties of Z-transforms, Inverse Z-transform using power series and partial fraction expansion.	08 hours L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO45.1	Explain the generation of signals, properties of system and the basic operations that can be performed on signals
CO45.2	Compute the response of a continuous and discrete time LTI system using convolution sum and convolution integral.
CO45.3	Analyze the frequency response of a given periodic continuous and discrete time signal using Fourier series and its properties.
CO45.4	Analyze the frequency response of a given aperiodic continuous and discrete time signal using Fourier transform and its properties.
CO45.5	Determine the Z-transform, inverse Z-transform and transfer functions of complex LTI system.

Textbooks:

9. Signals and Systems, Simon Haykin, Berry Van Veen Wiley India, 2nd Edition,2008.

Reference books:

1. Signals and Systems Nagoor Kani McGraw Hill 1st Edition 2010.
2. Fundamentals of Signals and Systems Michael J. Roberts, Govind K Sharma McGraw Hill 2nd Edition 2010

E-Books / Web References

1. https://www.ece.uvic.ca/~frodo/sigsysbook/downloads/signals_and_systems-3.0.pdf
2. https://mlichouri.files.wordpress.com/2013/10/fundamentals-of-signals-and-systems.pdf

MOOCs

1. https://archive.nptel.ac.in/courses/108/104/108104100/
2. https://archive.nptel.ac.in/courses/108/106/108106163/
3. https://www.udemy.com/course/signals-and-systems-c/

Scheme of Evaluation: (Ability Enhancement courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO45.1	3	2	-	-	-	-	-	-	-	-	-	2	-	-	1
CO45.2	3	3	-	-	-	-	-	-	-	-	-	2	-	-	1
CO45.3	3	3	-	-	-	-	-	-	-	-	-	2	-	-	1
CO45.4	3	3	-	-	-	-	-	-	-	-	-	2	-	-	1
CO45.5	3	3	-	-	-	-	-	-	-	-	-	2	-	-	1
22EEE45	3	3	-	-	-	-	-	-	-	-	-	2	-	-	1

SEMESTER – IV

Course: Data structures using C (Ability Enhancement course)

Course Code	22EEE46	CIE Marks	50
Hours/Week (L: T: P)	2:0:2	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: C Programming

Course Objectives:

CLO1	Understand the working of different data structures
CLO2	Identify and apply appropriate data structure to solve a given problem
CLO3	Implement data structure algorithms using C programming
CLO4	Develop applications using data structure algorithms.

Content	No. of Hours/ RBT levels
Review of C Programming concepts – arrays, pointers, structures. Introduction to Data structure, Classifications (Primitive and Non-primitive), Data structures operations **Searching** – linear search and binary search	05 Hours L3
Sorting – Insertion Sort, selection sort, radix sort **Linked List** – Linked list vs arrays, Singly linked list and doubly linked list– traversing, searching, insertion and deletion	05 Hours L4
Stack Introduction, definition and examples, primitive operations, Implementing pop, push and peek operations using C. Linked representation of stack, Stack Application – Parenthesis checker, tower of Hanoi.	06 Hours L2
Queue Queue and its array representation, primitive operations, Implementation of linear queue using C. Circular Queue and priority queue.	6 Hours L3
Binary Trees Introduction and definition, Node representation of binary tree, linked representation of binary tree, binary search tree, Creating a binary tree from a general tree. Traversing a binary tree – preorder, post order, in-order, level-order traversal.	6 hours L3

Sl. No.	Programs	No. of Hours/ RBT levels
1	Write a program to search an element in an array using the linear search technique.	2 hours L3
2	Write a program to search an element in an array using binary search.	2 hours L3
3	Write a program to sort an array using a. selection sort algorithm. b. insertion sort algorithm	2 hours L3

4	Write a C Program to Create a Linked List and Display it.	2 hours L3
5	Write a program to perform Push, Pop, and Peek operations on a stack	2 hours L3
6	Write a program to check nesting of parentheses using a stack.	2 hours L3
7	Write a program to implement stacks using Array to perform Push, Pop and Peek operations.	2 hours L3
8	Write a program to implement a linear queue.	2 hours L3
9	Write a program to implement a circular queue.	2 hours L3
10	Write a program in C to construct a binary tree	2 hours L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO46.1	Comprehend different types of data structures and its applications in problem solving.
CO46.2	Implement searching and sorting algorithms.
CO46.3	Implement basic operations on linked list and stack.
CO46.4	Describe primitive operations on linear, circular and priority queue.
CO46.5	Implement basic operations on binary tree.

Textbooks:

5. Data Structure using C, Reema Thereja, Oxford University Press, 2nd edition (2014).

Reference books:

10. Data structures using C and C++, Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tenenbaum, Pearson, 2nd Edition (2020)
11. Seymour Lipschutz, Data Structure with C, Schaum's Outlines, Special Indian Edition, 13th reprint, Tata McGraw Hill Education, 2015.

E-Books / Web References

1. https://aa.bbs.tr/lab/cen215-data-structures/Data-Structures-Using-C-2nd-edition.pdf
2. https://faculty.washington.edu/jstraub/dsa/Master_2_7a.pdf

MOOCs

1. https://nptel.ac.in/courses/106102064
6. https://www.udemy.com/course/data-structures-and-algorithms-in-c/

Scheme of Evaluation: (Ability Enhancement courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO46.1	3	3	2	-	2	-	-	-	-	-	-	2	-	-	-
CO46.2	3	3	2	-	2	-	-	-	-	-	-	2	-	-	-
CO46.3	3	3	2	-	2	-	-	-	-	-	-	2	-	-	-
CO46.4	3	3	2	-	2	-	-	-	-	-	-	2	-	-	-
CO46.5	3	3	2	-	2	-	-	-	-	-	-	2	-	-	-
22EEE46	3	3	2	-	2	-	-	-	-	-	-	2	-	-	-

SCHEME 2022

V & VI Semester
Scheme and Syllabus

Electrical & Electronics Engineering

GLOBAL ACADEMY OF TECHNOLOGY
(Autonomous Institution affiliated to VTU, Belagavi, Accredited by NAAC with 'A' grade, NBA Accredited CS, E&C, E&E, MECH and IS branches)Ideal Homes Township,

Department of Electrical and Electronics Engineering

Global Academy of Technology
HOD, EEE
Bangalore

Scheme and Syllabus
of
UG Autonomous Program – 2022 batch

V SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22EEE51	Management & Economics	PC	Respective Department	3	0	0	50	50	100	3
2	22EEE52	Power Electronics	IPC		3	0	2	50	50	100	4
3	22EEE53	Embedded System	IPC		3	0	2	50	50	100	4
4	22EEE54	Power System –II	PC		2	2	0	50	50	100	3
5	22EEE55X	Program Elective 1	PEC		3	0	0	50	50	100	3
6	22EEE56	Ability Enhancement Course – III (**Theory**)	AEC		2	0	0	50	50	100	2
	OR				**OR**						
	22EEE56	Auto CAD	AEC		1	0	2	50	50	100	2
7	22CIV57	Environmental Science	CV	Civil	1	0	0	50	50	100	1
	OR										
	22UHV57	Universal Human Values	BS	Respective Department							
				TOTAL				**350**	**350**	**700**	**20**

Program Elective 1*			
22EEE551	Object Oriented Programming Using C++	**22EEE553**	Advanced Control Systems
22EEE552	Digital System Design using Verilog HDL	**22EEE554**	Electromagnetic Field theory

***NPTEL for Credit transfer:** Students can take 12 weeks NPTEL course as an equivalent to Program elective. The NPTEL courses of duration less than 12 weeks will not be considered for credit transfer. The courses (only technical) taken are as per the recommendation of BOS of respective department. The similarity of the contents as offered by NPTEL should not exceed a maximum of 40% of the courses being registered by the student. The NPTEL course need to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not be considered. The validity of NPTEL certificate is for two years and it cannot be used more than once to avail the benefit. The student is eligible to transfer a maximum of nine credits in the entire duration of the program. The grades will be awarded as equivalent to the grades obtained in the NPTEL course.

SEMESTER V

Course: Management and Economics

Course Code	22EEE51	CIE Marks	50
Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Credits	03	Examination Hours	03

Course Learning Objectives:

CLO1	Discuss the importance of management and planning
CLO2	Understand the characteristics of organization and leadership Styles.
CLO3	Understand the importance of project management
CLO4	Understand the fundamentals of economic concepts.
CLO5	Discuss about breakeven analysis and deprecation.

Content	No. of Hours/ RBT levels
Module 1: Introduction to Management & Planning **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. Understanding aspects of finance, marketing and resources management in business.	08 / L2
Module 2: Organizing, Staffing, Directing and Controlling **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, Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling. Brief review of Innovation management.	08 / L2
Module 3: Project Management Objectives & Characteristics, Project Identification-Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, 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. Case studies on Project Management implementation	08 / L2
Module 4: Fundamental Economic Concepts Introduction to Engineering Economy: Necessities and Luxuries, Market segments, Supply and Demand, diminishing returns, Economic Indicators (GDP, GNP, GNI, Fiscal Deficit etc.); Time Value of Money: Time value equivalence, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price	08 / L2

elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems	
Module 5: Breakeven Analysis and Depreciation Basic concepts, Linear break even analysis, break even charts, algebraic relationships, break-even point alternatives, dumping, multiproduct alternatives and multiple alternatives, Nonlinear Break even analysis: marginal revenue and profit, marginal cost and average unit cost, Inflation and its effects, Inflation, its causes and consequences. Effects of inflation on Breakeven Analysis. Depreciation: Purpose and use, Declining value and replacement of assets, Depreciation and tax, Straight line method, Declining and double declining balance method.	08 / L2

Course Outcomes

Upon completion of this course, student will be able to:

CO51. 1	Explain the importance of Management and Planning
CO51. 2	Describe the characteristics of organization and leadership styles.
CO51. 3	Explain the role and importance of project management
CO51. 4	Understand the fundamentals of economic concepts.
CO51. 5	Explain the linear, non-linear breakeven analysis and deprecation concepts.

TEXTBOOKS:

1. Principles of Management P.C. Tripathi, P.N.Reddy McGraw Hill, 6th Edition, 2017
2. Engineering Economics by, James L. Riggs, David D. Bedworth, Sabah U. Randhawa McGraw Hill Education, 4th Edition, 2004.
3.

REFERENCE BOOKS:

1. Essentials of Management: An International, Innovation and Leadership perspective Harold Koontz, Heinz Weihrich McGraw Hill 10thEdition 2016

E-Books / Web References

https://www.youtube.com/watch?v=8GFXOWxlySs

MOOCs

https://onlinecourses.nptel.ac.in/noc20_mg58/preview

Scheme of Examination:

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE (40) + AAT (10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO – PO Mapping With Strengths

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO51.1	2	-	-	-	-	-	-	1	-	-	-	1	-	-	-
CO51.2	2	-	-	-	-	-	-	1	-	-	-	1	-	-	-
CO51.3	2	-	-	-	-	-	-	1	-	-	-	1	-	-	-
CO51.4	2	-	-	-	-	-	-	1	-	-	-	1	-	-	-
CO51.5	2	-	-	-	-	-	-	1	-	-	-	1	-	-	-
22EEE51	2	-	-	-	-	-	-	1	-	-	-	1	-	-	-

V SEMESTER

Course: Power Electronics (Integrated Program Core)

Course Code	22EEE52	CIE Marks	50
Hours/Week (L: T: P)	3:0:2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Elements of Electronics Engineering

Course Objectives:

CLO1	Understand the working principle and characteristics of different power electronic devices.
CLO2	Understand turn on, turn off, and protection methods of thyristor.
CLO3	Analyse the operation of single phase and three phase controlled rectifier circuits connected to different types of loads.
CLO4	Discuss the working of different types of chopper circuit, buck converter, boost converter and cycloconverter.
CLO5	Analyse the operation of AC voltage controllers and single-phase inverter circuits.

Content	No. of Hours/ RBT levels
Module 1: Power Semiconductor Devices Introduction to Power Electronics, Power Diodes – Diode Characteristics, Reverse Recovery Characteristics, Power MOSFETs – static characteristics, switching characteristics, IGBTs – static characteristics, switching characteristics, Silicon Controlled Rectifier – static Characteristics, Two-Transistor Model of Thyristor. Types of thyristors.	8 hours L1, L2
Module 2: Thyristor triggering, commutation and protection Thyristor Turn On, Thyristor Turn-Off, Thyristor Firing Circuits, Gate triggering, R & R-C triggering, Unijunction Transistor. UJT triggering. Natural & Forced commutation. di/dt Protection, dv/dt Protection. Snubber circuit. Series parallel combination of thyristors.	8 hours L1, L2, L3
Module 3: Controlled Rectifiers Introduction, Principle of uncontrolled and controlled rectifier, Single phase half wave controlled rectifier with R load, RL Load, RL Load and Freewheeling Diode, Full controlled and half controlled converter (with R, RL, RLE load). Single-Phase Dual Converters, Principle of operation of Three-Phase full Converters.	8 hours L1, L2, L3
Module 4: DC-DC Converter and Cycloconverter DC-DC converter – Principle of step-down chopper and its analysis with R-L Load. Step up chopper. Class A, B, C, D and E choppers. Performance parameters. Switched mode regulator, Buck converter and boost converter. Cycloconverter – Principle of operation of Single phase cycloconverter.	8 hours L1, L2, L3
Module 5: AC voltage controllers and Inverters AC Voltage Controllers: Introduction, Principle of phase control, Single-Phase Full-Wave Controllers with Resistive Loads, Single- Phase Full-Wave Controllers with Inductive Loads. DC-AC Converters: Introduction, principle of operation single-phase bridge inverters, three-phase bridge inverters 120 degree and 180 degree mode of operation, Voltage control of single-phase inverter – single pulse-width, multi-pulse width and sinusoidal pulse width modulation.	8 hours L1, L2, L3

Sl. No.	Experiments	No. of Hours/ RBT levels
1	Static Characteristics of SCR	2 hours/L2
2	Static Characteristics of MOSFET and IGBT	2 hours/L2
3	SCR digital triggering circuit for single phase controlled rectifier and AC voltage controller.	2 hours/L3
4	SCR turn on circuit using synchronized UJT relaxation oscillator.	2 hours/L3
5	Single phase controlled full wave rectifier with R load and R –L load.	2 hours/L3
6	Single phase MOSFET/IGBT based PWM inverter.	2 hours/L3
7	Speed control of universal motor using AC voltage controller.	2 hours/L3
8	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.	2 hours/L3
9	Simulation of semi-converter and full controlled converter with R and R-L load.	2 hours/L2
10	Simulation of single phase bridge inverter.	2 hours/L2
	Open Ended Experiments	
11	Design of Buck Converter using MATLAB.	
12	Design of three phase converter.	

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO52.1	Understand the working and characteristics of power diodes, power MOSFETs, IGBTs and SCRs.
CO52.2	Understand thyristor triggering methods, commutation techniques and protection methods of thyristor.
CO52.3	Analyse the operation of controlled rectifier circuits connected to different types of loads.
CO52.4	Discuss the operation of step-down, step-up chopper, buck converter, boost converter and cycloconverter.
CO52.5	Analyse the operation of single phase and three phase AC voltage controllers and single-phase inverters.

Textbooks:

1. Power Electronics: Circuits Devices and Applications Mohammad H Rashid, Pearson 4th Edition, 2014.
2. Power electronics, M.D Singh, K.B Khanchandani, Tata McGraw Hill, 2nd Edition, 2006

Reference books:

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. Elements of Power Electronics: Indian Edition, Philip T. Krein, Oxford University Press; Second edition (2017)
4. Power Electronics, P.C Sen, McGraw Hill Education; 2nd edition (2017)
5. Power Electronics by Daniel Hart, McGraw Hill India (2011)

E-Books / Web References

1. https://freevideolectures.com/course/2351/power-electronics/1
2. http://site.iugaza.edu.ps/malramlawi/files/RASHID_Power_Electronics_Handbook.pdf
3. https://atakarihome.files.wordpress.com/2018/09/m-d-singh-k-b-khanchandani-power-electronics.pdf

MOOCs

1. https://www.coursera.org/learn/power-electronics?specialization=power-electronics
2. https://onlinecourses.nptel.ac.in/noc22_ee03/preview

Scheme of Evaluation: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

3.

4. **Table: Distribution of weightage for CIE & SEE of Integrated courses**

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO52.1	3	2	-	2	-	-	-	2	2	2	-	-	-	-	2
CO52.2	3	2	-	2	-	1	-	2	2	2	-	-	-	-	2
CO52.3	3	2	-	2	3	-	-	2	2	2	-	2	-	-	3
CO52.4	3	2	-	2	-	-	-	2	2	2	-	2	1	-	3
CO52.5	3	2	-	2	3	-	-	2	2	2	-	2	1	-	3
22EEE52	3	2	-	2	3	1	-	2	2	2	-	2	-	-	3

SEMESTER – V

Course: Embedded System (Integrated Program Core)

Course Code	22EEE53	CIE Marks	50
Hours/Week (L: T: P)	3:0:2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Elements of Electronic Engineering (20ELN16/26)

Course Objectives:

CLO1	Learn the architecture and features of 8-bit 8051 microcontroller.
CLO2	Develop the embedded C programs for the given applications using 8051 microcontrollers.
CLO3	Understand 32-bit ARM controller
CLO4	Describe different blocks of Embedded System.
CLO5	Know the current trends and applications of embedded systems in industry

Content	No. of Hours/ RBT levels
Module 1:8051 Microcontrollers Introduction to Embedded system, Microcontroller, Comparison of Microprocessor and Microcontroller, Intel MCS 51 family, Architecture and Pin Functions of 8051 Microcontroller, CPU Organization, Program Counter, Internal and external Memory Organization, Registers, Stack operation Data types available in embedded C, time delay functions in 8051C	8 hours L2
Module 2: 8051 Microcontroller Based System Design Input/Output Ports, I/O Port Programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C, Data serialization using 8051C, Timers and counters, modes of operation of timers, Programming timers in 8051C.	8 hours L3
Module 3: 8051 interrupts and ARM-32bit Microcontroller Serial communication, serial port programming in 8051 C, Interrupt Service Routines Programming in C, Interfacing DAC, stepper motor interfacing, DC motor interfacing and PWM. **Architecture of ARM Cortex M3** –General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Register. Advanced Programming Features.	8 hours L2
Module 4: Typical Embedded System Definition, Embedded systems vs. General Computing Systems, Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components, PCB and Passive Components.	8 hours L2
Module 5: Trends in the Embedded Industry Processor trends in embedded system, Embedded OS trends, Development Language Trends, Open Standards, Frameworks and Alliances, Bottlenecks. Embedded Systems-Application and Domain Specific: Washing Machine-application specific Embedded System, Automotive- Domain Specific Example of Embedded Systems Design Case Studies: Digital camera, Embedded Systems in Automobile, Smart Card Reader, Automated Meter Reading System.	8 hours L2

Sl. No.	Experiments	No. of Hours/ RBT levels
PART A: Conduct the following experiments by writing C Program using Keil Microvision simulator		
1	Write an 8051 C program to send the data to the I/O ports with some delay.	

