ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)
EE 32009: CONTROL SYSTEM

<table>
<tr><th colspan="3">HOURS PER WEEK</th><th colspan="2">CREDITS</th><th colspan="5">MAXIMUM MARKS</th></tr>
<tr><th rowspan="2">L</th><th rowspan="2">P</th><th rowspan="2">TU</th><th rowspan="2">T</th><th rowspan="2">P</th><th colspan="2">THEORY</th><th colspan="2">PRACTICAL</th><th>TOTAL MARKS</th></tr>
<tr><th>CW</th><th>END SEM</th><th>SW</th><th>END SEM</th><td rowspan="2">200</td></tr>
<tr><td>3</td><td>2</td><td>-</td><td>3</td><td>1</td><td>30</td><td>70</td><td>40</td><td>60</td></tr>
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COURSE OBJECTIVE:

1. Mathematical tools to develop control systems model, time and frequency responses of dynamical systems, performance specifications.
2. Techniques for determining stability of systems.
3. Basic design aspects of various controllers and compensators.
4. Dynamical system analysis using state space model.

COURSE OUTCOME:

After completing the subject student will be able to:

EE32009(T).1: Develop mathematics models (TF and state space) of various physical systems.
EE32009(T).2: Define time domain and frequency domain specifications of a control system.
EE32009(T).3: Determine stability of a control system using time domain techniques and design appropriate controller for a given problem.
EE32009(T).4: Propose alternate solution via compensator design to get desired frequency domain specifications.
EE32009(T).5: Explain concepts of controllability and observability as well design of state feedback controller.

COURSE CONTENTS:

THEORY

S.NO.	CONTENT
1	<u>**UNIT1:**</u> Modelling of Dynamic Systems and Simulation – Integro differential equations of linear systems such as mechanical, hydraulic pneumatic and electrical systems. Block diagram and Signal flow graph method of representing the dynamic equations, Analogue simulation, linearity, impulse response and concept of transfer function, Mason's gain formula, control systems components - Error detectors, a-c and d-c Servomotors, servo-amplifiers (a-c & d-c) using operational amplifiers, Gyro, Resolver. Typical study of characteristics of these components. Concept of feedback as control theory - mathematical theory of feedback, return ratio, return difference, open and closed loop, understanding the necessity of feedback as real control action supplemented by a small example.

2	**UNIT2:** Time-Domain Analysis of Feedback Control Systems - Typical reference test signals and their significance, transient behaviour of closed loop systems under feedback control. Proportional plus derivative and rate feedback control actions for improving the transient response. Steady state behaviour of closed loop feedback control systems. Types of open loop transfer functions. Steady state errors. Proportional plus integral control action for the improvement of steady state errors.
3	**UNIT3:** Frequency-Domain Analysis of Feedback Control Systems - Concept of frequency-domain analysis, Bode plots, Polar plots. Bode of closed loop transfer function Mp and Bode plots of error transfer functions, Principle of Argument, Nyquist criteria. Conditionally stable closed loop systems, Transportation lag, Constant M and constant N loci, Loci of closed loop poles (root loci).
4	**UNIT4:** Compensation Techniques - Need for frequency-domain compensation, Different types of compensation, Phase-lead and Phase-lag compensation, Design of compensating networks for the desired frequency-domain closed loop performance.
5	**UNIT5:** State Space Method of Analysis - Fundamentals of state space: concept of state and state variable. Representation of linear system through state dynamics, Calculation of Eigen-values and Eigen-vectors, Modal matrix, Modal transformation, Elementary understanding controllability and observability, state feedback control. Stability analysis of feedback control systems - concept of stability, BIBO stability, asymptotic stability, Routh-Hurwitz stability analysis. Nyquist stability analysis and relative stability, gain margin and phase margin.

ASSESSMENT:

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

(b) The end-term theory examination weightage is 70%.

TEXT BOOKS:

1. B. C. Kuo, “Automatic Control Systems”, ninth edition, Wiley India, 2009.

2. K. Ogata, “Modern Control Engineering”, fifth edition, Prentice-Hall, 2010.

REFERENCE BOOKS:

1. J. L. Melsa & D. G. Schultz, “Linear Control Systems”, McGraw Hill, New York, 1969.
2. I. J. Nagrath & M. Gopal, “Control Systems Engineering”, fifth edition, New Age International (P) Ltd, New Delhi, 2009.
3. Joseph J. DiStefano, Allen R. Stubberud, Ivan J. Williams. “Schaum's outline of theory and problems of feedback and control systems”, McGraw-Hill, 2011.

CO-PO MAPPING:

CO'S	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	3	2	2	1	-	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-
CO3	3	3	2	2	1	-	-	-	-	-	-	-
CO4	3	-	2	2	1	-	-	-	-	-	-	-
CO5	3	3	-	-	1	-	-	-	-	-	-	-
Average	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

LABORATORY
Objective:

1. Students will be able to use the laboratory techniques, tools and practices of control engineering.
2. To families with the modeling of dynamical system and the characteristics of control components like servo motor, synchros.
3. To understand time and frequency responses of control system with and without controllers and compensators.
4. To simulate and analyse the stability using MATLAB software and design the compensators.