2	Write an 8051 C program to find the sum of first 10 integer numbers	2 hours L3
3	Write an 8051 C program to Shifting the bits right or left.	
4	Write an 8051 C program to add an array of 16-bit numbers and store the 32 bit result in internal RAM	2 hours L3
5	Write an 8051 C program to find the square of a number (1 to 10)	
6	Write an 8051 C program to get a byte of data from P0. If it is less than 100, send it to P1, otherwise send it to P2.	
7	Write an 8051 C program to count the number of ones and zeros in two consecutive memory locations	2 hours L3
8	Write an 8051 C program to display "Hello World" message	
9	Write an 8051 C program to convert the hexadecimal data 0xCFh to decimal and display the digits on ports P0, P1 and P2	2 hours L3
10	Write an 8051 C program to toggle the bits of port P0, P1 with the given delay	
	PART B: Interfacing Programs	
1.	Interface DAC to 8051 microcontrollers to generate different wave forms 1. Sine wave 2. square wave 3. Triangular wave 4. Ramp wave 5. Staircase wave	2 hours L3
2.	Stepper motor interface to 8051 microcontrollers	2 hours L3
3.	DC motor interface to 8051 microcontrollers	
4	Elevator interface to 8051 microcontrollers	2 hours L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO53.1	Describe the architecture and features of 8-bit 8051 microcontroller.
CO53.2	Apply the knowledge of embedded C for writing the programs using 8051 microcontroller.
CO53.3	Explain 32-bit ARM controller and its features
CO53.4	Describe different blocks of Embedded System
CO53.5	Understand domain specific applications of embedded systems through case studies

Textbooks:

1. The 8051 Microcontroller and Embedded Systems Using Assembly and C, Muhammad Ali Mazadi, Pearson, 2 nd Edition, 2008
2. Shibu K V, " to Embedded Systems", First Edition, Tata McGraw Hill Education Private Limited, 2009
3. Joseph Yiu,"The Definitive Guide to the ARM Cortex-M3", Second Edition, Newnes, (Elsevier), 2008

Reference books:

6. Raj Kamal, "Embedded Systems – Architecture, Programming and Design", edition, Mc Graw Hill, 2012
7. James K Peckol "Embedded Systems – A contemporary Design Tool", edition, John Weily, 2008

E-Books / Web References

1. https://onlinecourses.nptel.ac.in/noc20_cs15/course

MOOCs

1 https://nptel.ac.in/course/

Scheme of Evaluation: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO53.1	3	3	1		3			3	3	3		3			2
CO53.2	3	3	1		3			3	3	3		3			2
CO53.3	3	3	1		3			3	3	3		3			2
CO53.4	3	3	1		3			3	3	3		3			2
CO53.5	3	3	1		3			3	3	3		3			2
Average	3	3	1		3			3	3	3		3			2

V SEMESTER

Power System II			
Subject Code	22EEE54	**CIE Marks**	50
Hours/Week (L:T)	2:2:0	**SEE Marks**	50
Credits	3	**Examination Hours**	03

Course Learning Objectives: At the end of the course the student should be able to:

CLO1	Understand one line diagram, impedance diagram/reactance diagram, per unit system, modelling of Power System Components
CLO2	Understand short circuit analysis on a synchronous machine and to select appropriate circuit breakers and current limiting reactors.
CLO3	Calculate sequence impedances of power system components and draw sequence network of a given system.
CLO4	Calculate the currents, voltages and power of a LG/LL and LLG on an unbalanced alternator and unsymmetrical faults on a power system with and without fault impedance.
CLO5	Understand steady state and transient stability , application of equal area criteria and methods of improving stability.

Content	No. of Hrs/ RBT levels
MODULE I – Per Unit Representation & Modeling of Power System Components	
Per unit quantities-single phase and three phase-selection of base quantities -advantages of per unit system –changing the base of per unit quantities Modelling of power system components - Steady State Model of Synchronous Machine, Power Transformer, Transmission Lines Representation of Loads. Single Line Diagram, Impedance and Reactance diagrams and their importance.	08 Hours/ L1, L2
MODULE II – Symmetrical Fault Analysis	
Introduction, Transients on a Transmission Line, Short Circuit Analysis of a Synchronous Machine – Unloaded and Loaded, Short Circuit MVA, Current limiting reactors, Selection of Circuit Breakers. Simple problems on fault current calculation.	08 Hours/ L1, L2
MODULE III – 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	08 Hours/ L1, L2
MODULE IV – 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	8 Hours/ L1, L2
MODULE V – Power System Stability	
Steady state, dynamic and transients stability , Dynamics of a Synchronous Machine, Swing Equation, Equal Area Criterion, critical clearing angle, Multi machine stability studies, Numerical Solution of Swing Equation by Point by Point method, Runge Kutta, Modified Euler's Method. Methods of Improving transient stability.	8 hours L1,L2
Total Hours	**40 Hours**

Course Outcomes: The students will be able to:

CO 54.1	Understand one line diagram, impedance diagram/reactance diagram, per unit system, modelling of Power System Components
CO 54.2	Understand short circuit analysis on a synchronous machine and to select appropriate circuit breakers and current limiting reactors.
CO 54.3	Calculate sequence impedances of power system components and draw sequence network of a given system.
CO 54.4	Calculate the currents, voltages and power of a LG/LL and LLG on an unbalanced alternator and unsymmetrical faults on a power system with and without fault impedance.
CO 54.5	Understand steady state and transient stability, application of equal area criteria and methods of improving stability.

TEXTBOOKS:

1. D P Kothari, I J Nagarath, Power System Engineering , Mc Graw Hill Education, Second Editiion, 2008
2. William D. Stevenson Jr , Elements of Power System Analysis, McGraw Hill Education; 4th edition , 2017

REFERENCES:

1. J.Duncan Glover et al, Power System Analysis and Design, Cengage, 4th Edition, 2008
2. Hadi Sadat, Power System Analysis Mc Graw Hill Education, 1st Edition, 2002

WEB LINKS:

1. https://nptel.ac.in/courses/108105067
2. https://ocw.mit.edu/courses/6-061-introduction-to-electric-power-systems-spring-2011/
3. https://www.classcentral.com/course/swayam-power-system-analysis-14243
4. https://onlinecourses.nptel.ac.in/noc22_ee17
5. https://www.udemy.com/course/electrical-power-engineering

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 54.1	3	2	2	-	-	-	1	-	-	-	-	2	1	2	-
CO 54.2	3	2	2	-	-	-	1	-	-	-	-	2	1	2	-
CO 54.3	3	2	2	-	-	-	1	-	-	-	-	2	1	2	-
CO 54.4	3	2	2	-	-	-	1	-	-	-	-	2	1	2	-
CO 54.5	3	-	2	-	-	-	1	-	-	-	-	2	1	2	-
Average	3	2	2	-	-	-	1	-	-	-	-	2	1	2	-

SEMESTER – V

Course: Object Oriented Programming Using C++ (Program Elective 1)

Course Code	22EEE551	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Basic knowledge of C programming

Course Objectives:

CLO1	Solve the problem with object-oriented approach.
CLO2	Analyze the problem statement and build object-oriented system model
CLO3	Describe the characters and behavior of the objects that comprise a system
CLO4	Explain function overloading, operator overloading and virtual functions.
CLO5	Define encapsulation, inheritance and polymorphism

Content	No. of Hours/ RBT levels
Module 1: Beginning with C++ and its Features Applications of C++, structure of C++ program, Variables, Different Operators, expressions, C++ statements, basic data types, derived data types, user defined data types, storage classes, dynamic initialization of variables, memory management operators, manipulators, type cast operator, implicit conversions, control structures in C++ , functions	8 hours L2
Module 2: Function overloading , Classes and Objects Function overloading, inline functions ,recursive functions Specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, array of objects, objects as function arguments ,returning objects, static data members, static member functions, nested class	8 hours L3
Module 3: Constructors, Destructors and Operator Overloading Constructors, parameterized constructors, multiple constructors in a class, Dynamic initialization of objects, copy constructor, constructing two dimensional arrays, Destructors, operator overloading, Overloading Unary and binary operators, Manipulation of strings using operators	8 hours L3
Module 4: Inheritance, Pointers, Virtual Functions, Polymorphism Derived Classes, Single inheritance, multilevel inheritance, multiple inheritance, hierarchical inheritance, hybrid inheritance, virtual base classes ,abstract classes, constructors in derived classes, pointers to objects, this pointer, Virtual and pure virtual functions	8 hours L3
Module 5: Streams and Working with Files C++ streams and stream classes, formatted and unformatted I/O operations, managing output with manipulators, Classes for file stream operations, opening and closing a file, Detecting End of File, File modes, sequential input and output operations, updating a file.	8 hours L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO551.1	Build the basic knowledge of object-oriented programming.
CO551.2	Introduce the concept of classes, objects and their significance in real world.
CO551.3	Apply the concept of constructors, destructors and operator overloading in programs
CO551.4	Apply the concept of data hiding, inheritance, virtual functions.
CO551.5	Utilize I/O operations and file streams in programs.

Textbooks:

1 Object Oriented Programming with C++ E.Balaguruswamy TMH 6th Edition, 2013

Reference books:

1. Object Oriented Programming with C++ Robert Lafore Galgotia publication 2010
2. Object Oriented Programming with C++ Sourav Sahay Oxford University 2006

E-Books / Web References

https://www.educative.io/courses/
https://www.pdfdrive.com/title-of-the-subject-object-oriented-programming-using-c-e17429149.html

MOOCs

1 http://udemy.com
2.http://coursera.com

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO551.1	3	2	2	-	1	-	-	-	-	-	-	3			3
CO551.2	3	2	2	-	1	-	-	-	-	-	-	3			3
CO551.3	3	2	2	-	1	-	-	-	-	-	-	3			3
CO551.4	3	2	2	-	1	-	-	-	-	-	-	3			3
CO551.5	3	2	2	-	1	-	-	-	-	-	-	3			3
Average	3	2	2		1							3			3

SEMESTER – V

Course: Digital System Design using Verilog HDL **(Program Elective 1)**

Course Code	22EEE552	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites:

Digital system design

Course Objectives:

CLO1	Learn different modelling concepts in Verilog HDL
CLO2	Verilog based modeling of digital circuits using Gate Level and Data flow styles
CLO3	Understand Behavioral modeling, Tasks and Functions in Verilog
CLO4	Developing the Digital Circuit Applications
CLO5	Logic Synthesis and its effects in Verification of digital circuits.

Content	No. of Hours/ RBT levels
Module 1: Overview of Digital Design with Verilog HDL and Hierarchical Modeling Concepts Overview of Digital Design with Verilog HDL: Evolution of CAD, emergence of HDLs, typical HDL-flow, trends in HDLs. Hierarchical Modeling Concepts: Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block. Basic Concepts: Lexical conventions, data types, system tasks, compiler directives. Modules and Ports: Module definition, port declaration, connecting ports. Hierarchical Names.	**08 Hours/ L1, L2**
Module 2: Gate level and dataflow modeling Gate-Level Modeling: Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays. Dataflow Modeling: Continuous assignments, delay specification, expressions, operators, operands, operator types.	**08 Hours/ L1, L2,L3**
Module 3: Behavioral Modeling, Tasks and Functions Behavioral Modeling: Structured procedures, initial and always, blocking and non-blocking statements, delay control, Timing Control, conditional statements, Multiway branching, loops. Tasks and Functions: Differences between tasks and functions, declaration, invocation, automatic tasks and functions.	**08Hours/ L1, L2,L3**
Module 4: Design examples and State Machine Charts BCD to 7 segment Display Decoder, Traffic Light Controller, Synchronization and Debouncing, Shift and Add Multiplier, Binary Divider State Machine Charts: SM Charts, Derivation of SM Charts, Realization of SM Charts. Implementation of Dice Game.	**8 Hours/ L1, L2, L3**
Module 5: Useful Modeling Techniques and Logic Synthesis with Verilog Useful Modeling Techniques: Procedural Continuous Assignments, Overriding Parameters, Conditional Compilation and Execution, Useful System Tasks. Logic Synthesis with Verilog: Logic Synthesis, Impact of Logic Synthesis, Verilog HDL Synthesis, Synthesis Design Flow and Verification of Gate Level Netlist.	**8 hours L1,L2,L3**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO552.1	Analyze the Verilog programs using different abstract levels.
CO552.2	Design and Verify the functionality using test benches.
CO552.3	Develop a Verilog program with tasks and functions.
CO552.4	Apply the SM Charts to realize the digital circuits.
CO552.5	Interpret the verification of digital circuit using logic synthesis

Textbooks:

1.Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
2.Charls H. Roth Jr, Lizy K, John and Byeong K. Lee, Digital Systems Design Using Verilog, 1
St Edition, Cengage Learning, 2016.

Reference books:

1. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL" Pearson (Prentice Hall), Second edition.
2. Peter J. Ashenden, Digital Design: An Embedded Systems Approach using Verilog,1 st Edition, Elsevier, 2015
3. Stephen Brown and Zvonkoc Vranesic, Fundamentals of Digital Logic with Verilog Design, 1st Edition, Mc-Graw-Hill Publication, 2003.

E-Books /Web References:

1.https://www.mitzon.com/mooc/digital-design-using-verilog-hdl-programming-with- practical/
2.https://www.coursera.org/learn/fpga-hardware-description-languages

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO552.1	3	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO552.2	3	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO552.3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO552.4	3	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO552.5	3	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-

SEMESTER – V

Course: Advanced Control Systems (Program Elective 1)

Course Code	22EEE553	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Control Systems

Course Objectives:

CLO1	Construct state models for linear continuous – time LTI systems using Physical and Phase Variables.
CLO2	Solve the state equations for linear continuous – time systems.
CLO3	Understand the procedure to test controllability and observability of a system.
CLO4	Understand the pole placement technique to design state feedback controller and state observer.
CLO5	Discuss different Nonlinearities, their characteristics and the behaviour of Nonlinear systems

Content	No. of Hours/ RBT levels
Module 1: State Space Analysis Modern Control Theory versus Conventional Control Theory, Concept of State, State Variables and State Model, State Space Equations, State Model of Linear Time Invariant Systems, State Model for Single Input-Single Output and Multi Input-Multi Output Systems, State Space Representation of Systems Using Physical and Phase Variables, State Space Representation of Mechanical and Electrical Systems, Advantages and Disadvantages of and physical and Phase Variables.	8 hours/ L1, L2, L3
Module 2: State Space Analysis (Continued) State Space Representation from Transfer Functions: Controllable Canonical form, Observable canonical for Diagonal forms. Diagonalization. Transfer Function from State Model. Solution of State Equations: Computation of State Transition Matrix by Infinite Series Method, Laplace Transform Method	8 hours/ L1, L2, L3
Module 3: Controllability and Observability of Linear Systems Controllability of Linear Systems: Definition of Complete State Observability, Condition for Complete Controllability, Tests for Controllability, Output Controllability. Observability of Linear Systems: Definition of Observability, Condition for Complete Observability, Tests for Observability.	8 hours/ L1, L2, L3
Module 4: 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, necessary and sufficient condition of state observation.	8 hours/ L1, L2, L3
Module 5: Nonlinear Systems Introduction to nonlinear systems, Characteristics of Nonlinear System, Behaviour of nonlinear systems-Frequency-amplitude dependence, Jump resonance,	8 hours/ L1, L2

Subharmonic oscillations, Limit cycles, Frequency entrainment, Asynchronous quenching; Common physical nonlinearities- Saturation, Dead zone, Friction; Approaches for the analysis of nonlinear systems; Describing function for: (i) Saturation without any dead zone, (ii) Relay with Dead zone, (iii) Relay with dead zone and hysteresis.	

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO553.1	Develop state models for linear continuous – time LTI systems using Physical and Phase Variables.
CO553.2	Apply matrix algebra to find the solution of state equations for linear continuous – time systems.
CO553.3	Examine controllability and observability of a system using different testing techniques.
CO553.4	Design State feedback controller and state observer for systems to improve the performance of a given systems.
CO553.5	Explain different nonlinearities that can exists in a system, their characteristics and behaviour of nonlinear systems.

Textbooks:

1. I.J Nagrath, M Gopal, Control Systems Engineering, New Age International Publishers; 6th edition 2017.
2. Anand Kumar, Control Systems, PHI, 2nd Edition 2014.

Reference books:

1. Ogata, Modern Control Engineering, Pearson Education India; 5th edition, 2015
2. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems. Wiley, 9th edition.
3. A. Nagoor kani, Advanced Control Systems Engineering, CBS Publications, 2019

E-Books / Web References

1. https://en.wikibooks.org/wiki/Control_Systems 2.
2. https://www.youtube.com/watch?v=HcLYoCmWOjI&list=PLBInK6fEyqRhqzJT87LsdQKYZBC9 3ezDo

MOOCs

1. https://nptel.ac.in/courses/108/106/108106098/
2. https://nptel.ac.in/courses/108/102/108102043/

Scheme of Evaluation:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO553.1	3	2	-	-	2	-	-	-	-	-	-	2	-	-	3
CO553.2	3	2	-	-	2	-	-	-	-	-	-	2	-	-	3
CO533.3	3	1	-	-	2	-	-	-	-	-	-	2	-	-	3
CO533.4	3	2	-	-	2	-	-	-	-	-	-	2	-	-	3
CO533.5	3	-	-	-	-	-	-	-	-	-	-	2	-	-	2
22EEE553	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**

SEMESTER V

Course: Electromagnetic Field Theory (Program Elective 1)

Course Code	22EEE554	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Engineering Mathematics, Fundamentals of Electrical Engineering

Course Objectives:

CLO1	Understand different coordinate systems for understanding the concept of gradient,divergence and curl of a vector.
CLO2	Understand the application of Coulomb's Law and Gauss Law for electric fields produced by different charge configurations.
CLO3	Evaluate the energy and potential due to a system of charges.
CLO4	Explain the behavior of electric field across a boundary between a conductor and dielectricand between two different dielectrics.
CLO5	Understand the time varying fields and Maxwell`s equations.

Content	No. of Hours/ RBT levels
Module 1: Vector Analysis and Electrostatics **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. Problems. **Electrostatics:** Coulomb's Law and electric field intensity: Experimental law of Coulomb, Electric field intensity, Types of charge distributions. Field due to variouscharge distributions-Line charges, Surface charge, Volume charge. Fields due to infinite line charge, charged circular ring, infinite sheet charge. **Electric flux density, Gauss' law, and divergence:** Electric flux and flux density, Fluxdensity for various charge distributions-Line charge, surface charge, volume charge. Gauss' law, Divergence, Maxwell's First equation (Electrostatics), vector operator and divergence theorem.	8 hours L1, L2, L3
Module 2: Energy, potential, Conductors and Dielectrics **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 system of charges, Potential gradient, Energydensity in an electrostatic field. Conductors and dielectrics: Current and current density, Continuity of current, metallic conductors, Conductor properties and boundary conditions, boundary conditions for perfect Dielectrics.	10 Hours L2, L3, L4 etc.
Module 3: Poisson`s and Laplace`s equation and Steady magnetic fields Poisson's and Laplace's equations: Derivations of Poisson's and Laplace's Equations. Examples of the solutions of Laplace's and Poisson's equations. Steady magnetic fields: Biot-Savart law, Ampere's circuital law, Curl, Stokes' theorem, magnetic flux and flux density, scalar and Vector magnetic potentials.	8 hours L1, L2, L3

Module 4: Magnetic Forces and Materials Magnetic forces and materials: Force on a moving charge and differential current element, Force between differential current elements, Force and torque on a closed circuit. Magnetic materials: Magnetization and permeability, Magnetic boundary conditions, Magnetic circuit, Potential energy and forces on magnetic materials.	8 hours L1, L2, L3, L4
Module 5: Time Varying fields and Maxwell`s equations Time varying fields and Maxwell's equations: Faraday's law, displacement current, General field relations for time varying Electric and Magnetic fields. Maxwell's equation in point and Integral form.	8 hours L1, L2, L3, L4

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO554.1	Understand different coordinate systems, Coulomb's Law and Gauss Law for differentcharge configurations.
CO554.2	Calculate the energy and potential due to a system of charges with boundaryconditions.
CO554.3	Explain the Poisson's, Laplace equations and behaviour of steady magnetic fields.
CO554.4	Explain the behaviour of magnetic fields and magnetic materials.
CO554.5	Apply Maxwell`s equations for time varying fields.

Textbooks:

1. Engineering Electromagnetics, William H Hayt Jr. and John A Buck, Tata McGraw-Hill, 7thedition, 2006.
2. Elements of electromagnetics, Matthew NO Sadiku Oxford university press, 3rd edition,2007.

Reference books:

1. Electromagnetics with Applications, John Krauss and Daniel A Fleisch, McGraw-Hill, 5th edition,
   1999.
2. Electromagnetic Waves And Radiating Systems, Edward C. Jordan and Keith G Balmain, Prentice – Hallof India / Pearson Education, 2nd edition, 1968.Reprint 2002.
3. Field and Wave Electromagnetics , David K Cheng, Pearson Education Asia, 2nd edition, - 1989, Indian Reprint – 2001.
4. Electromagnetics, J A Edminister Tata McGrawhill, Schaum' s outlines, IInd Edition 2006

E-Books / Web References

1. https://ocw.mit.edu/resources/res-6-002-electromagnetic-field-theory-a-problem-solving-approach-spring-2008/textbook-contents/
2. https://physics.bgu.ac.il/~gedalin/Teaching/Mater/EMFT_Book.pdf
3. https://vtechworks.lib.vt.edu/handle/10919/84164
4. https://engineering.purdue.edu/wcchew/ece604f19/EMFTAll20191204.pdf

MOOCs

1. https://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/2. https://nptel.ac.in/courses/108/106/108106073/
3. https://www.coursera.org/learn/electrodynamics-electric-magnetic-fields
4. https://www.edx.org/course/electricity-and-magnetism-maxwells-equations

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO554.1	3												3	2	
CO554.2	3	2											3	2	
CO554.3	3	2											3	3	
CO554.4	3												3	3	
CO554.5	3	2										1	3	3	
Average	3	2										1	3	3	

SEMESTER – V

Course: Auto CAD (AEC)

Ability Enhancement Course-III			
Course Code	22EEE56	**CIE Marks**	50
Hours/Week (L: T: P)	1: 0: 2	**SEE marks**	50
No. of Credits	3	**Examination Hours**	03

Prerequisites: Electrical Machines-I and II , Power Systems-I and II.

Course Objectives:

CLO1	To discuss the terminology of DC and AC armature windings.
CLO2	To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
CLO3	To discuss the substation equipment, their location in a substation and development of a layout for substation.
CLO4	To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
CLO5	To explain development of sectional views of Transformers, DC machine and alternators using the design data, and sketches

Content	No. of Hours/ RBT levels
Module 1: Winding Diagrams **Winding Diagrams:** (a). Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings. (b). Developed Winding Diagrams of A.C. Machines: (c). Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings.	8 hours L3
Module 2: Single Line Diagrams **Single Line Diagrams:** Single Line Diagrams of Generating Stations and Substations Covering Incoming Circuits, Outgoing Circuits, Busbar Arrangements (Single, Sectionalised Single, Main and Transfer, Double Bus Double Breaker, Sectionalised Double Bus, One and a Half Circuit Breaker Arrangement, Ring Main),Power Transformers, Circuit Breakers, Isolators,Earthing Switches,Instrument Transformers, Surge or Lightning Arresters, Communication Devices (PowerLine Carrier) and Line Trap	8 hours L3
Module 3: Electrical Machine Assembly Drawings Using Design Data, Sketches or Both Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Transformers – Sectional Views Of Single And Three Phase Core And Shell Type Transformers	8 hours L3
Module 4: Electrical Machine Assembly Drawings Using Design Data, Sketches or Both Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: D.C. Machine – Sectional Views of Yoke with Poles, Armature and Commutator dealt separately	8 hours L3
Module 5: Electrical Machine Assembly Drawings Using Design Data, Sketches or Both Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Alternator – Sectional Views of Stator and Rotor dealt separately.	8 hours L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO56.1	Discuss the terminology and types of DC and AC armature windings.
CO56.2	Develop armature winding diagram for DC and AC machines
CO56.3	Develop a layout for substation using the standard symbols for substation equipment. .
CO56.4	Draw sectional views of core and shell types transformers using the design data.
CO56.5	Draw sectional views of assembled DC machine and alternator or its parts using the design data or the sketches.

Textbooks:

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.

Reference books:

1. A course in Electrical Machine design A. K. Sawhney DhanpatRai 6th Edition, 2013
2. Electrical Engineering Drawing K. L. Narang SatyaPrakashan 2014

E-Books / Web References

1. https://images.autodesk.com/adsk/files/autocad_aca_user_guide_english.pdf
2. https://static.sdcpublications.com/pdfsample/978-1-63057-339-3-1-cw77gw9lwo.pdf
3. https://iastate.pressbooks.pub/visualgraphiccomm/chapter/chapter-1/

MOOCs

https://www.my-mooc.com/en/video/autocad-complete-tutorial-for-beginners-part-1/

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO56.1	2	2	-	-	3	-	-	-	-	-	-	-	3	3	-
CO56.2	2	2	2	-	3	-	-	-	-	-	-	-	3	3	-
CO56.3	2	2	2	-	3	-	-	-	-	-	-	-	3	3	-
CO56.4	2	2	2	-	3	-	-	-	-	-	-	-	3	3	-
CO56.5	2	2	2	-	3	-	-	-	-	-	-	-	3	3	-
21EEE56	2	2	2	-	3	-	-	-	-	-	-	-	3	3	-

SEMESTER – V/VI

Course: Environmental Science

Course Code	22CIV57/66	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	1	Examination Hours	1 hour

Course Learning Objectives:

CLO1	The fundamentals of environmental science.
CLO2	The types of natural resources
CLO3	The various global environmental concerns.
CLO4	The types of wastes generated and their handling at a basic level
CLO5	The area of environmental law and policies with a few important acts in the field

Content	No. of Hours/ RBT Levels
Module 1 **Environment:** • Definition, scope & importance • Components of Environment Ecosystem: Structure and function of various types of ecosystems • Human Activities – Food, Shelter, and Economic & Social Security. • Population - Growth, variation among nations – population explosion and impact on environment **Biodiversity:** Types, Value, Hot spots, Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.	04 Hours / L2
Module 2 **Natural Resources**: Forest, Water, Mineral, Food, Energy, Land Environmental Pollution - Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards.	04 Hours / L2
Module 3 **Global Environmental Concerns** (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.	04 Hours / L2
Module 4 **Sources:** Sources of Solid waste, Types of solid waste, Physical and Chemical composition of municipal solid waste. Solid Waste Management Rules in India, Sources and management of E – Waste, Biomedical Waste, Hazardous waste, and construction waste at individual and community level. Socio-economic aspect of waste management Environmental Toxicology.	04 Hours / L2
Module 5 **Latest Developments in Environmental Pollution Mitigation Tools** (Concept and Applications): Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship, NGOs.	04 Hours / L2

COURSE OUTCOMES: Upon completion of this course, student will be able to:

22CIV57.1/66.1	Understand holistically the key concepts "Environment", and "Biodiversity".
22CIV57.2/66.2	Classify the types of natural resources available and the effects of anthropogenic interventions.
22CIV57.3/66.3	Express the gravity of various global environmental concerns.
22CIV57.4/66.4	Categorize the types of wastes generated and their handling at a basic level.
22CIV57.5/66.5	Understand the importance of environmental law and policies.

Textbooks:

1. Environmental studies, Benny Joseph, Tata Mcgraw-Hill 2nd edition 2012
2. Environmental studies, S M Prakash, pristine publishing house, Mangalore 3rd edition-2018
3. Gilbert M.Masters, Introduction to Environmental Engineering and Science, 2nd edition, Pearson Education, 2004

Reference books:

1. Benny Joseph, Environmental studies, Tata Mcgraw-Hill 2nd edition 2009
2. M.Ayi Reddy Textbook of Environmental Science and Technology, BS publications 2007
3. Dr. B.S Chauhan, Environmental Studies, University of science press 1st edition

Web References:

https://www.hzu.edu.in/bed/E%20V%20S.pdf

https://onlinecourses.nptel.ac.in/noc23_hs155/preview

https://onlinecourses.swayam2.ac.in/cec19_bt03/preview

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	50	50
	CIE Test-2	50	
	CIE Test-2	50	
SEE	Semester End Examination	50	50
		Grand Total	100

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
22CIV57.1/66.1	2	-	-	-	-	-	3	-	-	-	-	-	1	-	-
22CIV57.2/66.2	2	1	-	-	-	-	3	-	-	-	-	1	1	-	1
22CIV57.3/66.3	2	-	2	-	-	2	3	1	-	-	-	1	1	-	1
22CIV57.4/66.4	2	2	-	-	-	2	3	-	-	-	-	-	-	-	1
22CIV57.5/66.5	2	-	-	-	-	2	3	-	-	-	-	-	-	1	1
Average	**2**	**1.5**	**2**	**-**	**-**	**2**	**3**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**

Low-1: Medium-2: High-3

SEMESTER – V/VI

Course: Universal Human Values

Course Code	22UHV57/66	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	1	Examination Hours	1 hour

Course Learning Objectives:

CLO1	To create an awareness on Engineering Ethics and Human Values.
CLO2	To understand social responsibility of an engineer.
CLO3	To appreciate ethical dilemma while discharging duties in professional life.

Content	No. of Hours
Module 1 **Introduction to Value Education** • Value Education, Definition, Concept and Need for Value Education. • The Content and Process of Value Education. • Basic Guidelines for Value Education, • Self-exploration as a means of Value Education. • Happiness and Prosperity as parts of Value Education.	05 Hours
Module 2 **Harmony in the Human Being** • Human Being is more than just the Body. • Harmony of the Self ('I') with the Body. • Understanding Myself as Co-existence of the Self and the Body. • Understanding Needs of the Self and the needs of the Body. • Understanding the activities in the Self and the activities in the Body.	05 Hours
Module 3 **Harmony in the Family and Society and Harmony in the Nature** • Family as a basic unit of Human Interaction and Values in Relationships. • The Basics for Respect and today's Crisis: Affection, Guidance, Reverence, Glory, Gratitude and Love, • Comprehensive Human Goal: The Five Dimensions of Human Endeavour. • Harmony in Nature: The Four Orders in Nature. • The Holistic Perception of Harmony in Existence.	05 Hours
Module 4 **Social Ethics** • The Basics for Ethical Human Conduct, Defects in Ethical Human Conduct. • Holistic Alternative and Universal Order, • Universal Human Order and Ethical Conduct. • Human Rights violation and Social Disparities.	05 Hours
Module 5 **Professional Ethics** • Value based Life and Profession., Professional Ethics and Right Understanding. • Competence in Professional Ethics. • Issues in Professional Ethics – The Current Scenario. • Vision for Holistic Technologies • Production System and Management Models.	05 Hours

COURSE OUTCOMES: Upon completion of this course, student will be able to:

22UHV57.1/66.1	Understand the significance of value inputs in a classroom and start applying them intheir life and profession
22UHV57.2/66.2	Distinguish between values and skills, happiness and accumulation of physical facilities,the Self and the Body, Intention and Competence of an individual, etc.
22UHV57.3/66.3	Understand the role of a human being in ensuring harmony in society and nature.
22UHV57.4/66.4	Distinguish between ethical and unethical practices and start working out the strategy toactualize a harmonious environment wherever they work.

Textbooks:

1.A.N Tripathy, New Age International Publishers, 2003. 2.Bajpai.
B. L, New Royal Book Co, Lucknow, Reprinted, 2004 3.Bertrand
Russell Human Society in Ethics & Politics

Reference books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. Corliss Lamont, Philosophy of Humanism.
4. Gaur. R.R. , Sangal. R, Bagari G.P, A Foundation Course in Value Education,Excel Books, 2009.
5. Gaur. R.R. , Sangal R , Bagaria G.P, Teachers Manual, Excel Books, 2009.
6. I.C. Sharma, Ethical Philosophy of India, Nagin & co, Julundhar
7. William Lilly- Introduction to Ethics -Allied Publisher

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	50	50
	CIE Test-2	50	
	CIE Test-2	50	
SEE	Semester End Examination	50	50
		Grand Total	100

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
22UHV57.1/66.1	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
22UHV57.2/66.2	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
22UHV57.3/66.3	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
22UHV57.4/66.4	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
Average	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-

Low-1: Medium-2: High-3

Scheme and Syllabus
of
UG Autonomous Program – 2022 batch
VI SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22EEE61	Industrial Drives and its Applications	PC	Respective Department	2	2	0	50	50	100	3
2	22EEE62	Power system –III	IPC		3	0	2	50	50	100	4
3	22EEE63	Internet of Things and its Applications	IPC		3	0	2	50	50	100	4
4	22EEE64X	Program Elective 2	PEC		3	0	0	50	50	100	3
5	22EEE65X	Open Elective 1	OEC	Offering Department	3	0	0	50	50	100	3
6	22CIV66	Environmental Science	HSM	Civil	1	0	0	50	50	100	1
	OR										
	22UHV66	Universal Human Values	BS	Respective Department							
7	22EEEMP67	Mini Project	MP	Respective Department	Two Contact hours per week			50	50	100	2
							TOTAL	350	350	700	20

Program Elective 2*			
22EEE641	Artificial Intelligence	22EEE643	Micro grids
22EEE642	VLSI Design	22EEE644	Modern Utilization of Electrical Power
Open Elective 1 (Offered to other branch students)			
22EEE651	Electric Vehicles		
22EEE652	Industrial Automation		

***NPTEL for Credit transfer**: Students can take 12 weeks NPTEL course as an equivalent to Program elective. The NPTEL courses of duration less than 12 weeks will not be considered for credit transfer. The courses (only technical) taken are as per the recommendation of BOS of respective department. The similarity of the contents as offered by NPTEL should not exceed a maximum of 40% of the courses being registered by the student. The NPTEL course need to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not be considered. The validity of NPTEL certificate is for two years and it cannot be used more than once to avail the benefit. The student is eligible to transfer a maximum of nine credits in the entire duration of the program. The grades will be awarded as equivalent to the grades obtained in the NPTEL course.

VI SEMESTER

Course: Industrial Drives and Applications

Course Code	22EEE61	CIE Marks	50
Hours/Week (L: T: P)	2:2:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Electric Machines-I, Electric Machines-II, Power Electronics

Course Objectives:

CLO1	Discuss dynamics and modes of operation of electrical drives.
CLO2	Determine power rating of electric motors for continuous, intermittent and short time duty.
CLO3	Explain the operation of dc, induction and synchronous motors under normal, transient and faulty conditions.
CLO4	Understand the speed control methods to control the speed of Dc and Induction motors
CLO5	Understand the types and speed control methods of synchronous and stepper motor drive.

Content	No. of Hours/RBT levels
Module 1: Introduction: 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 Multi-quadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time in Transient Operations, SteadyState Stability. Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating.	08 / 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, Multi-quadrant Operation of DC Separately Excited Motor Fed From Fully Controlled Rectifier, Rectifier Control of DC Series Motor, Chopper Control of Separately Excited DC Motor, Chopper Control of Series Motor.	08 / 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, Methods of starting and braking.	08 / L1, L2, L3
Module 4: Induction Motor Drives (continued) Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources. Voltage Source Inverter (VSI) Control, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control.	08 / L1, L2, L3, L4
Module 5: Synchronous Motor, Brushless DC Motor and Stepper Motor Drives Operation from fixed frequency supply-starting, Self-controlled synchronous motor drive employing load commutated thyristor inverter, Starting Large Synchronous Machines Brushless dc Motor Drives for servo applications. Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor.	08 / L1, L2

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO61.1	Understand dynamics and modes of operation of electrical drives.
CO61.2	Determine power rating of electric motors for continuous, intermittent and short time duty.
CO61.3	Analyse behavior of dc, induction and synchronous motors under normal, transient and faulty conditions.
CO61.4	Apply appropriate method to control DC and induction motor drive.
CO61.5	Understand the control methods with reference to synchronous and stepper motor drives.

Textbooks:

1. Fundamentals of Electrical Drives by Gopal K. Dubey, Narosa Publishing House, 2nd Edition, 2001.

Reference books:

1. Electrical Drives: Concepts and Applications, Vedum Subrahmanyam, McGraw Hill, 2nd Edition, 2011.
2. Electric Drives, N.K De, P.K. Sen, PHI Learning, 1st Edition, 2009

E-Books / Web References

1. https://www.google.co.in/books/edition/Fundamentals_of_Industrial_Drives/l8McyPSJ0qMC?hl=en&gbpv=1

MOOCs

1. https://nptel.ac.in/courses/108108077
2. https://www.coursera.org/learn/motors-circuits-design

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO61.1	3	3	-	-	-	1	-	-	-	-	-	-	2	-	-
CO61.2	3	3	-	-	-	2	-	-	-	-	-	-	2	-	-
CO61.3	3	3	-	-	-	1	-	-	-	-	-	2	2	-	3
CO61.4	3	3	-	-	-	1	-	-	-	-	-	2	2	-	3
CO61.5	3	2	-	-	-	1	-	-	-	-	-	2	2	-	3
22EEE61	3	3	-	-	-	1	-	-	-	-	-	2	2	-	3

VI SEMESTER

Power System III (Integrated Program Course)			
Subject Code	22EEE62	**CIE Marks**	50
Hours/Week (L:T)	3:0:2	**SEE Marks**	50
Credits	4	**Examination Hours**	03

Course Learning Objectives: At the end of the course the student should be able to:

CLO1	Discuss performance of protective relays, components of protection scheme and relay terminology.
CLO2	Discuss construction, operating principles and performance of various distance and differential relays.
CLO3	Explain the principle of circuit interruption and different types of circuit Breakers and fuses
CLO4	Discuss generation of high voltages and currents and their measurement
CLO5	Understand Non-Destructive Testing of Materials and Electrical Apparatus

Content	No. of Hrs/ RBT levels
MODULE I – Introduction to Power System Protection	
Need for protective schemes, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Performance of Protective Relaying, Classification of Protective Relays, 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. Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Phase Fault Protective Scheme, Directional Earth Fault Relay.	08 Hours/ L1, L2
MODULE II – Distance & Differential Protection	
Distance Protection: Impedance Relay, Reactance Relay, Mho Relay, Reach of Distance Relays. **Differential Protection:** Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection. Protection of Generators, Transformer Protection, Bus zone Protection, Frame Leakage Protection.	08 Hours/ L1, L2, L3
MODULE III – Circuit Breakers & Fuses	
Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, SF6 Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers. Types of Fuses, Applications of HRC Fuses, Selection of Fuse.	08 Hours/ L1, L2
MODULE IV – Generation of High Voltage & Current and their Measurement	
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. 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. Sphere gap for measurement of high voltages. Effect of atmospheric conditions on measurements using spheregap.	8 Hours/ L1, L2

MODULE V – 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	8 hours L1,L2
Total Hours	**40 Hours**

	Content	No. of Hours/ RBT levels
1.	IDMT characteristics of electromechanical type over-current relay.	2 hours/L3
2.	Operating characteristics of electromechanical type over-voltage relay.	2 hours/L3
3.	Operating characteristics of microprocessor based (numeric) over-current relay for feeder protection.	2 hours/L3
4.	Operating characteristics of microprocessor based over/under voltage relay.	2 hours/L3
5.	Operating characteristics of Microprocessor based overcurrent relay.	2 hours/L3
6.	Overload protection, high set over current protection. Earth fault protection of motor using microprocessor-based relay SPAM 150C.	2 hours/L3
7.	Measurement of HVAC and HVDC using Standard Spheres.	2 hours/L3
8.	Spark-over characteristics of air insulation subjected to (HVDC & HVAC) with spar-over characteristics corrected to STP for uniform and non-uniform field configuration.	2 hours/L3
9.	Generation Protection using Merz Prize Protection.	2 hours/L2
10.	Breakdown strength of transformer oil using oil-testing kit.	2 hours/L2

Course Outcomes: The students will be able to:

CO62.1	Understand the performance of protective relays, components of protection scheme and relay terminology over current protection.
CO62.2	Apply distance and differential relays for the protection of generators & transformers.
CO62.3	Explain the construction and operation of different types of circuit breakers and fuses.
CO62.4	Summarize generation of high voltages & currents and their measurements.
CO62.5	Understand non-destructive testing of materials and electric apparatus, high-voltage testing of electric apparatus.

TEXTBOOKS:

3. Badri Ram, D.N.Vishwakarma, Power System Protection and Switchgear , Mc Graw Hill Education, Second Editiion, 2008
4. M.S. Naidu, Kamaraju , High Voltage Engineering, McGraw Hill Education; 5th edition , 2013

REFERENCES:

3. N. Veerappan S.R.Krishnamurthy, Power System Switchgear and Protection, S Chnd, First Edi. 2009
4. E. Kuffel, W.S. Zaengl, J. Kuffel, High Voltage Engineering Fundamentals, Newnes, 2nd Edition, 2000
5. Wadhwa C.L, High Voltage Engineering, New Age International, 3rd Edition 2012

WEBLINKS;

1. https://nptel.ac.in/courses/108107167
2. https://ocw.mit.edu/courses/6-061-introduction-to-electric-power-systems-spring- 2011/

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO62.1	3	2	-	1	-	1	1	2	2	2	-	2	-	3	2
CO62.2	3	2	-	1	-	1	1	2	2	2	-	2	1	3	2
CO62.3	3	2	-	1	-	1	1	2	2	2	-	2	-	3	2
CO62.4	3	2	-	1	-	1	1	2	2	2	-	2	-	3	2
CO62.5	3	2	-	1	-	1	1	2	2	2	-	2	-	3	2
Average	3	2	-	1	-	1	1	2	2	2	-	2	1	3	2

SEMESTER – VI

Course: Internet of Things and its Applications (Integrated Program Core)

Course Code	22EEE63	CIE Marks	50
Hours/Week (L: T: P)	3:0:2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Python programming

Course Objectives:

CLO1	Understand the basics and necessity of IoT.
CLO2	Explain the system management protocols and design methodology in IoT
CLO3	Use Raspberry Pi for interfacing applications
CLO4	Understand the basics of cloud computing and execute the programs using cloud
CLO5	Discuss the cloud application design methodologies

Content	No. of Hours/ RBT levels
Module 1: Introduction to Internet of Things (IoT) Introduction, Physical design of IoT, Logical design of IoT, IoT Enabling Technologies, IoT Levels & Deployment Templates. Domain Specific IoTs: Home automation, smart parking, weather monitoring, smart vending machines, remote vehicle diagnostics, machine diagnosis and prognosis, wearable electronics IoT and M2M, Difference between IoT and M2M, SDN abd NFV for IoT, software defined networking, network function virtualization.	8 / L2
Module 2: IoT system management and Platform Design methodology Need for IoT systems management, simple network management protocol (SNMP),limitations of SNMP, network operator requirements, NETCONF,YANG, IoT systems management with NETCONF-YANG,NETOPEER IoT Design Methodology, Case study on IoT system for weather monitoring	8 / L2
Module 3: IoT Physical Devices Basic building blocks of an IoT device, Raspberry Pi board, Raspberry Pi interfaces-serial, SPI,I2C, Programming Raspberry Pi with Python-controlling LED with Raspberry Pi, Interfacing an LED and switch with Raspberry Pi, Interfacing a light sensor(LDR) with Raspberry Pi, other IoT Devices	8 / L3
Module 4: Cloud computing Introduction to cloud computing, characteristics of cloud computing, cloud models, cloud services examples, cloud-based services and applications, cloud concepts and technologies-virtualization, load balancing, scalability and elasticity, deployment, replication, monitoring, software defined networking network function virtualization, MapReduce, identity and access management, service level agreements, billing	8 / L2
Module 5: Cloud application design methodologies Introduction, design considerations for cloud applications- scalability, reliability and availability, security, maintenance and upgradation, performance, Reference architectures for cloud applications, Cloud application design methodologies-service oriented architecture, cloud component mode, IaaS, PaaS and SaaS services for cloud applications, model view controller, RESTful web services, Data storage approaches-Relational (SQL) approach, Non-relational (non-SQL) approach	8 / L2

Sl. No.	Experiments	No. of Hours/ RBT levels
1	Write a program to interface RGB LED to ESP32 and execute to test the output	2 hours/ L3
2	Write a program to interface IR/LDR with ESP32 and to turn on LED after sensor detection.	2 hours/ L3
3	Write a program to interface DC Motor to ESP32 and control the direction of rotation.	2 hours/ L3
4	Write a program for turning on LED using Bluetooth and ESP32.	2 hours/ L3
5	Demonstrate, reading the ultrasonic sensor data to smartphone using Bluetooth, which is interfaced to ESP32.	2 hours/ L3
6	Write a program for reading Temperature and Humidity using DTH sensor interface to ESP32, display the data on serial monitor.	2 hours/ L3
7	Write a Program for displaying the "Hello World" on OLED using ESP32.	2 hours/ L3
8	Write a program for reading Temperature and Humidity using DTH11 sensor, interfaced to SP32, display the data on OLED.	2 hours/ L3
9	Demonstrate, reading Temperature and Humidity using DTH11 sensor, interfaced to ESP32, display the data on Things Speak cloud.	2 hours / L3
10	Write a program to interface RGB LED to Raspberry Pi Pico and execute to test the output	2 hours / L3
11	Write a program to interface Pushbutton with an LED for Raspberry Pi Pico and execute to test the output.	2 hours/ L3
12	Write a program to interface Relay for Raspberry Pi Pico and execute to test the output.	2 hours / L3
13	Write a program on Raspberry Pi to publish temperature data to MQTT broker.	2 hours / L3
14	Write a program to create TCP server on Raspberry Pi and respond with humidity data to TCP client when requested.	2 hours / L3
15	Write a program to create UDP server on Raspberry Pi and respond with humidity data to UDP client when requested.	2 hours / L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO63.1	Understand the fundamentals and applications of IoT.
CO63.2	Describe the system management and design methodology in IoT
CO63.3	Use Raspberry Pi and ESP32 for interfacing applications
CO63.4	Explain the basics of cloud computing and execute the programs with cloud
CO63.5	Discuss the cloud application design methodologies

TEXTBOOKS:

1. Arshdeep Bahga, "Internet of Things - A hands on approach", 2018,universities press.
2. Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-on Approach", 2013 universities press.

REFERENCE BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1 st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010
3. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, "Internet ofThings: Architectures, Protocols and Standards", ISBN: 978-1-119-35967.

E Books: IoT-From Research and Innovation to Market Deployment_IERC

MOOCs: Introduction to Arduino Uno by IIT Kharagpur

https://www.youtube.com/watch?v=NkZdosZH6Wo

Scheme of Evaluation: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

1.

2. **Table: Distribution of weightage for CIE & SEE of Integrated courses**

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO63.1	3	1	1	-	3	-	-	3	3	3	-	-	-	-	3
CO63.2	3	1	1	-	3	-	-	3	3	3	-	1	-	-	2
CO63.3	3	1	1	-	3	-	-	3	3	3	-	1	-	-	2
CO63.4	3	1	1	-	3	-	-	3	3	3	-	1	-	-	2
CO63.5	3	1	1	-	3	-	-	3	3	3	-	1	-	-	2
22EEE63	3	1	1	-	3	-	-	3	3	3	-	1	-	-	2

SEMESTER – IV

Course: Artificial Intelligence (Professional Elective 2)

Course Code	22EEE641	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Course Objectives:

CLO1	Understand the significance of Artificial Intelligence (AI) along with basic principles, techniques and its applications
CLO2	Define the principles involved in various searching algorithms
CLO3	Recognize the complexity involved in searching process under certain unfavorable conditions
CLO4	Explain the principles involved in adversarial search problems
CLO5	Categorize the information based on level of uncertainty involved

Content	No. of Hours/ RBT levels
Module 1: Fundamental concepts of AI Artificial Intelligence – Introduction to AI - Foundations of Artificial Intelligence - History of Artificial Intelligence - State of the Art - Risks and Benefits of AI Intelligent Agents - Agents and Environments - Concept of Rationality - Nature of Environments - Structure of Agents.	8 hours L1, L2
Module 2: Searching algorithms and strategies Solving Problems by Searching - Problem-Solving Agents - Search Algorithms - Uninformed Search Strategies - Informed (Heuristic) Search Strategies.	8 hours L1, L2
Module 3: Searching in complex environments Search in Complex Environments - Local Search and Optimization Problems - Local Search in Continuous Spaces - Search with Nondeterministic Actions - Search in Partially Observable Environments - Online Search Agents and Unknown Environments.	8 hours L1, L2
Module 4: Adversarial Search and Games Game Theory - Optimal Decisions in Games - Heuristic Alpha--Beta Tree Search - Monte Carlo Tree Search Constraint Satisfaction Problems - Defining Constraint Satisfaction Problems - Constraint Propagation: Inference in CSPs - Backtracking Search for CSPs.	8 hours L1, L2
Module 5: Uncertainty and knowledge base Uncertain knowledge and decision - Acting under Uncertainty - Basic Probability Notation - Bayes' Rule and Its Use - Naive Bayes Models - Sequential Decision Problems - Algorithms for Markov Decision Processes.	8 hours L1, L2

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO641.1	Understand the fundamental aspects involved in AI and its applications
CO641.2	Apply basic principles involved in formulating searching strategies
CO641.3	Understand the various searching techniques in complex environments
CO641.4	Explain constraint propagation methods in adversarial search environments
CO641.5	Describe the decision-making philosophy in uncertain environments

Textbooks:

1. Artificial Intelligence: A Modern Approach (3rd edition) by Stuart Russell and Peter Norvig.
2. Winston, Patrick Henry. Artificial Intelligence. 3rd ed. Addison-Wesley, 1992. ISBN: 9780201533774.

Reference books:

1. Artificial Intelligence and Intelligent Systems, OXFORD University Press, New Delhi, 2005- N. P. Padhay.
2. Nils J. Nilsson, "Artificial Intelligence: A new Synthesis", Harcourt Asia Pvt. Ltd., 2000.
3. Elaine Rich and Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw-Hill, 2003.
4. George F. Luger, "Artificial Intelligence-Structures and Strategies for Complex Problem Solving", Pearson Education / PHI, 2002

E-Books / Web References

1. https://medium.com/machine-learning-in-practice/my-curated-list-of-ai-and-machine-learning-resources-from-around-the-web-9a97823b8524
2. https://github.com/norvig/paip-lisp
3. https://www.ximilar.com/the-best-resources-on-artificial-intelligence-and-machine-learning/
4. https://www.business2community.com/business-innovation/6-online-resources-that-will- help-you-understand-artificial-intelligence-better-02065673

MOOCs

1. https://www.edx.org/course/artificial-intelligence-ai
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-034-artificial-intelligence-fall-2010/lecture-videos/
3. https://www.udacity.com/course/intro-to-artificial-intelligence--cs271
4. https://online-learning.harvard.edu/course/cs50s-introduction-artificial-intelligence-python?delta=0
5. https://course.elementsofai.com/

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO641.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO641.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO641.3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO641.4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO641.5	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	2	1	-	-	-	-	-	-	-	-	-	-	2	-

SEMESTER – VI

Course: VLSI Design (Professional Elective 2)

Course Code	22EEE642	Course Code	50
Hours/Week (L: T: P)	3:0:0	Hours/Week (L: T: P)	50
No. of Credits	3	No. of Credits	03

Prerequisites: Analog Electronics, Digital System Design

Course Objectives:

CLO1	Impart knowledge of MOS transistor theory and CMOS technologies
CLO2	Learn the operation principles and analysis of inverter circuits.
CLO3	Design Combinational, sequential and dynamic logic circuits as per the requirements
CLO4	Infer the operation of Semiconductors Memory circuits.
CLO5	Demonstrate the concepts of CMOS testing

Content	No. of Hours/ RBT levels
Module 1: Introduction to VLSI **Introduction:** A Brief History, MOS Transistors, CMOS Logic, MOS Transistor Theory: Introduction, Long-channel I-V Characteristics, Non-ideal I-V Effects, DC Transfer Characteristics	8 / L2
Module 2: Fabrication **Fabrication:** CMOS Fabrication and Layout, VLSI Design Flow, Introduction, CMOS Technologies, Layout Design Rules, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitances	8 /L2
Module 3: Delay **Delay:** Introduction, Transient Response, RC Delay Model, Linear Delay Model, Logical Efforts of Paths, Combinational Circuit Design: Introduction, Circuit families	9 / L3
Module 4: Sequential Circuit Design and Logic Circuits **Sequential Circuit Design:** Introduction, Circuit Design for Latches and Flip-Flops, Dynamic **Logic Circuits:** Introduction, Basic Principles of Pass Transistor Circuits, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques	7 / L3
Module 5: Semiconductor Memories, Testing and Verification **Semiconductor Memories:** Introduction, Dynamic Random Access Memory (DRAM) and Static Random Access Memory (SRAM) **Testing and Verification:** Introduction, Logic Verification Principles, Manufacturing Test Principles, Design for testability	8 /L2

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO642.1	Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.
CO642.2	Draw the basic gates using the stick and layout diagrams with the knowledge of physical design aspects.
CO642.3	Demonstrate ability to design Combinational, sequential and dynamic logic circuits as per the requirements
CO642.4	Interpret Memory elements along with timing considerations
CO642.5	Interpret testing and testability issues in VLSI Design

TEXTBOOKS:

1. "CMOS Digital Integrated Circuits: Analysis and Design" - Sung Mo Kang & Yosuf Leblebici, Third Edition, Tata McGraw-Hill.
2. "CMOS VLSI Design- A Circuits and Systems Perspective"- Neil H. E. Weste, and David Money Harris4th Edition, Pearson Education.

REFERENCE BOOKS:

1. Adel Sedra and K. C. Smith, "Microelectronics Circuits Theory and Applications", 6th or 7th Edition, Oxford University Press, International Version, 2009.
2. Douglas A Pucknell & Kamran Eshragian, "Basic VLSI Design", PHI 3rd Edition, (original Edition – 1994).
3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", TMH, 2007.

E-Books /Web References:

1. https://link.springer.com/chapter/10.1007/978-1-4613-1985-6_2

MOOCs:

1. https://nptel.ac.in/courses/117101058
2. E-learning: www.vtu.ac.in

Scheme of Examination:
Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.
Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO642.1	3	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO642.2	3	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO642.3	2	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO642.4	2	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO642.5	3	2	2	-	-	-	-	-	-	-	-	-	-	-	2
22EEE642	3	2	2	-	-	-	-	-	-	-	-	-	-	-	2

SEMESTER – VI

Course: Micro Grids (Professional Elective 2)

Course Code	22EEE643	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Prerequisites: PS-I & PS-II

Course Objectives:

CLO1	Understand the operation and control of microgrid
CLO2	Analyze the centralized and decentralized operation of micro grids
CLO3	Understand the different types of intelligent controllers of microgrids
CLO4	Understand the different types of protection techniques of microgrids
CLO5	Investigate the operation of multi micro grids

Content	No. of Hours/ RBT levels
Module 1 **Concept of Microgrids:** Introduction to the concept of microgrid, Operation and Control of Microgrids, Market Models for Microgrids, Status Quo and Outlook of Microgrid Applications, Microgrid Control Architecture, Centralized and Decentralized Control, Forecasting.	07 Hours/ L2, L3
Module 2 **Centralized and Decentralized control:** Centralized Control: Economic Operation, Participation in Energy Markets Mathematical Formulation, Solution Methodology. Decentralized Control: Multi-Agent System Theory, Agent Communication and Development, Agent Communication Language, Agent Ontology and Data Modeling, Coordination Algorithms for Microgrid Control, Game Theory and Market Based Algorithms, Scalability and Advanced Architecture and State Estimation	08 Hours/ L2, L3
Module 3 **Intelligent Local Controllers:** Introduction, Inverter Control Issues in the Formation of Microgrids, Control Strategies for Multiple Inverters, Implications of Line Parameters on Frequency and Voltage Droop Concepts and Development and Evaluation of Innovative Local Controls to Improve Stability	08 Hours/ L2, L3
Module 4 **Microgrid protection:** Introduction, Challenges for Microgrid Protection, Adaptive Protection for Microgrids, Adaptive Protection Based on Pre-Calculated Settings, Microgrid with DER Switched off, in Grid-Connected Mode, Microgrid with Synchronous DERs Switched on in Grid, Connected and Islanded Modes, Adaptive Protection System Based on Real-Time Calculated Settings, Communication Architectures and Protocols for Adaptive Protection.	09 Hours/ L2, L3
Module 5 **Operation of Multi-Microgrids:** Introduction, Multi-Microgrid Control and Management Architecture, Coordinated Voltage/var Support, Coordinated Frequency Control, Emergency Functions (Black Start), Dynamic Equivalents	08 hours L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO643.1	Understand the concept of microgrids
CO643.2	Analyze the centralized and decentralized control strategies of microgrids
CO643.3	Apply the different intelligent controllers for microgrids
CO643.4	Apply the different protection techniques for microgrid control
CO643.5	Analyze the operation of multi-Microgrids

Textbooks:

4. Microgrids Architecture and control, N. D. Hatziargyriou, IEEE Press Series, John Wiley & Sons Inc, 2013, 1st Edition.

Reference books:

8. Microgrid Dynamics and Control, H. Bevrani, B. François, and T. Ise, John Wiley & Sons, 2017, 1st Edition.
9. Cooperative Synchronization in Distributed Microgrid Control, Bidram, V. Nasirian, A. Davoudi, F. L. Lewis, Springer, 2017, 1st Edition.

E-Books / Web References

1. https://onlinecourses.nptel.ac.in/noc20_ee84/preview
2. http://nitttrc.edu.in/nptel/courses/video/108107143/L01.html

MOOCs

1. https://nptel.ac.in/courses/108107143

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component. CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.
Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.
All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively.
Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses.

	Component	Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Quiz /AAT	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO643.1	3	2	-	-	-	-	-	-	-	-	-	1	3	1	-	-
CO643.2	3	2	-	-	-	-	-	-	-	-	-	1	3	1	-	-
CO643.3	3	-	2	-	-	-	-	-	-	-	-	1	3	1	-	-
CO643.4	3	-	-	-	-	-	-	-	-	-	-	1	3	1	-	-
CO643.5	3	-	-	-	-	-	-	-	-	-	-	1	3	1	-	-
Average	3	2	2	-	-	-	-	-	-	-	-	1	3	1	-	-

Low-1: Medium-2: High-3

SEMESTER – VI

Course: Modern Utilization of Electrical Power (Professional Elective 2)

Course Code	22EEE644	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Power System I (22EEE44)

Course Objectives:

CLO1	Describe electric heating and different methods of electric heating.
CLO2	Discuss electric welding and different methods of electric welding and their applications.
CLO3	Illustrate the laws of illumination and design methods for various type of lighting.
CLO4	Explain the motors used and their control in electric traction.
CLO5	Discuss power supply arrangement in electric traction

Content	No. of Hours/ RBT levels
Module 1: Electric Heating: Introduction, Advantages of Electrical Heating, Heating Methods, Resistance Heating, Direct Resistance Heating, Indirect Resistance Heating, Radiating Heating,Electric Arc Furnace, Indirect Arc Furnace, Electron Bombardment Heating, High Frequency Heating, Induction Heating, Dielectric Heating.	08 Hours/ L1 & L2
Module 2: Electric Welding: Introduction, Classification, Electric Arc Welding, Weld Metal Deposition, Coated Electrodes, Types of Joints and Applicable Welds, Requirements of Good Weld, Atomic Hydrogen Welding, Inert Gas Metal Arc Welding, Carbon Arc Welding, Electric Supply for Arc Welding, Resistance Welding, Spot Welding, Projection Welding, Butt Welding, Electron Beam Welding, Electro Slag Welding, Plasma Arc Welding, Laser Welding, Ultrasonic Welding, Power Supply for Resistance Welding.	08 Hours/ L1 & L2
Module 3: Illumination: Introduction, Nature of Light, Definitions, Polar Curve, Laws of Illumination, Sources of Light, Requirements of Good Lighting, Diffusing and Reflecting Surfaces, Types of Light Fittings, Methods of Lighting Calculation, Factory Lighting, Street Lighting, Flood Lighting, Photometry, Integrating Sphere.	08 Hours/ L2 & L3
Module 4: Electric Traction: Introduction, Systems of Traction, Systems of Electric Traction, Speed-Time Curvesfor Train Movements, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion. Motors – Significant Features of Traction Drives, Desirable Properties of Traction Motors, Traction Motors, Suitability of Series Motor for Traction Duty, Series Motors-Parallel Operation withUnequal Wheel Diameters, Series Motors-Series Operation with Unequal Diameters, Tractive Effort and Horse Power, A.C. Series Motor, Three Phase Induction Motor, Applications of Three Phase induction motor & Permanent Magnet Synchronous motors. Electronic Control – Speed Relations of D.C. Motors, Thyristor Control of D.C. Motors, D.C. Motor Supplied by three phase thyristor rectifiers, Field Excitation of D.C. Motor and generator from rectifier, Chopper Control of D.C. Motors, Closedloop System for automatic speed control of D.C. Motor, Automatic Control.	08 Hours/ L2 & L3
Module 5: Power Supply Arrangement and Braking of Electric Traction: Braking – Introduction, Advantages and Disadvantages of Electrical Braking over Mechanical	

Braking, Requirements of a Braking System, Types of Braking, Electric Braking Plugging, Rheostatic, Regenerative Braking, Energy Saving in egenerative Braking. Electric Traction – System of Electric Traction, A.C. Electrification, Transmission Lines to Sub-stations, Sub-stations, Feeding & Distributing System on A.C. Traction, Feeding & Distribution System for D C Tramways, Electrolysis by Currents through Earth, Negative Booster, System of Current Collection, Trolley Wires.	08 Hours/ L2 & L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO644.1	Explain different types of electric heating.
CO644.2	Classify various methods of electric welding and their applications.
CO644.3	Design lighting scheme for different application.
CO644.4	Analyze systems of electric traction, speed time curves and mechanics of train movement.
CO644.5	Discuss the motors used for electric traction, their control & braking and power supply systemused for electric traction

Textbooks:

1. A Text Book on Power System Engineering A. Chakrabarti et al Dhanpat Rai and Co 2nd Edition, 2010
2. Modern Utilization of Electric Power, Pradip Kumar Sadhu Soumya Das, CBS Publishers & Distributors Pvt Ltd

Reference books:

1. Utilization, Generation and Conservation of Electrical Energy Sunil S Rao Khanna Publishers1st Edition, 2011
2. Utilization of Electric Power and Electric Traction G.C. Garg Khanna Publishers 9th Edition, 2014

E-Books / Web References

1. https://easyengineering.net/utilisation-of-electrical-power-by-rajput/
2. https://book.jobscaptain.com/utilisation-of-electrical-power/
3. https://irieen.indianrailways.gov.in/uploads/files/1302522976022-PSI%20FINAL.pdf

MOOCs

1 **https://nptel.ac.in/courses/108105060**
2. E-learning: www.vtu.ac.in
3. https://www.youtube.com/watch?v=4pkREvVx5A0
4. https://nptel.ac.in/courses/108105060

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept

videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO644.1	3	2	-	-	-	1	-	-	-	-	-	-	-	2	-
CO644.2	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO644.3	3	2	2	-	-	-	-	1	-	-	-	1	-	2	-
CO644.4	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO644.5	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	2	2	-	-	1	-	1	-	-	-	1	-	2	-

SEMESTER – VI

Course: Electric Vehicles (Open Elective 1)

Course Code	22EEE651	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives:

CLO1	Understand Vehicle Fundamentals
CLO2	Explain electric, hybrid electric and plug in hybrid electric vehicle, their architecture and technology
CLO3	Explain the use of power electronics converters and various electric drives suitable for electric vehicles
CLO4	Discuss different energy storage technologies used for hybrid electric vehicles and their control and battery management systems
CLO5	Demonstrate different configurations of electric vehicle charging techniques

Content	No. of Hours/ RBT levels
Module 1: Vehicle Fundamentals: Vehicle Basics, Roadway Fundamentals, Laws of motion, vehicle kinetics, Dynamics of Vehicle Motion, Propulsion Power, Velocity & Acceleration, EV Powertrain Component Sizing.	8 hours L2
Module 2: Basics of EV Technology: Economic and environment impact of electrical vehicle. Basics of the EV, HEV configurations – Series hybrid, parallel hybrid, series parallel hybrid, complex hybrid systems. Power Flow control in HEV configurations. Basics of Plug-In Hybrid Electric Vehicle (PHEV) and its architecture.	8 hours L2
Module 3: Power Electronics in Electric Vehicles: Power Electronics in Electric Vehicles: Power electronics circuits used for control and distribution of electric power in DC-DC, AC-DC, DC-AC converters used for HEV. **Electric Machines and Drives in Electric Vehicles:** Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Synchronous Motor, Switched Reluctance Motor, BLDC motor, Synchronous Reluctance Motors with their advantages and disadvantages.	8 hours L2
Module 4: Energy Storage in EVs: Batteries – and their types, Fuel Cells - and their types, basics of Fuel Cell Vehicles (FCEVs,) Ultra Capacitors and Ultra high speed Flywheels, their features and design. Hybridization of Energy Sources. Battery Management Systems- block diagram and functions.	8 hours L2
Module 5: EV Charging Technologies: EV Charging Technologies: Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging. ISO standards for EV charging.	8 hours L2

Course Outcomes: The students will be able to:

CO 651.1	Understand Vehicle Fundamentals
CO651.2	Understand the architecture and technology of electric, hybrid electric and plug in hybrid electric vehicle
CO 651.3	Analyze the use of different power electronics converters and electrical machines in hybrid electric vehicles
CO651.4	Explain the use of different energy storage systems used for electric vehicles
CO651.5	Understand the control and configurations of EV charging stations

TEXTBOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press , 2004
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, Third Edition, CRC Press 2021

REFERENCES:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley , 2003
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd. , 2011

WEBLINKS:

1. https://nptel.ac.in/courses/108106170
2. cw.mit.edu/courses/16-682-technology-in-transportation-spring-2011

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 651.1	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO 651.2	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO 651.3	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO 651.4	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO 651.5	3	-	2	1	-	-	1	-	-	-	-	2	1	2	2
Average	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2

SEMESTER – VI

Course: Industrial Automation (Open Elective 1)

Course Code	22EEE652	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives:

CLO1	To give an overview of the automation technologies such as PLCs, SCADA and DCS used in Industries.
CLO2	To provide a fundamental understanding of Programmable Logic Controllers and develop PLC programs for industrial sequential applications
CLO3	To understand the architecture of Distributed Control Systems
CLO4	To provide an insight to SCADA and its industrial applications
CLO5	Understand basic industrial robots with their control, design and application in automation Industries.

Content	No. of Hours/ RBT levels
Module 1: Automation Overview: Introduction: Automation overview, Need and Benefits of automation systems, Architecture of Industrial Automation system, Types of Automation Systems; Fixed, Programmable and Flexible, Different Systems- PLC, HMI, SCADA, DCS	8 hours L2
Module 2: Programmable Logic Controllers: Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries	**8 hours L2**
Module 3: Distributed Control System: Computers in Process Automation, Process Automation Networks, Protocols, Distributed Control Systems, Hardware Units of DCS, Communications in DCS Architecture. Operation, Monitoring, Control and Data Acquisition in DCS	**8 hours L2**
Module 4: Supervisory Control and Data Acquisition: Evolution of SCADA, SCADA Architecture, Functions- Data Acquisition, Data Communication, Elements- MTU, RTU. SCADA Security, Application of SCADA, Basic overview of Industrial Internet of things IIoT	**8 hours L2**
Module 5: Robotics in Industrial Automation: Definitions, Types of Robots, , Degrees of Freedom, Robot classification on the basis of – Co-ordinate Systems, Power Source, Methods of Control, Programming method, AI in Robotics : Applications in manufacturing and material management, defence, medical, industries, etc.	**8 hours L2**

Course Outcomes: The students will be able to:

CO 652.1	Understand basics of automation technologies such as PLCs, SCADA and DCS used in Industries.
CO 652.2	Understand Programmable Logic Controllers and develop PLC programs for industrial sequential applications
CO 652.3	Explain the architecture of Distributed Control Systems
CO 652.4	Understand SCADA and its industrial applications
CO 652.5	Understand basic industrial robots with their control, design and application in automation Industries.

TEXTBOOKS:

1 Chanchal Dey & Sunit Kumar Sen, Industrial Automation Technologies, CRC Press , 2003
2. Mikell P Groover, Industrial Robotics, Technology, Programming & Applications, Mc Graw Hill Education, 2012

REFERENCES:

3. Frank Petruzella, Programmable Logic Controllers, Mc Graw Hill Education, Fifth Edition 2017
4. Stamatios Manesis , George Nikolakopolous, Introduction to Industrial Automation, CRC Press , 2018

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc20_me39/preview

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 652.1	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2
CO 652.2	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2
CO 652.3	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2
CO 652.4	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2
CO 652.5	3	-	2	1	2	-	1	-	-	-	-	2	1	1	2
Average	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2

SEMESTER –VI

COURSE: MINI PROJECT

Course Code	22EEEMP67	CIE Marks	50
Hours/Week (L: T: P)	0:0:2	SEE Marks	50
No. of Credits	2	Examination Hours	03

Mini-project work: Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-Project:

a. Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

b. Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college. The CIE marks awarded for the Mini- Project shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE for Mini-Project:

a. Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.

b. Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Review-1	**50**	**50**
	Review-2		
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

SCHEME 2022

VII & VIII Semester Scheme and Syllabus

Electrical & Electronics Engineering

GLOBAL ACADEMY OF TECHNOLOGY
(Autonomous Institution affiliated to VTU, Belagavi. Accredited by NAAC with 'A' grade. NBA Accredited CS, E&C, E&E, MECH and IS branches)Ideal Homes Township,

Department of Electrical and Electronics Engineering

Scheme and Syllabus
of
UG Autonomous Program – 2022 batch

VII SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22EEE71	Digital Signal Processing	PC	Respective Department	2	2	0	50	50	100	3
2	22EEE72	Power System –IV	IPC		3	0	2	50	50	100	4
3	22EEE73	Electrical Vehicles	IPC		3	0	2	50	50	100	4
4	22EEE74X	Program Elective 3	PEC		3	0	0	50	50	100	3
5	22EEE75X	Open Elective 2	OEC	Offering Department	3	0	0	50	50	100	3
6	22EEEP76	Project Phase 1	MP	Two Contact hours per week				100	-	100	2
				TOTAL				350	250	600	19

Program Elective 3*			
22EEE741	Machine Learning	22EEE743	Switched Mode Power converters
22EEE742	Robotics & Automation	22EEE744	FACTS & HVDC
Open Elective 2 (Offered to other branch students)			
22EEE751	Smart Grid Technology		
22EEE752	Electrical Energy Conservation & Auditing		

***NPTEL for Credit transfer:** Students can take 12 weeks NPTEL course as an equivalent to Program elective. The NPTEL courses of duration less than 12 weeks will not be considered for credit transfer. The courses (only technical) taken are as per the recommendation of BOS of respective department. The similarity of the contents as offered by NPTEL should not exceed a maximum of 40% of the courses being registered by the student. The NPTEL course need to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not be considered. The validity of NPTEL certificate is for two years and it cannot be used more than once to avail the benefit. The student is eligible to transfer a maximum of nine credits in the entire duration of the program. The grades will be awarded as equivalent to the grades obtained in the NPTEL course.

SEMESTER – VII

Course: Digital Signal Processing

Course Code	22EEE71	CIE Marks	50
Hours/Week (L: T: P)	2:2:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Fourier Transforms, Z transforms, complex variables

Course Objectives:

CLO1	Explain basic signals, their classification, basic operations on signals, and the properties of the systems.
CLO2	Explain computation of convolution of signals in continuous and discrete time domain and the properties of impulse response representation.
CLO3	Compute discrete Fourier Transform of a sequence by direct method, Linear transformation Method and using Fast Fourier Transformation Algorithms.
CLO4	Design IIR all pole analog filters and transform them into digital filter using Impulse Invariant and Bilinear Transformation Techniques.
CLO5	Design FIR filters using Window Method and Frequency Sampling Method.

Content	No. of Hours/ RBT levels
Module 1: Discrete Fourier Transforms (DFT) Introduction to DFT, Properties of DFT, multiplication of two DFTs- the circular convolution, additional DFT properties, use of DFT in linear filtering, overlap-save and overlap-add method	8/ L1, L2,L3
Module 2: Fast-Fourier-Transform (FFT) algorithms Direct computation of DFT, need for efficient computation of the DFT (FFT algorithms). Radix-2 FFT algorithm for the computation of DFT and IDFT–decimation-in-time and Decimation-in-frequency algorithms.	8/ L1, L2,L3
Module 3: Design of Infinite Impulse Response (IIR) Filters Characteristics of commonly used analog IIR filters – Butterworth and Chebyshev Type - I filter, Analog to analog frequency transformations. Design of Digital IIR filters from analog filters (Butterworth and Chebyshev) - Impulse invariance method. Mapping of transfer functions: Bilinear transformation method.	8/ L1, L2,L3
Module 4: Design of Finite Impulse Response (FIR) Filters Introduction to FIR filters, design of FIR filters using - Rectangular, Hamming, Hanning and Kaiser window techniques, FIR filter design using frequency sampling Technique.	8/ L1, L2,L3
Module 5: Digital Filter Realization and Applications of DSP Implementation of discrete-time systems: Structures for IIR Systems - direct form I and direct form II, cascade and parallel structures. Structures for FIR systems-direct form, cascade and Linear Phase Form. Applications of DSP: Voice Processing, Image processing	8/ L1, L2,L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO71.1	Compute Discrete Fourier Transform of a sequence and the convolution of two sequences.
CO71.2	Compute Discrete Fourier Transform of a sequence by using fast methods
CO71.3	Design Butterworth and Chebyshev IIR digital filters using impulse variance and bilinear transformation methods.
CO71.4	Design FIR filters using window techniques and frequency sampling methods.
CO71.5	Implement IIR and FIR filter using different forms.

TEXTBOOKS:

1. Digital Signal Processing: Principles, Algorithms and Applications, Jhon G Proakis, Dimitris K Manolakis, Printice Hall, 4th Edition.
2. Digital Signal Processing by S. Salivahanan, 4th Edition, 2019.
3. Digital Signal Processing, A Nagoor Kani, Tata McGraw-Hill, 2nd Edition, 2017.

REFERENCE BOOKS:

1. Digital Signal Processing, Anand Kumar, Prentice Hall India Learning Private Limited, 2nd Edition, 2015.
2. Digital Signal Processing: A computer Based Approach with DSP Laboratory Using MATLAB, Sanjit K Mitra, McGraw-Hill, 2001

E-Books / Web References

1. http://www.freebookcentre.net/Electronics/DSP-Books
2. https://www.electronicsforu.com/special/cool-stuff-misc/8-free-digital-signal-processing-ebooks

MOOCs

1. https://nptel.ac.in/courses/117102060
2. https://onlinecourses.nptel.ac.in/noc21_ee20/preview

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO71.1	3	2	2	-	2	-	-	-	-	-	-	1	-	-	2
CO71.2	3	2	2	-	2	-	-	-	-	-	-	1	-	-	2
CO71.3	3	2	2	-	2	-	-	-	-	-	-	1	-	-	2
CO71.4	3	2	2	-	2	-	-	1	-	-	-	1	-	-	2
CO71.5	3	2	2	-	2	-	-	1	-	-	-	1	-	-	2
22EEE71	3	2	2	-	2	-	-	1	-	-	-	1	-	-	2

VII SEMESTER

Power System IV (Integrated Program Course)			
Subject Code	22EEE72	**CIE Marks**	50
Hours/Week (L:T)	3:0:2	**SEE Marks**	50
Credits	4	**Examination Hours**	03

Course Learning Objectives: At the end of the course the student should be able to:

CLO1	To explain formulation of network models, bus admittance matrix for solving load flow problems and bus impedance matrix for the use in short circuit studies in power systems.
CLO2	To explain load flow analysis using different methods and compare them
CLO3	Solve issues of economic load dispatch and unit commitment problems.
CLO4	To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control
CLO5	To explain voltage and reactive power control in an interconnected power system.

Content	No. of Hrs/ RBT levels
MODULE I – 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. Z Bus Formulation by Step by step building algorithm without mutual coupling between the elements by addition of link and addition of branch. Z bus Algorithm for Short Circuit Studies.	08 Hours/ L1, L2, L3
MODULE II – Load Flow Studies	
Classification of buses. Power flow equation, Operating Constraints, Data for Load flow, Gauss Seidal iterative method. Newton-Raphson method derivation in Polar form, Fast decoupled load flow method, Flow charts of LFS methods. Comparison of Load Flow Methods	08 Hours/ L1, L2, L3, L4
MODULE III – 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. Unit Commitment: Introduction, Constraints and unit commitment solution by priorty list method and dynamic forward DP approach (Flow chart and Algorithm only).	08 Hours/ L1, L2, L3
MODULE IV – Automatic Generation Control	
Introduction, Schematic diagram of load frequency and excitation voltage regulators of turbo generators, Load frequency control (Single area case), Turbine speed governing system, Model of speed governing system, Turbine model, Generator load model, Complete block diagram of representation of load frequency control of an isolated power system, Steady state analysis, Control area concept, Proportional plus Integral Controller Two area load frequency control,	8 Hours/ L1, L2
MODULE V –	
Control of Voltage and Reactive Power: Introduction, Generation and absorption of reactive power, Relation between voltage, power and reactive power at a node, Methods of voltage control: (i) Injection of reactive power, Shunt capacitors and reactors, Series capacitors, Synchronous compensators, Series injection. (ii) Tap changing transformers. Combined use of tap changing transformers and reactive power injection, Hybrid Booster transformers, Phase shift transformers, Voltage collapse.	8 hours L1,L2
Total Hours	**40 Hours**

S.no.	Experiments
1	ABCD parameters: Formation for symmetric Π/T configuration. Verification of AD-BC=1and determination of efficiency and regulation.
2.	Determination of Power angle diagrams, reluctance power, excitation, emf and regulation for Salient and Non salient pole synchronous machines
3.	To obtain swing curve and to determine critical clearing time and regulation for a single machine connected to infinite bus.
4.	Formation of Y-Bus with and without mutual coupling by (i) Inspection method and (ii) Singular transformation method.
5.	Determination of bus currents, bus power and line flow for a specified system voltage (Bus) profile.
6	Formation of Z-bus using Z bus building algorithm (without mutual coupling)
7	Formation of Jacobian for a system of 4 buses in polar co-ordinates (No PV buses)
8	Determination of fault currents and voltages in a single transmission line for SLGF and DLG
9	LFA using G-S, N-R and FDLF method, both PQ and PV buses
10	Optimal Generator scheduling for Thermal power plants

Course Outcomes: The students will be able to:

CO 72.1	Calculate bus impedance and bus admittance matrices for power system.
CO 72.2	Analyse load flow analysis using Gause-Seidal, Newton Raphson and fast decoupled method.
CO 72.3	Solve issues of economic load dispatch and unit commitment problems.
CO 72.4	Explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control
CO 72.5	Understand voltage and reactive power control in an interconnected power system

TEXTBOOKS:

1. D P Kothari, I J Nagarath, Power System Engineering , Mc Graw Hill Education, Second Edition, 2008
2. William D. Stevenson Jr , Elements of Power System Analysis, McGraw Hill Education; 4th edition , 2017

REFERENCES:

1. J. Duncan Glover et al, Power System Analysis and Design, Cengage, 4th Edition, 2008
2. Hadi Sadat, Power System Analysis Mc Graw Hill Education, 1st Edition, 2002

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc22_ee17
2. https://www.udemy.com/course/electrical-power-engineering
3. https://nptel.ac.in/courses/108105067
4. https://ocw.mit.edu/courses/6-061-introduction-to-electric-power-systems-spring-2011/
5. https://www.classcentral.com/course/swayam-power-system-analysis-14243

Scheme of Evaluation: (Integrated courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

1.

2. **Table: Distribution of weightage for CIE & SEE of Integrated courses**

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 72.1	3	2	2	1	3	-	1	2	2	2	-	2	1	3	1
CO 72.2	3	2	2	1	3	-	1	2	2	2	-	2	1	3	1
CO 72.3	3	2	2	1	-	-	1	2	2	2	-	2	1	3	1
CO 72.4	3	2	2	1	3	-	1	2	2	2	-	2	1	3	1
CO 72.5	3	-	2	1	-	-	1	2	2	2	-	2	1	3	1
Average	3	2	2	1	3	-	1	2	2	2	-	2	1	3	1

SEMESTER – VII

Course: Electric Vehicles (Integrated Program Core)

Course Code	**22EEE73**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:2**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Prerequisites: Power Electronics/ Electric Machines

Course Objectives:

CLO1	Understand Vehicle Fundamentals
CLO2	Explain electric, hybrid electric and plug in hybrid electric vehicle, their architecture and technology
CLO3	Understand electric propulsion unit and its control for application to electric vehicles.
CLO4	Discuss different energy storage technologies and their control, used for hybrid electric vehicles and functions of battery management systems
CLO5	Demonstrate different configurations of electric vehicle charging techniques

Content	No. of Hours/ RBT levels
Module 1: Vehicle Fundamentals Vehicle Basics, Roadway Fundamentals, Laws of motion, vehicle kinetics, Dynamics of Vehicle Motion, Propulsion Power, Velocity & Acceleration, EV Powertrain Component Sizing.	8 hours L2
Module 2: Basics of EV Technology Economic and environment impact of electrical vehicle. Basics of the EV, HEV configurations – Series hybrid, parallel hybrid, series parallel hybrid, complex hybrid systems. Power Flow control in HEV configurations. Basics of Plug-In Hybrid Electric Vehicle (PHEV) and its architecture.	8 hours L2
Module 3: Electric Propulsion Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives and Synchronous reluctance motor drives , drive system efficiency.	8 hours L2
Module 4: Energy Storage in EVs Batteries – and their types, Fuel Cells - and their types, basics of Fuel Cell Vehicles (FCEVs,) Ultra Capacitors and Ultra high speed Flywheels, their features and design. Hybridization of Energy Sources. Battery Management Systems-block diagram and functions.	8 hours L2
Module 5: EV Charging Technologies EV Charging Technologies: Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging. ISO standards for EV charging.	8 hours L2

Sl. No.	Experiments	No. of Hours/ RBT levels
1	Modelling and Simulation of an Electric Vehicle using MATLAB/Simulink	2 hours L3
2	Simulate a Battery Pack Model for an Electric Vehicle.	2 hours L3
3	Simulation of Buck Boost Converters using MATLAB.	2 hours L3
4	Simulation of AC/DC three phase PWM converters, to understand the concept of charging from grid	2 hours L3
5	Observe the performance of various sensors used in Electric Vehicles	2 hours L3
6	To plot the Speed torque characteristics of a BLDC motor	2 hours L3
7	Study the Performance of Electric Vehicle Powered with Solar and Li Ion Battery	2 hours L3
8	To plot the charging discharging characteristics of lead acid and lithium ion batteries	2 hours L3
9	Study of Running, reversing and braking in BLDC Hub motor	2 hours L3
10	To observe the charging of Battery using Regenerative Braking	2 hours L3

Course Outcomes: The students will be able to:

CO73.1	Understand Vehicle Fundamentals
CO 73.2	Understand the architecture and technology of electric, hybrid electric and plug in hybrid electric vehicle
CO 73.3	Develop the electric propulsion unit and its control for application to electric vehicles.
CO 73.4	Explain the use of different energy storage systems used for electric vehicles
CO 73.5	Understand the control and configurations of various EV charging technologies

TEXTBOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press , 2004
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, Third Edition, CRC Press 2021

REFERENCES:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley , 2003
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd. , 2011

WEBLINKS:

1. https://nptel.ac.in/courses/108106170
2. cw.mit.edu/courses/16-682-technology-in-transportation-spring-2011

Scheme of Evaluation: (Integrated courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

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4. **Table: Distribution of weightage for CIE & SEE of Integrated courses**

	Component	Marks	Total Marks
CIE	CIE Test-1	30	50
	CIE Test-2	30	
	CIE Test-3	30	
	Laboratory	20	
SEE	Semester End Examination	100	50
		Grand Total	100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 73.1	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO 73.2	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO 73.3	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO 73.4	3	2	2	1	-	-	1	-	-	-	-	2	1	2	2
CO 73.5	3	-	2	1	-	-	1	-	-	-	-	2	1	2	2

VII SEMESTER

MACHINE LEARNING (Professional Elective 3)			
Course Code	22EEE741	**CIE Marks**	50
Hours/Week (L: T: P)	3:0:0	**SEE Marks**	50
No. of Credits	3	**Examination Hours**	03

Prerequisites: AI

Course Learning Objectives:

CLO1	Define machine learning and problems relevant to machine learning.
CLO2	Differentiate supervised, unsupervised and reinforcement learning.
CLO3	Apply neural networks, Bayes classifier and k nearest neighbor, for problems appear in machine learning.
CLO4	Apply Bayesian learning techniques for problems appear in machine learning.
CLO5	Apply Instance based and reinforcement learning techniques for problems appear in machine learning.

Content	No. of Hours/ RBT levels
Module 1: Concept Learning and General-to-Specific Ordering Well-posed learning problems, designing a learning system, Perspectives and issues in machine learning, Concept learning task, Concept learning as search, FIND-S, Version spaces and candidate elimination algorithm, Inductive bias.	**07 Hours/ L2 & L3**
Module 2: Decision Tree Learning and Kernel Machines Decision Tree Learning: Decision tree representation, Problems for decision tree learning, Decision tree learning algorithm, Hypothesis space search, Inductive bias in decision tree learning, Issues in decision tree learning. Kernel Machines: Support vector machines – SVMs for regression, SVMs for classification, Choosing C, A probabilistic interpretation of SVMs	**08 Hours/ L2 & L3**
Module 3: Artificial Neural Networks Neural network representations, Appropriate problems for neural network learning, Perceptron's, Multilayer networks and Backpropagation algorithm, Convergence and local minima, Representational power of feedforward networks, Hypothesis space search and inductive bias, Hidden layer representations, Generalization, Overfitting, Stopping criterion, An Example - Face Recognition.	**08 Hours/ L2 & L3**
Module 4: Bayesian Learning Bayes theorem and concept learning, Maximum likelihood and least-squared error hypothesis, Maximum likelihood hypotheses for predicting probabilities, Minimum Description Length principle, Bayes optimal classifier, Gibbs algorithm, Naive Bayes classifier, An Example – Learning to classify text; Bayesian belief networks, EM Algorithm.	**09 Hours/ L2 & L3**
Module 5: Instance Based Learning and Reinforcement Learning Instance Based Learning: k-Nearest Neighbor learning, Locally weighted regression, Radial basis functions, Case-based reasoning. Reinforcement Learning: The learning task, Q-learning, Nondeterministic rewards and actions, Temporal difference learning, Generalizing from examples, Relationship to dynamic programming	**08 hours L2 & L3**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO741.1	Understand the concept learning algorithms to automatically infer a general description for a given learning problem.
CO741.2	Analyze the underlying mathematical models within machine learning algorithms and learning tasks.
CO741.3	Apply suitable machine learning algorithms for various types of learning tasks.
CO741.4	Design efficient neural architectures to model patterns for a given learning problem.
CO741.5	Apply machine learning algorithms to solve societal problems such as face recognition, text classification

Textbooks:

1. Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

Reference books:

1. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, 4th Edition, 2020.
2. Shai Shalev Shwartz, Shai Ben David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.

E-Books / Web References

https://swayam.gov.in/nd1_noc19_cs52/preview
https://www.udemy.com/course/machinelearning/

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO741.1	3	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO741.2	2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO741.3	2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO741.4	3	3	3	1	-	-	-	-	-	-	-	-	-	2	-
CO741.5	2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
2EEE741	3	3	2	1	-	-	-	-	-	-	-	-	-	2	-

SEMESTER VII

Course: Robotics & Automation (Professional Elective 3)

Course Code	22EEE742	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites:

Programming in a high-level language, Sensor and Transducers

Course Objectives:

CLO1	To Identify robots and its peripherals, applications
CLO2	To understand the concepts of Robotic system
CLO3	To know spatial transformation and AI in robotics
CLO4	To understand Kinematic motion of robotics
CLO5	To Control robots for industrial and non-industrial applications.

Content	No. of Hours/ RBT levels
Module 1: Robot basics and Elements Fundamentals of Robotics & Automation: Automation and robotics, history of robotics, robotics market and future prospects, robot anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, robotic sensors, robot programming and work cell control, robot applications	**08 Hours/ L1, L2**
Module 2: Robot Motion Analysis, Sensors and Control Introduction to manipulator kinematics, homogeneous transformations and robot kinematics, configuration of a robot controller, types of end effecters, mechanical grippers, other types of grippers, tools as end effectors, robot/end effector interface, consideration in gripper selection and design, problems. Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics.	**08 Hours/ L1, L2**
Module 3: Machine Vision & Artificial Intelligence Introduction to machine vision, sensing and digitizing function in machine vision, image processing and analysis, training the vision system, robotic applications. Artificial Intelligence (AI): Introduction & goals of AI in research, AI techniques, LISP programming, AI & robotics, LISP in factory, robotic paradigms	**08 Hours/ L1, L2**

Module 4: **Robotics in Manufacturing/Automation , Material Transfer, Machine Loading/Unloading** Robot cell layouts, multiple robots and machine interference, considerations in work -cell design, work-cell control, interlocks, error detection and recovery, work -cell controller, robot cycle time analysis. Material Transfer, Machine Loading/Unloading: General considerations in robot material handling, material transfer applications, machine loading and unloading.	**8 Hours/ L1, L2**
Module 5: Robots in Automatic Processing Operations, Assembly & Inspection: Introduction, spot welding, continuous arc welding, spray coating, other processing operations. Assembly and robotic assembly automation, parts presentation methods, assembly operations, compliance and remote centre compliance (RCC) device, assembly system configurations, adaptable programmable assembly system, designing for robotic assembly, inspection automation. **Autonomous Mobile Robots**: Introduction, Planning &Navigation: Introduction, basic control scheme for mobile robots (only basic understanding of perception, localization, path planning & motion control)	**8 hours L1,L2**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO742.1	Explain the key components of robotic technologies
CO742.2	Explain various sensors in Robots.
CO742.3	Solve problems in spatial transformation
CO742.4	Acquire knowledge in kinematic motion of Robots.
CO742.5	Formulate Motion planning techniques to navigate and perform the given task

Textbooks:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications", 2nd Edition, Tata McGraw Hill, 2012.
2. 2. Roland Siegwart, Illah R. Nourbakhsh, and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2ndEdition, PHI, 2011.

Reference Books:

1. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112105249
- https://nptel.ac.in/courses/112101098

Scheme of Examination:

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-athon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE (40) + AAT (10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO742.1	3	2	1	-	-	-	-	-	-	-	-	1	-	-	2
CO742.2	3	2	1	-	-	-	-	-	-	-	-	1	-	-	2
CO742.3	3	2	1	-	-	-	-	-	-	-	-	1	-	-	2
CO742.4	3	2	1	-	-	-	-	-	-	-	-	1	-	-	2
CO742.5	3	2	1	-	-	-	-	-	-	-	-	1	-	-	2
Average	3	2	1	-	-	-	-	-	-	-	-	1	-	-	2

SEMESTER – VII

Course: Switched Mode Power Converters (Professional Elective 3)

Course Code	22EEE743	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Power Electronics

Course Objectives:

CLO1	Understand the working of buck converter and boost converter under continuous and discontinuous conduction mode.
CLO2	Illustrate the working of CUK converter and Buck-boost converter.
CLO3	Understand the working of flyback converter, forward converter and push pull converter with reference to switched mode power supplies.
CLO4	Analyze switched mode Dc to AC single phase and three phase inverters with different switching schemes.
CLO5	Illustrate the techniques for zero-voltage and zero-current switching of resonant pulse inverters.

Content	No. of Hours/ RBT levels
Switched Mode DC-to-DC Converter Introduction, control of DC-DC converters, buck converters, boost Converter, Continuous Conduction mode, boundary between continuous and discontinuous conduction – critical values of inductance/load resistance - discontinuous conduction mode with constant output voltage - Output voltage ripple.	8 hours/ L1, L2, L3
Switched Mode DC-to-DC Converter Buck-boost converter, Continuous Conduction mode, boundary between continuous and discontinuous conduction – critical values of inductance/load resistance - discontinuous conduction mode with constant output voltage, Cuk converter – Full-ridge dc-dc Converter – PWM with bipolar voltage and unipolar voltage switching –comparison of dc-dc converters	8 hours/ L1, L2, L3
Switched Mode Power Supplies Linear Power Supply – disadvantages of linear power supply – switched mode power supply – dc-dc converters with electrical isolation. Fly back converter – continuous & discontinuous conduction mode, double ended fly back converter – forward converters – basic forward converter – practical forward converter – continuous conduction mode only - double ended forward converter – push pull converter.	8 hours/ L1, L2, L3
Switched Mode DC to AC converter Introduction, pulse width modulated switching scheme, square wave switching scheme, 1-phase square wave full-bridge inverter PWM switching scheme – PWM with bipolar & unipolar voltage switching, harmonic analysis of output voltage, output control by voltage cancellation, single phase push-pull inverter. Pulse width modulated 3-phase voltage source inverter	8 hours/ L1, L2, L3
Resonant Converters - Basic resonant circuit concepts – series resonant circuit – parallel resonant circuit – load resonant converter - ZCS resonant converter - L type & M type - ZVS resonant converter – comparison of ZCS & ZVS Resonant Converters	8 hours/ L1, L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO743.1	Analyze buck converter and boost converter under continuous and discontinuous conduction mode.
CO743.2	Illustrate the working of CUK converter and Buck-boost converter.
CO743.3	Analyze flyback converter, forward converter and push pull converter.
CO743.4	Analyze switched mode Dc to AC single phase and three phase inverters with different switching schemes.
CO743.5	Explain the techniques for zero-voltage and zero-current switching of resonant pulse inverters.

Textbooks:

1. Power Electronics Converters, Applications and Design (For Module 5: Chapters 16 and 17), Ned Mohan et al. Wiley, 3 rd Edition, 2014.
2. Power Electronics: Circuits Devices and Applications, Mohammad H Rashid, Pearson education, 4 th Edition, 2014.

Reference books:

1. Power Electronics, Daniel W Hart, McGraw Hill 1st Edition, 2011
2. Switch-Mode Power Converters: Design and Analysis, Keng C. Wu, Academic Press Inc (1 December 2005)

E-Books / Web References

1. https://ee.iisc.ac.in/wp-content/uploads/2023/01/SMPC_VRamnarayanan.pdf

MOOCs

1. https://nptel.ac.in/courses/108105180
2. https://www.coursera.org/learn/converter-circuits?specialization=power-electronics

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO743.1	3	2	-	-	-	-	-	-	-	-	-	2	-	-	3
CO743.2	3	2	-	-	-	-	-	-	-	-	-	2	-	-	3
CO743.3	3	1	-	-	-	-	-	-	-	-	-	2	-	-	3
CO743.4	3	2	-	-	-	-	-	-	-	-	-	2	-	-	3
CO743.5	3	2	-	-	-	-	-	-	-	-	-	2	-	-	3
22EEE743	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**

SEMESTER – VII

Course: FACTS & HVDC (Professional Elective 3)

Course Code	22EEE744	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: PS-I & PS-II

Course Objectives:

CLO1	To explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
CLO2	To describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability
CLO3	To describe series Controllers Thyristor -Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
CLO4	To explain advantages of HVDC power transmission, overview and organization of HVDC system.
CLO5	To describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter

Content	No. of Hours/ RBT levels
Module 1 **FACTS Concept and General System Considerations:** FACTS concept and General system considerations – Transmission Interconnections, Flow of power in an AC system, Loading capability, Power flow and dynamic stability considerations of a transmission interconnection, basic types of FACTS controllers, IEEE definitions, FACTS devices in India and abroad, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.	07 Hours/ 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), Switching Converter Type Var Generators, Basic Operating Principles, Basic Control Approaches. Static VAR Compensators: SVC and STATCOM, the Regulation Slope. Comparison between STATCOM and SVC, V –I and V –Q Characteristics, Transient stability, Response Time	08 Hours/ L2, L3
Module 3 **Static Series Compensators:** Objectives of Series Compensation, Concept of Series Capacitive Compensation. Voltage Stability, Improvement of Transient Stability, variable impedance type series compensators: GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor (GCSC, TSSC, TCSC), Static synchronous Series Compensator (SSSC), Transmitted Power Versus Transmission Angle Characteristics.	08 Hours/ L2, L3
Module 4 **Introduction to HVDC System** Basic Concepts Necessity of HVDC systems, Economics and Terminal equipment of HVDC transmission systems, Types of HVDC Links, Apparatus required for HVDC Systems, Comparison of AC and DC Transmission, Application of DC Transmission System, Planning and Modern trends in D.C. Transmission. Analysis of HVDC Converters: Choice of Converter Configuration, Analysis of Graetz circuit, Characteristics of 6 Pulse and 12 Pulse converters.	09 Hours/ L2, L3

Module 5	08 hours L2, L3
Converter and HVDC System Control Principles of DC link control – Converter control characteristics – System control hierarchy – Firing angle control – Current and extinction angle control – Starting and stopping of DC link – Power control	

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO744.1	Explain transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters and benefits from FACTS technology.
CO744.2	Analyze shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
CO744.3	Analyze series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
CO744.4	Explain advantages of HVDC power transmission, overview and organization of HVDC system.
CO744.5	Describe the basic components of a converter, the control techniques used for converter control.

Textbooks:

1. Hingorani, Narain G., and Laszlo Gyugyi. Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems. New York: IEEE Press, 2000.
2. K. R. Padiyar, HVDC Power Transmission Systems: Technology and system Interactions, New Age International (P) Limited, and Publishers, 1990.

Reference books:

E-Books / Web References

1. https://onlinecourses.nptel.ac.in/noc20_ee84/preview
2. http://nitttrc.edu.in/nptel/courses/video/108107143/L01.html

MOOCs

1. https://nptel.ac.in/courses/108107143

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.

Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.

All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

SEMESTER – VII

Course: Smart Grid Technology (Open Elective-2)

Course Code	22EEE751	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Prerequisites: PS-I, PS-II, PS-III & PS-IV

Course Objectives:

CLO1	Understand the operation of Smart Grid technologies
CLO2	Understand the Smart Grid Architecture
CLO3	Understand the different types of Tools and Techniques for Smart Grid
CLO4	Understand the different types of Communication Technologies in Smart Grid
CLO5	Understand the smart meters and advanced metering infrastructure

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Smart Grid:** Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India.	07 Hours/ L2, L3
Module 2 **Smart Grid Architecture:** Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, IP-based systems, power line communications, supervisory control and data acquisition system, advanced metering infrastructure. The fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration	08 Hours/ L2, L3
Module 3 **Tools and Techniques for Smart Grid:** Computational Techniques – Static and Dynamic Optimization Techniques for power applications such as Economic load dispatch – Computational Intelligence Techniques – Evolutionary Algorithms in power system – Artificial Intelligence techniques and applications in power system	08 Hours/ L2, L3
Module 4 **Communication Technologies in Smart Grid:** Introduction to Communication Technology, Two Way Digital Communications Paradigm, Synchro- Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid.	09 Hours/ L2, L3
Module 5 **Smart Meters and Advanced Metering Infrastructure** Introduction to Smart Meters, Advanced Metering infrastructure (AMI)drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED)&their application for monitoring & protection	08 hours L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO751.1	Understand the features of Smart Grid
CO751.2	Assess the role of automation and digitization in Transmission and Distribution
CO751.3	Analyze Smart grids with evolutionary algorithms
CO751.4	Analyze Communication Technologies used in smart grid
CO751.5	Understand the operation of smart meters and the importance of Advanced Metering Infrastructure

Textbooks:

1. Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, CRC Press, 2013, 1st Edition.
2. Renewable and Efficient Electric Power System, G. Masters, Wiley–IEEE Press, 2013, 2nd Edition.

Reference books:

1. Synchronized Phasor Measurements and their Applications, A.G. Phadke and J.S. Thorp, Springer, 2017, 2nd Edition.
2. Wind Power in Power Systems, T. Ackermann, Hoboken, N J, USA, John Wiley, 2012, 2nd Edition.

E-Books / Web References

3. https://ieeexplore.ieee.org/book/9509795
4. https://www.elsevier.com/books/advances-in-smart-grid-power-system/tomar/978-0-12-824337-4

NPTEL/MOOCs

1 https://nptel.ac.in/courses/108107113

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.
Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.
All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively.
Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Quiz /AAT	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO751.1	3	2	2	2	2	2	-	-	-	-	-	-	1	3	1	-
CO751.2	1	2	3	3	1	2	-	-	-	-	-	-	1	3	1	-
CO751.3	2	2	3	2	2	2	-	-	-	-	-	-	1	3	1	-
CO751.4	3	2	3	2	2	3	-	-	-	-	-	-	1	3	1	-
CO751.5	2	2	3	2	2	2	-	-	-	-	-	-	1	3	1	-
Average	2	2	3	2	2	2	-	-	-	-	-	-	1	3	1	-

Low-1: Medium-2: High-3

SEMESTER VII

Course: Electrical Energy Conservation and Auditing (Open Elective 2)

Course Code	22EEE752	CIE Marks	50
Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Credits	3	Examination Hours	3

Course Learning Objectives:

CLO 1	Understand the current energy scenario and importance of energy conservation.
CLO 2	Describe the importance of Energy audit.
CLO 3	Explain energy conservation act auditing of boilers.
CLO 4	Explain auditing of furnaces, power plant and pumps.
CLO 5	Explain auditing of fans, cooling towers, and Buildings.

Content	No. of Hours/ RBT levels
Module 1: Fundamentals of Energy and Energy Scenario: Fundamentals of Energy, Various Types of Energy, Commercial and Non-commercial Energy, Grades of Energy, Energy Demand and Supply in India, Energy Scenario in India, Energy Security in India, Future Energy Strategy. **Energy Management and Energy Conservation Opportunities**: Energy Management, Tariff, Energy Conservation.	**L1, L2, L3 08**
Module 2: Energy Audit: Concept of Energy Audit, Type of Energy Audit, Collecting Data Strategy, Technical and Economic Feasibility, Types of Energy Conservation Measures, Understanding Energy Costs, Benchmarking and Energy Performance, Plant Energy Performance, Fuel and Energy Substitution.	**L1, L2, L3 08**
Module 3: Energy Audit (Continued): The Energy Conservation Act, 2001 and Its Features, Responsibilities and Duties to be Assigned Under the Energy Conservation Act, 2001. **Energy Audit of Boilers**: Classification of Boilers, Parts of a Boiler, Efficiency of Boiler, Role of Excess Air in Boiler Efficiency, Energy-Saving Methods.	**L1, L2, L3 08**
Module 4: **Energy Audit of Furnaces**: Parts of a Furnace, Classification of Furnaces, Energy-Saving Measures in Furnaces, Furnace Efficiency. **Energy Audit of a Power Plant**: Indian Power-Plant Scenario, How is Energy Audit of Power Plants Helpful? Types of Power Plants, Energy Audit of Power Plant. **Energy Audit of Pumps:** Centrifugal Pump, Positive-Displacement Pump, Pump terms and Affinity Laws, Flow Control and Pump Losses, Series and Parallel Arrangement of Pumps, Selection of Pump, Energy-Saving Potential in a Pump.	**L1, L2, L3 08**
Module 5: **Energy Audit of Fans and Blowers:** Classification of Fans, Fan Laws and Curves, Power Consumption by a Fan, Energy-Saving Potential in Fans. **Energy Audit of Cooling Tower**: Classification of Cooling Towers, Performance of a Cooling Tower, Components of a Cooling Tower **Energy Audit Applied to Buildings**: Energy-Saving Measures in New Buildings, Water Audit, How to Audit Your Home? General Energy-saving Tips Applicable to New as Well as Existing Buildings.	**L1, L2, L3 08**

Course Outcomes

Upon completion of this course, student will be able to:

CO 752. 1	Discuss the current energy scenario and importance of energy conservation.
CO 752. 2	Explain energy conservation measures the importance of Energy audit.
CO 752. 3	Discuss the energy conservation and its features, responsibilities, and duties to be assigned under the act.
CO 752. 4	Conduct the energy audit of Boilers, Furnaces, Power Plant
CO 752. 5	Conduct the energy audit of fans, cooling towers and Buildings.

Textbooks:

1. Energy Management Conservation and Audits, Anil Kumar, Om Prakash, Prashant Singh Chauhan, Samsher First edition 2020, CRC Press.
2. Handbook of Energy Audit, Sonal Desai, 2015, McGraw Hill Education (India) Private Limited

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

E-Books / Web References

1. http://sites.google.com>venusict.org>ntpl-video-link

MOOCs

1. https://nptel.ac.in/courses/112105221
2. https://nptel.ac.in/courses/105102175

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO – PO Mapping With Strengths

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 752. 1	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO 752. 2	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO 752. 3	3	1	-	1	-	-	-	1	-	-	1	-	-	1	-
CO 752. 4	3	1	-	1	-	-	-	1	1	-	1	-	-	1	-
CO 752. 5	3	1	-	1	-	-	-	1	1	-	1	-	-	1	-
Average	3	1	-	1	-	-	-	1	1	-	1	-	-	1	-

SEMESTER –VII

COURSE: PROJECT PHASE-I

Course Code	22EEEP76	CIE Marks	100
Hours/Week (L: T: P)	0:0:4	SEE Marks	-
No. of Credits	2	Examination Hours	-

Content
Project work phase - 1: Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6. **CIE procedure for Project Work Phase - 1:** a. **Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology) using Rubrics, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the Project report shall be the same for all the batch mates. b. **Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates as per Rubrics covering all Program Outcomes.

Table 1: Distribution of weightage for CIE of Regular courses

	Component	Marks	Total Marks
CIE	Review-1	**100**	**100**
	Review-2		
SEE	Semester End Examination	--	--
Grand Total			**100**

Scheme and Syllabus
of
UG Autonomous Program – 2022 batch

VIII SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22EEE81	Smart Grid	PC	Respective Department	4	0	0	50	50	100	4
2	22EEE82X	Program Elective 4	PEC		3	0	0	50	50	100	3
3	22EEE83X	Program Elective 5	PEC		3	0	0	50	50	100	3
4	22EEEP84	Project work phase – II	MP	Two Contact hours per week				100	100	200	8
5	22EEES85	Technical Seminar	MP	One Contact hour per week				100	--	100	1
6	22INT86	Internship	INT	Completed during the intervening period of VI and VII Semester				100	--	100	2
				TOTAL				**450**	**250**	**700**	**21**

Program Elective 4*			
22EEE821	Industrial Automation	22EEE823	Electrical Power Quality
22EEE822	Micro Electro Mechanical Systems	22EEE824	Electrical Distribution Systems
Program Elective 5*			
22EEE831	Soft Computing Techniques	22EEE833	Electrical Energy Conservation & Auditing
22EEE832	Image Processing	22EEE834	Energy Storage Systems

***NPTEL for Credit transfer**: Students can take 12 weeks NPTEL course as an equivalent to Program elective. The NPTEL courses of duration less than 12 weeks will not be considered for credit transfer. The courses (only technical) taken are as per the recommendation of BOS of respective department. The similarity of the contents as offered by NPTEL should not exceed a maximum of 40% of the courses being registered by the student. The NPTEL course need to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not be considered. The validity of NPTEL certificate is for two years and it cannot be used more than once to avail the benefit. The student is eligible to transfer a maximum of nine credits in the entire duration of the program. The grades will be awarded as equivalent to the grades obtained in the NPTEL course.

SEMESTER – VIII

Course: Smart Grid (Professional Core)

Course Code	22EEE81	CIE Marks	50
Hours/Week (L: T: P)	4:0:0	SEE Marks	50
No. of Credits	04	Examination Hours	03

Prerequisites: PS-I, PS-II, PS-III & PS-IV

Course Objectives:

CLO1	Understand the operation of Smart Grid technologies
CLO2	Understand the Smart Grid Architecture
CLO3	Understand the different types of Tools and Techniques for Smart Grid
CLO4	Understand the different types of Communication Technologies in Smart Grid
CLO5	Understand the smart meters and advanced metering infrastructure

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Smart Grid:** Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India.	07 Hours/ L2, L3
Module 2 **Smart Grid Architecture:** Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, IP-based systems, power line communications, supervisory control and data acquisition system, advanced metering infrastructure. The fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration	08 Hours/ L2, L3
Module 3 **Tools and Techniques for Smart Grid:** Computational Techniques – Static and Dynamic Optimization Techniques for power applications such as Economic load dispatch – Computational Intelligence Techniques – Evolutionary Algorithms in power system – Artificial Intelligence techniques and applications in power system	08 Hours/ L2, L3
Module 4 **Communication Technologies in Smart Grid:** Introduction to Communication Technology, Two Way Digital Communications Paradigm, Synchro- Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid.	09 Hours/ L2, L3
Module 5 **Smart Meters and Advanced Metering Infrastructure** Introduction to Smart Meters, Advanced Metering infrastructure (AMI)drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED)&their application for monitoring & protection	08 hours L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO81.1	Understand the features of Smart Grid
CO81.2	Assess the role of automation and digitization in Transmission and Distribution
CO81.3	Analyze Smart grids with evolutionary algorithms
CO81.4	Analyze Communication Technologies used in smart grid
CO81.5	Understand the operation of smart meters and the importance of Advanced Metering Infrastructure

Textbooks:

3. Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, CRC Press, 2013, 1st Edition.
4. 2. Renewable and Efficient Electric Power System, G. Masters, Wiley–IEEE Press, 2013, 2nd Edition.

Reference books:

3. Synchronized Phasor Measurements and their Applications, A.G. Phadke and J.S. Thorp, Springer, 2017, 2nd Edition.
4. Wind Power in Power Systems, T. Ackermann, Hoboken, N J, USA, John Wiley, 2012, 2nd Edition.

E-Books / Web References

5. https://ieeexplore.ieee.org/book/9509795
6. https://www.elsevier.com/books/advances-in-smart-grid-power-system/tomar/978-0-12-824337-4

NPTEL/MOOCs

1 https://nptel.ac.in/courses/108107113

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.

Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.

All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Quiz /AAT	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO81.1	3	2	2	2	2	2	-	-	-	-	-	-	1	3	1	-
CO81.2	1	2	3	3	1	2	-	-	-	-	-	-	1	3	1	-
CO81.3	2	2	3	2	2	2	-	-	-	-	-	-	1	3	1	-
CO81.4	3	2	3	2	2	3	-	-	-	-	-	-	1	3	1	-
CO81.5	2	2	3	2	2	2	-	-	-	-	-	-	1	3	1	-
Average	2	2	3	2	2	2	-	-	-	-	-	-	1	3	1	-

Low-1: Medium-2: High-3

SEMESTER – VIII

Course: Industrial Automation (Professional Elective 4)

Course Code	22EEE821	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives:

CLO1	To give an overview of the automation technologies such as PLCs, SCADA and DCS used in Industries.
CLO2	To provide a fundamental understanding of Programmable Logic Controllers and develop PLC programs for industrial sequential applications
CLO3	To understand the architecture of Distributed Control Systems
CLO4	To provide an insight to SCADA and its industrial applications
CLO5	Understand basic industrial robots with their control, design and application in automation Industries.

Content	No. of Hours/ RBT levels
Module 1: Automation Overview Introduction: Automation overview, Need and Benefits of automation systems, Architecture of Industrial Automation system, Types of Automation Systems; Fixed, Programmable and Flexible, Different Systems- PLC, HMI, SCADA, DCS	8 hours L2
Module 2: Programmable Logic Controllers Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries	8 hours L2
Module 3: Distributed Control System Computers in Process Automation, Process Automation Networks, Protocols, Distributed Control Systems, Hardware Units of DCS, Communications in DCS Architecture. Operation, Monitoring, Control and Data Acquisition in DCS	8 hours L2
Module 4: Supervisory Control and Data Acquisition Evolution of SCADA, SCADA Architecture, Functions- Data Acquisition, Data Communication, Elements- MTU, RTU. SCADA Security, Application of SCADA, Basic overview of Industrial Internet of things IIoT	8 hours L2
Module 5: Robotics in Industrial Automation Definitions, Types of Robots, , Degrees of Freedom, Robot classification on the basis of – Co-ordinate Systems, Power Source, Methods of Control, Programming method, AI in Robotics : Applications in manufacturing and material management, defence, medical, industries, etc.	8 hours L2

Course Outcomes: The students will be able to:

CO 821.1	Understand basics of automation technologies such as PLCs, SCADA and DCS used in Industries.
CO 821.2	Understand Programmable Logic Controllers and develop PLC programs for Industrial sequential applications
CO 821.3	Explain the architecture of Distributed Control Systems
CO 821.4	Understand SCADA and its industrial applications
CO 821.5	Understand basic industrial robots with their control, design and application in automation Industries.

TEXTBOOKS:

1 Chanchal Dey & Sunit Kumar Sen, Industrial Automation Technologies, CRC Press , 2003

2. Mikell P Groover, Industrial Robotics, Technology, Programming & Applications, Mc Graw Hill Education, 2012

REFERENCES:

3. Frank Petruzella, Programmable Logic Controllers, Mc Graw Hill Education, Fifth Edition 2017

4. Stamatios Manesis , George Nikolakopolous, Introduction to Industrial Automation, CRC Press , 2018

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc20_me39/preview

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.

Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.

All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Quiz /AAT	10	
SEE	Semester End Examination	100	50
Grand Total			100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 821.1	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2
CO 821.2	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2
CO 821.3	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2
CO 821.4	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2
CO 821.5	3	-	2	1	2	-	1	-	-	-	-	2	1	1	2
Average	3	2	2	1	2	-	1	-	-	-	-	2	1	1	2

SEMESTER – VIII

Course: Micro Electro Mechanical Systems (MEMS) (Professional Elective 4)

Course Code	22EEE822	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Elements of Electronic Engineering

Course Objectives:

CLO1	Understand overview of MEMS and MEMS Processing I.
CLO2	Know MEMS Processing II and Materials required for MEMS.
CLO3	Understand MEMS Sensors and Actuators.
CLO4	Explain Design and Simulation of MEMS.
CLO5	Know the applications of MEMS.

Content	No. of Hours/ RBT levels
Module 1: Overview of MEMS and MEMS Processing I Introduction, Multidisciplinary Field Applications of Microsystems, Forecasts and Trends. Processing I Introduction, Basic IC Technology, Oxidation, Diffusion, Ion Implantation, Chemical Vapor Deposition, Physical Vapor Deposition, Epitaxy, Photolithography.	8 hours L2
Module 2: MEMS Processing II and Materials Processing II Introduction, Etching Techniques, Bulk Micromachining, Surface Micromachining, LIGA Process, Comparison of Micromachining Techniques. Materials Introduction, Substrates, Active Materials, Silicon, Silicon Compounds, Gallium Arsenide, Quartz, Piezoelectric Materials, Polymers, Packing Materials.	8 hours L2,
Module 3: MEMS Sensors and Actuators Sensors Introduction, MEMS Sensors, Electrostatic Sensors, Thermal Micro sensor, Piezoelectric Sensors, Magnetostrictive Sensors. Actuators Introduction, Electric Field-Driven Actuators, Piezoelectric Actuator, Magnetic Field-Driven Actuators, Ionic Polymer-Based Actuators, Mechanical Transformers and Thermal Actuators.	8 hours L2,
Module 4: Design and Simulation of MEMS Introduction-Mems Design and Simulation: Low-Level System Models, Process-Level Simulations, Device-Level Simulations, System Simulations, MEMS Simulation Techniques. Case Study: Cantilever Beam Design and Simulation: Electromechanical Analysis of Basic MEMS Device, Developing the Layout Design, Building the Model, Simulation Analysis. Case Study: Gyroscope Design and Simulation: Modal Analysis, DC and Modal Analysis, AC Analysis, Pull-in Voltage.	8 hours L2, L3

Module 5 MEMS Applications Introduction: Automotive Applications, Consumer Market Applications, Military Applications, Medical Applications, Home Applications. MEMS and Smart Structures: Biomimetic Smart Structures, Smart Materials and Systems, Damage Detection in Composite Structures. Vibration-Sensing Smart Devices: Design and Function, Measurement Sensitivity, Applications. Micro actuators for Vibration Control: Flow chart for GA-Based Designs Morphing of Flexible Structures Using Mems: Shape Morphing Systems, Monomorph Actuators.	8 hours L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO822.1	Explain overview of MEMS and MEMS Processing I.
CO822.2	Discuss MEMS Processing II and Materials required for MEMS.
CO822.3	Describe MEMS Sensors and Actuators.
CO822.4	Design and Simulation of MEMS.
CO822.5	Illustrate the applications of MEMS.

Textbooks:

1. Microelectromechanical Systems (MEMS) Dilip Kumar Bhattacharya and BrajeshKumar Kaushik CENGAGE Learning India Pvt. Ltd. 2015 ISBN-13: 978-81-315-2588-3

Reference books:

1. Tai-Ran Hsu, MEMS and Micro systems: Design and Manufacture,Tata Mc Graw-Hill Edition 2002
2. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools andProcesses, Springer, 2015.

E-Books / Web References

MOOCs

1. https://www.nptelvideos.com/video.php?id=788
2. https://www.youtube.com/watch?v=j9y0gfN9WMg
3. https://www.youtube.com/watch?v=EALXTht-stg
4. https://www.youtube.com/watch?v=unj23A8br0U

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.

Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.

All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/ group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Quiz /AAT	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO822.1	3	2	1			1	1	1				1			-
CO822.2	3	2	1			1	1	1				1			2
CO822.3	3	2	1			1	1	1				1			2
CO822.4	3	2	1			1	1	1				1			2
CO822.5	3	2	1			1	1	1				1			2
Average	3	2	1			1	1	1				1			2

SEMESTER – VIII

Course: Electrical Power Quality (Professional Elective 4)

Course Code	22EEE823	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Electrical Power Systems

Course Objectives:

CLO1	Familiarize with the power quality terminologies and power quality problems.
CLO2	Analyze various sources of harmonic generation.
CLO3	Explain the working of various custom power devices.
CLO4	Apply DSTATCOM to improve power quality.
CLO5	Understand the working of power quality measurement devices.

Content	No. of Hours/RBT levels
Module 1: Introduction to Power Quality **Introduction:** Introduction to Electrical Power Quality, Impacts of power quality problems on end users, power quality standards, power quality terminologies – total harmonic distortions, transients, voltage fluctuations, short duration and long duration voltage variations, voltage imbalance. Power Quality problems - Poor load power factor, Harmonic contents in loads, Notching, DC offset, Supply voltage distortion, Voltage sag/ swell, flicker.	8 hours/ L1, L2
Module 2: Harmonics **Harmonics:** Definition of harmonics, Odd and even order harmonics, causes of voltage and current harmonics, individual and total harmonic distortions, Harmonic current generating loads – fluorescent lighting, adjustable speed drive. Effect of harmonics on power system devices – transformer, AC motors, capacitor bank, Guidelines for harmonic voltage and current limitations, Harmonic current mitigation by harmonic current cancellation and harmonic filters. Harmonic Filter design using case study.	8 hours/ L1, L2, L3
Module 3: Custom Power Devices **Custom Power Devices:** Introduction to custom power devices, Network reconfiguring devices, load compensation using DSTATCOM, voltage regulation using DSTATCOM, protecting sensitive loads using DVR, Unified power quality conditioner (UPQC). Applications of custom power devices.	8 hours/ L1, L2
Module 4: Load Compensation using DSTATCOM **Load Compensation using DSTATCOM:** Compensating Single-Phase Loads, Ideal Three-Phase Shunt Compensator Structure, Instantaneous PQ theory, Generating Reference Currents using Instantaneous PQ Theory.	8 hours/ L1, L2, L3
Module 5: Control of DSTATCOM and Power Quality Measurement Devices **Control of DSTATCOM:** DSTATCOM structure, Control of DSTATCOM Connected to a Stiff Source, DSTATCOM Structure for Weak Supply Point Connection. **Power Quality Measurement Devices:** Harmonic Analyzer, transient disturbance analyzer, true RMS meters	8 hours/ L1, L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO823.1	Understand the power quality terminologies and power quality issues with reference to electrical power systems.
CO823.2	Analyze various sources of harmonic generation and their mitigation techniques.
CO823.3	Understand various custom power devices and their working.
CO823.4	Use DSTATCOM to compensate load and improve power quality
CO823.5	Understand control algorithm of DSTATCOM and working of power quality measurement devices.

Textbooks:

3. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh, Gerard Ledwich, Springer (1 January 2009).
4. Electric power quality problems –M.H.J. Bollen IEEE series-Wiley India publications,2011.

Reference books:

3. R.C.Duggan Electric Power Systems Quality, Tata MC Graw Hill Publishers, Third Edition, 2012.
4. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad," Power Quality Problems & Mitigation Techniques" Wiley, 2015.

E-Books / Web References

2. https://www.intechopen.com/books/62
3. https://www.svec.education/wp-content/uploads/2020/01/power-quality-course-material.pdf
4. https://www.academia.edu/27079425/Power_Quality_pdf

MOOCs

3. https://onlinecourses.nptel.ac.in/noc21_ee103/preview
4. https://onlinecourses.nptel.ac.in/noc20_ee10/preview

Scheme of Evaluation:

Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO823.1	3	-	-	-	-	-	-	-	-	-	-	2	-	2	-
CO823.2	3	2	1	-	-	-	-	-	-	-	-	2	-	2	2
CO823.3	3	1	-	-	-	-	-	-	-	-	-	2	-	2	2
CO823.4	3	2	1	-	-	-	-	-	-	-	-	2	-	2	2
CO823.5	3	2	-	-	-	-	-	-	-	-	-	2	-	2	2
22EEE823	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**2**

VIII SEMESTER

Electrical Distribution Systems (Professional Elective 4)			
Subject Code	22EEE824	**CIE Marks**	50
Hours/Week (L:T)	3:0:0	**SEE Marks**	50
Credits	3	**Examination Hours**	03

Course Learning Objectives: At the end of the course the student should be able to:

CLO1	Distinguish between transmission and distribution systems
CLO2	understand design considerations of feeders
CLO3	compute voltage drop and power loss in feeders
CLO4	understand protection of distribution systems
CLO5	examine the power factor improvement

Content	No. of Hrs/ RBT levels
MODULE I – Introduction	
Introduction to distribution system, Distribution system planning, Factors effecting the Distribution system planning, Load modelling and characteristics. Coincidence factor - contribution factor - Loss factor - Relationship between the load factor and loss factor. Load growth, Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.	08 Hours/ L1, L2
MODULE II – Distribution Feeders	
Design Considerations of Distribution Feeders: Radial, loop and network types of primary feeders, Introduction to low voltage distribution systems (LVDS) and High voltage distribution systems (HVDS), voltage levels, Factors effecting the feeder voltage level, feeder loading, Application of general circuit constants (A,B,C,D) to radial feeders, basic design practice of the secondary distribution system, secondary banking, secondary network types, secondary mains.	08 Hours/ L1, L2, L3
MODULE III – Substations	
Location of Substations: Rating of distribution substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations. Optimal location of Substations (Perpendicular bisector rule and X, Y co-ordinate method). System Analysis: Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines, manual methods of solution for radial networks, three phase balanced primary lines, analysis of non-three phase systems, method to analyze the distribution feeder cost.	08 Hours/ L1, L2
MODULE IV – Protection	
Objectives of distribution system protection, types of common faults and procedure for fault calculations, over current Protective Devices: Principle of operation of Fuses, Auto-Circuit Recloser - and Auto-line sectionalizes, and circuit breakers. Coordination: Coordination of Protective Devices: Objectives of protection co-ordination, general coordination procedure, Types of protection coordination: Fuse to Fuse, Auto-Recloser to Fuse, Circuit breaker to Fuse, Circuit breaker to Auto-Recloser.	8 Hours/ L1, L2
MODULE V – Compensation for Power Factor Improvement	
Capacitive compensation for power-factor control - Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), effect of series capacitors, difference between shunt and series capacitors, Calculation of Power factor correction, capacitor allocation - Economic justification of capacitors - Procedure to determine the best capacitor location.	8 hours L1,L2
Total Hours	**40 Hours**

Course Outcomes: The students will be able to:

CO824.1	Distinguish between transmission, and distribution line
CO824.2	Design the feeders
CO824.3	Compute power loss and voltage drop of the feeders
CO824.4	Design protection of distribution systems
CO824.5	Understand the importance of power factor improvement.

TEXTBOOKS:

3. Turan Gonen, Electric Power Distribution System Engineering, CRC Press, 3rd Edition 2014.
4. V. Kamaraju, Electrical Power Distribution Systems, Tata Mc Graw Hill Publishing Company, 2 nd edition, 2010.

REFERENCES:

1. G. Ram Murthy, Electrical Power Distribution hand book, 2nd edition, University press 2004.
2. A.S. Pabla, Electric Power Distribution, Tata McGraw Hill Publishing company, 6th edition, 2013.

WEBLINKS;

1. https://nptel.ac.in/courses/108107167
2. https://ocw.mit.edu/courses/6-061-introduction-to-electric-power-systems-spring- 2011/

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO824.1	3	2	-	-	-	-	-	-	-	-	-	-	-	3	
CO824.2	3	2	-	-	-	-	-	-	-	-	-	-	-	3	
CO824.3	3	2	1	-	-	-	-	-	-	-	-	-	-	3	
CO824.4	3	2	-	-	-	-	-	-	-	-	-	-	-	3	
CO824.5	3	2	1	-	-	-	-	-	-	-	-	-	-	3	
Average	3	2	1	-	-	-	-	-	-	-	-	-	-	3	

SEMESTER – VIII

Course: Soft Computing Techniques (Professional Elective 5)

Course Code	22EEE831	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Introduction to artificial intelligence

Course Objectives:

CLO1	Explain Soft computing concepts like fuzzy logic and genetic Algorithm
CLO2	Understand fuzzy system, fuzzy logic and its applications.
CLO3	Use elementary search techniques to solve real time problems.
CLO4	Explain genetic algorithm, Traditional optimization and its scope of applications.
CLO5	Apply soft computing principle in neuro-fuzzy hybrid system.

Content	No. of Hours/ RBT levels
Module 1: Introduction: Difference between hard and soft computing, Requirement of soft computing, Application area of soft computing. **Fuzzy Systems**: Rough Sets, Crisp sets, Fuzzy Sets, Set Membership, Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Fuzzy Extension Principle.	08 / L1, L2
Module 2: Fuzzy Logic Introduction to fuzzy logic, classical sets, operations on classical sets – union, intersection, complement, difference, properties of classical set, function mapping. Crisp Logic A Review, Fuzzy Logic Basics Fuzzy Truth in Terms of Fuzzy Sets, Fuzzy Rules, Fuzzy Reasoning. **Fuzzy Inference Systems:** Introduction, Fuzzification of the Input Variables, Application of Fuzzy Operators on the Antecedent Parts of the Rules, Evaluation of the Fuzzy Rules, Aggregation of Output Fuzzy Sets Across the Rules, Defuzzification of the Resultant Aggregate Fuzzy Set, Fuzzy Controllers.	08 / L1, L2
Module 3: Elementary Search Techniques **Elementary Search Techniques:** State Spaces, State Space Search—Basic Graph Search Algorithm, Informed and Uninformed Search Exhaustive Search— Breadth-first Search (BFS), Depth-first Search (DFS), Comparison Between BFS and DFS. Heuristic Search.	08 / L1, L2, L3
Module 4: Genetic Algorithm Genetic Algorithm, Biological background, Traditional optimization and search techniques, gradient based local optimization method, random search, stochastic hill climbing. Advantages, Limitation and applications.	08 / L1, L2
Module 5: Hybrid Soft Computing Techniques: Introduction, comparison of fuzzy systems with neural network, characteristics of Neuro-fuzzy hybrid Systems – Cooperative neuro fuzzy system, general neuro-fuzzy system. Adaptive Neuro-Fuzzy system.	08 / L1, L2, L3

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO831.1	Understand the requirements of soft computing and basics of fuzzy systems.
CO831.2	Describe fuzzy logic and it's applications
CO831.3	Apply elementary search techniques to solve real time problems.
CO831.4	Understand genetic algorithm, Traditional optimization and its scope of applications.
CO831.5	Apply soft computing principle in neuro-fuzzy hybrid system.

Textbooks:

1. Samir Roy, Udit Chakraborty, Introduction to soft computing: neuro-fuzzy and genetic algorithms, Pearson, 2013.

Reference books:

5. Dr. S. N. Sivanandam, Dr. S. N. Deepa, Principles of Soft Computing, Wiley, 2nd Edition 2011.
6. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications by S Rajasekaran, G.A Vijayalakshmi. PHI.

E-Books / Web References

5. https://techdifferences.com/difference-between-soft-computing-and-hard-computing.html
6. https://wisdomplexus.com/blogs/applications-soft-computing/
7. https://link.springer.com/content/pdf/10.1007/978-3-642-22577-2_2.pdf

MOOCs

5. https://nptel.ac.in/courses/106105173

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50

Grand Total	100

CO/PO/PSO Mapping															
CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO831.1	3	1	-	-	2	-	-	-	-	-	-	2	-	-	2
CO831.2	3	2	-	-	2	-	-	-	-	-	-	2	-	-	2
CO831.3	3	2	-	-	2	-	-	-	-	-	-	2	-	-	2
CO831.4	3	1	-	-	2	-	-	-	-	-	-	2	-	-	2
CO831.5	3	2	-	-	2	-	-	-	-	-	-	2	-	-	2
22EEE831	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**

SEMESTER –VIII

Course: Image processing (Professional elective 5)

Course Code	20EEE832	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites:

Course Objectives: This course will enable students to

CLO1	Understand the fundamentals of digital image Processing
CLO2	Understand the image transforms used in digital image processing
CLO3	Understand the image enhancement techniques used in Digital image processing.
CLO4	Understand the image restoration techniques and methods used in digital image processing.
CLO5	Understand the morphological operations used in digital image processing

Content	No. of Hours/ RBT levels
Module 1 Introduction, Origins of Digital Image Processing, Examples of fields that use Digital image processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, An introduction to mathematical tools used in digital image processing	**8 Hours** **L1, L2, L3**
Module 2 Image Sampling and Quantization, Some Basic Relationships Between Pixels, Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters.	**8 Hours** **L1, L2, L3.**
Module 3 **Filtering in the Frequency Domain:** Basics of Filtering in the Frequency Domain, image smoothing using frequency domain filters, Image Sharpening Using Frequency Domain Filters, Selective Filtering. Image Segmentation: Fundamentals, point line and edge detection, Thresholding,	**8 Hours** **L1, L2, L3.**
Module 4 **Image Restoration and Reconstruction:** A model of image degradation and restoration process, Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering.	**8 Hours** **L1, L2, L3.**
Module 5 **Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing.	**8 Hours** **L1,L2, L3**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO832.1	Using fundamental principles of Digital image processing illustrate image digitization and basic relationships between pixels.
CO832.2	Apply image processing techniques in both the spatial domains.
CO832.3	Apply image processing techniques in both the frequency domains.
CO832.4	Analyze image restoration techniques in both spatial and frequency domains.
CO832.5	Explain the concept of colour image processing and morphological image processing.

TextBook:

Digital Image Processing- Rafel C Gonzalez and Richard E. Woods, PHI 3rd Edition 2010.

Reference Books:

1. Digital Image Processing- S.Jayaraman, S. Esakkirajan,T. Veerakumar, TataMcGrawHill2014.
2. Fundamentals of Digital Image Processing- A K. Jain, Pearson 2004.

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reducedto 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **onefull question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is addedto test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and threetests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproductionof research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	40	50
	CIE Test-2	40	
	CIE Test-3	40	
	Assignments	10	
SEE	Semester End Examination	50	50
Grand Total			100

CO-PO and PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO832.1	1	-	-	-	-	-	1	-	1	1	-	2	1	1
CO832.2	1	-	-	-	-	-	1	-	1	1	-	2	1	1
CO832.3	3	-	2	-	2	-	1	-	1	-	-	2	1	1
CO832.4	2	-	1	-	2	3	2	-	1	1	-	2	1	1
CO832.5	2	-	2	-	1	3	1	-	1	1	-	2	1	1
22EEE832	2		2		2	3	1		1	1		2	1	1

SEMESTER VIII

Course: Electrical Energy Conservation and Auditing (Professional Elective 5)

Course Code	22EEE833	CIE Marks	50
Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Credits	3	Examination Hours	3

Course Learning Objectives:

CLO 1	To explain fundamentals of energy, the current energy scenario, energy management and energy conservation.
CLO 2	To explain the importance of Energy audit, concept of energy audit, the energy conservation act and its features.
CLO 3	To explain energy audit of fans, power plants.
CLO 4	To explain energy of lighting systems and electric motors.
CLO 5	To explain Energy-Saving Measure in existing as well as new buildings

Content	No. of Hours/ RBT levels
Module 1: Fundamentals of Energy and Energy Scenario: Fundamentals of Energy, Various Types of Energy, Commercial and Non-commercial Energy, Grades of Energy, Energy Demand and Supply in India, Energy Scenario in India, Energy Security in India, Future Energy Strategy. **Energy Management and Energy Conservation Opportunities**: Energy Management, Tariff, Energy Conservation.	**L1, L2, L3 08**
Module 2: Electrical Energy Management: Maximum Demand Basics, Improvement of Power Factor, Capacitor Locations, Pump, Fan Systems. **Energy Audit:** Concept of Energy Audit, Type of Energy Audit, Collecting Data Strategy, Technical and Economic Feasibility, Types of Energy Conservation Measures, Understanding Energy Costs, Benchmarking and Energy Performance, Plant Energy Performance, Fuel and Energy Substitution.	**L1, L2, L3 08**
Module 3: Energy Audit (Continued): The Energy Conservation Act, 2001 and Its Features, Responsibilities and Duties to be Assigned Under the Energy Conservation Act, 2001. **Energy Audit of Fans:** Classification of Fans, Fan Laws and Curves, Power Consumption by a Fan, Energy-Saving Potential in Fans.	**L1, L2, L3 08**
Module 4: Energy Audit of a Power Plant: Indian Power-Plant Scenario, How is Energy Audit of Power Plants Helpful?, Types of Power Plants, Energy Audit of Power Plant. **Energy Audit of Motors**: Classification of Motors, Parameters Related to Motors, Efficiency of Motors, Energy Conservation in Motors,	**L1, L2, L3 08**
Module 5: Energy Audit of Lighting Systems: Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures, Reflectors, Lenses and Louvers, Lighting Control Systems, Lighting System Audit, Energy-Saving Opportunities. **Energy Audit Applied to Buildings**: Energy-Saving Measures in New Buildings, Water Audit, How to Audit Your Home? General Energy-saving Tips Applicable to New as Well as Existing Buildings.	**L1, L2, L3 08**

Course Outcomes

Upon completion of this course, student will be able to:

CO 833. 1	Discuss the fundamentals of energy, the current energy scenario, energy management and energy conservation.
CO 833. 2	Explain the importance of Energy audit, concept of energy audit, the energy conservation act and its features.
CO 833. 3	Conduct energy audit of fans, power plants.
CO 833. 4	Conduct energy audit of motors and lighting systems
CO 833. 5	Explain energy saving measures in existing as well as new buildings.

Textbooks:

1. Energy Management Conservation and Audits, Anil Kumar, Om Prakash, Prashant Singh Chauhan, Samsher First edition 2020, CRC Press.
2. Handbook of Energy Audit, Sonal Desai, 2015, McGraw Hill Education (India) Private Limited

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

E-Books / Web References

3. http://sites.google.com>venusict.org>ntpl-video-link

MOOCs

3. https://nptel.ac.in/courses/112105221
4. https://nptel.ac.in/courses/105102175

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.
CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

CO – PO Mapping With Strengths

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 833. 1	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO 833. 2	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO 833. 3	3	1	-	1	-	-	-	1	-	-	1	-	-	1	-
CO 833. 4	3	1	-	1	-	-	-	1	1	-	1	-	-	1	-
CO 833. 5	3	1	-	1	-	-	-	1	1	-	1	-	-	1	-
Average	3	1	-	1	-	-	-	1	1	-	1	-	-	1	-

SEMESTER – VIII

Course: Energy Storage Systems (Program Elective 5)

Course Code	**22EEE834**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives:

CLO1	Understand the need of Energy storage systems
CLO2	Acquire knowledge pertaining to various ways to store energy
CLO3	Explain the various applications of Energy Storage

Content	No. of Hours/ RBT levels
Module 1: Introduction to Energy Systems Energy Storage Systems Issues & Opportunities, Need for energy storage; Different modes of energy storage; Utilization of energy storage devices, specific areas of applications of energy storage system.	8 hours L2
Module 2: Thermal Energy Storage Necessity, latent heat storage system, Phase Change Materials (PCMs) and classifications, properties of the PCM's for different temperature range, selection criteria of PCMs for heating and cooling in buildings, PCM's use in Solar dryer, water heating system, Latent heat thermal energy storage (LHTES) systems in refrigeration and air-conditioning applications; Energy storage-super-capacitors, Magnetic Energy storage-Superconducting systems	8 hours L2
Module 3: Mechanical Energy Storage Methods Pumped Hydro Energy Storage Systems (PHESSs); KE and Compressed Air Energy Storage Systems (CAESSs); Flywheels, Thermo-chemical energy storage, Fuel cell (FC) as energy storage systems and Applications (PEMF, SOFC, Microbial Fuel Cell, etc), Hydrogen storage methods and types (Metal hydrides, metallic alloy hydrides).	8 hours L2
Module 4: Electrochemical Energy Storage Reaction Mechanism in Electrochemical Cell, determination of voltage and capacities of Electrochemical cells, Lead Acid and Lithium Ion Batteries, Battery System Models, applications	8 hours L2
Module 5: Design and Applications of Energy Storage Renewable energy storage-Battery sizing and stand-alone applications, stationary (Power Grid application), Small scale application-Portable storage systems and medical devices, Mobile storage Applications- Electric vehicles (EVs), types of EVs, batteries and fuel cells, future technologies, hybrid systems for energy storage.	8 hours L2

Course Outcomes: The students will be able to:

CO 834.1	Understand the need of energy storage systems
CO 834.2	Acquire knowledge of Thermal Energy Storage Systems
CO 834.3	Understand various mechanical energy storage systems.
CO 834.4	Understand the fundamentals of Electrochemical Energy Storage.
CO 834.5	Understand the various applications of Energy storage

TEXTBOOKS:

5. Kalaiselvam, S., and R. Parameshwaran. Thermal Energy Storage Technologies for Sustainability: Systems Design, Assessment and Applications. Elsevier.

6. Robert A Huggins, Energy Storage, Springer Publications , 2010

REFERENCES:

1. Energy Storage - Technologies and Applications by Ahmed Faheem Zobaa, InTech
2. Christopher D. Rahn and Chao-Yang Wang, Battery Systems Engineering, Wiley, 2013

WEBLINKS

1. https://energystorage.org
2. https://www.smart-energy.com/storage/the-different-types-of-energy-storage-and-their-opportunities/
3. https://onlinecourses.nptel.ac.in/noc21_mm34

Scheme of Evaluation:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE final marks.

CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/ assignments/term paper/ open ended experiments/ mini-projects/ concept videos/ partial reproduction of research work/ oral presentation of research work/group activity/ developing a generic toolbox for problem solving/ report based on participation in create-a-thon/ make-a-thon/ code-a-thon/ hack-a-thon conducted by reputed organizations/ any other.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test – 1	40	50 (Average of Three CIE(40)+ AAT(10))
	CIE Test – 2	40	
	CIE Test – 3	40	
	Quiz / assignment/group discussion/presentation/mini projects	10	
SEE	Semester End Examination	100	50
Grand Total			100

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 834.1	3	2	2	1	-	-	2	-	-	-	-	2	-	2	2
CO 834.2	3	2	2	1	-	-	2	-	-	-	-	2	-	2	2
CO 834.3	3	2	2	1	-	-	2	-	-	-	-	2	-	2	2
CO 834.4	3	2	2	1	-	-	2	-	-	-	-	2	-	2	2
CO 834.5	3	-	2	1	-	-	2	-	-	-	-	2	-	2	2
Average	3	2	2	1	-	-	2	-	-	-	-	2	-	2	2

SEMESTER –VIII

COURSE: PROJECT WORK PHASE-II

Course Code	22EEEP84	CIE Marks	100
Hours/Week (L: T: P)	0:0:2	SEE Marks	100
No. of Credits	8	Examination Hours	03

Content
CIE procedure for Project Work Phase - II: **a. Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates using Rubrics. **b. Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates as per Rubrics covering all Program Outcomes. **SEE for Project Work Phase - II:** **a. Single discipline**: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department. **b. Interdisciplinary:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong.

Table 1: Distribution of weightage for CIE of Regular courses

	Component	Marks	Total Marks
CIE	Review-1	**100**	**100**
	Review-2		
SEE	Semester End Examination	**100**	**100**
Grand Total			**200**

SEMESTER –VIII

COURSE: TECHNICAL SEMINAR

Course Code	22EEES85	CIE Marks	100
Hours/Week (L: T: P)	1 hour/week	SEE Marks	--
No. of Credits	1	Examination Hours	-

Technical Seminar:

All the students admitted to IV year of BE/B. Tech shall have to do power point presentation on any topic related to Aeronautical Engineering during VIII Semester and make a report of the presented topic referring to journals in that area. The prescribed credit shall be included in VIII Semester and shall be considered for the award of bachelor's degree. Those who do not present the Technical Seminar shall be declared fail and shall have to complete during subsequent University examination after satisfying the Technical Seminar requirements.

CIE procedure for Seminar:

The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the Seminar shall be based on the evaluation of Seminar report, presentation skill and question and answer session in the ratio 50:25:25.

Typical Evaluation pattern for regular courses is shown in Table 1:

Table 1: Distribution of weightage for CIE of Regular courses

	Component	Marks	Total Marks
CIE	Review-1	**100**	**100**
	Review-2		
SEE	Semester End Examination	--	--
Grand Total			**100**

SEMESTER –VIII

COURSE: INTERNSHIP

Course Code	22INT86	CIE Marks	100
Hours/Week (L: T: P)	--	SEE Marks	-
No. of Credits	2	Examination Hours	-

Internship:

All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters.

Internship examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

CIE procedure for Internship:

The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Internship shall be based on the evaluation of Internship report, presentation skill and question and answer session in the ratio 50:25:25.

SEE for Internship:

Contribution to the Internship and the performance of each Student shall be assessed individually in the semester end examination (SEE) conducted at the department.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Review-1	50	50
	Review-2		
SEE	Semester End	50	50
Grand Total			100

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