LABORATORY OUTCOMES:

1: Develop professional quality systems, textual and graphical tools to obtain the results in obtaining the expected data analysis.
2: Evaluate the error and compare different error detectors, according to their performance requirement in control systems.
3: Determine the performance characteristics and speed control of various servo motors.
4: To create the optimal results by using different types of controller for systems of first and second order system.
5: Make use of standard inputs for steady state error analysis via IT tools.

List of Experiments:

Experiment No.	Objective
1	To determine the performance characteristics of an angular position error detector using potentiometers.
2	To determine the characteristics of a Synchro Transmitter Receiver pair and its use as an angular error detector.
3	To find the transfer function of an A.C. Servomotor with estimations of time constant.
4	To find the transfer function of a D.C. Servomotor with field and armature control.
5	To estimate the angular position of an AC servo motor as a carrier control system.
6	Determination of the time response characteristics of a DC Servo angular position control system.

7	To perform closed loop Speed control of a D.C Servomotor.
8	To determine the performance characteristics of a DC motor for speed control with PWM type power driver.
9	To determine the performance characteristics of a DC motor for speed control with SCR type power driver.
10	Analysis of Proportional + Integrator + Derivative (PID) control actions for various order systems on learning/training modules along with programming on MATLAB.
11	Mini Projects: Basic understanding of IT tools such as machine learning, Python, google colab.

Course Assessment: Students will be assessed on

(a) Continuous evaluation of LABORATORY journals with a weightage of 40% of the total marks. It includes lab attendance as well as experiments performed in the lab.

(b) The end-term practical examination weightage is 60%.

CO-PO MAPPING:

CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	-	-	-	1	-	1	1
CO2	3	-	2	-	-	-	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-
CO4	3	3	-	2	1	-	-	-	-	1	-	-
CO5	3	3	-	-	1	-	-	-	1	1	1	1
Average	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**

B.E. THIRD YEAR (4 YDC) ELECTRICAL ENGINEERING
SEMESTER 'A'

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE 32005	Microprocessors & Operating System	4	-	2	3	1	70	30	40	60	200

Course Objectives:

Microprocessor is the fundamental course for graduate students in the engineering program. The purpose of this course is to get acquainted with the fundamentals of microprocessor systems. This course discuss about the basics of micro-operations, architecture and internal organization of Intel 8-bit microprocessor 8085. The Main memory system design and Input-Output interfacing forms an essential part for practical implementation of the concepts in embedded system design. For programming concepts, software model, assembly and machine language programming are explored. Students will be able to demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor. Furthermore, different peripheral devices and their interfacing is discussed for real time applications. The structure, function and architecture of computers are introduced. Besides this, it also serves knowledge on characteristics of modern computer systems.

UNIT: 1

ALU & Microprocessor: Register transfer, Bus and Memory Transfer, Arithmetic micro-operations, Four-bit arithmetic circuit, logic micro-operations, Shift micro-operation. Single stage of ALU. Evolution and development of microprocessor, internal organization of 8-bit microprocessor 8085, System clock, bus cycle, timing diagram

UNIT: 2

Main memory and I/O system design: Types of main memory, RAM/ROM interface and addressing decoding technique. Memory Mapped I/O and Peripherals I/O, Serial I/O.

UNIT: 3

8085 programming concept: Software model, addressing modes, instruction set, assembly and machine language programming, Counters, Time delays. Stack and Subroutines. Interrupts.

UNIT: 4

I/O Devices: Programmable Peripheral Interface(8255), Programmer timer(8254) DMA controller(8237), Keyboard and Display controller(8279) and ADC/DAC: (architecture, interfacing to 8-bit microprocessor, programming, block diagram, operating modes, initialization).

UNIT: 5

Operating System: Types of operating system, services, utilities, system calls. Disk allocation methods, disk schedulers, Case study of UNIX and DOS. Process Concept, Scheduling concept, Types of Schedulers, Process State Diagram, Scheduling Algorithms. Paging Segmentation, Paged Segmentation and Demand Paging

Course Outcomes: After completing this course students will able to:
EE32005(T).1: Explore the internal organization and architecture of 8-bit microprocessor and peripheral devices.
EE32005(T).2: Impart the knowledge about the data handling and interfacing techniques for memory and I/Os.
EE32005(T).3: Develop simple programs for 8-bit microprocessor based system.
EE32005(T).4: Interface the programmable peripheral devices (PPD) to incorporate extended features of PPD in the microprocessor based systems.
EE32005(T).5: Explain the basic operations and internal structure of Operating Systems.

Course Assessment: Students will be assessed on
(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

Text Books:
1. Mohamed Rafiquzzaman, "Microprocessor and Microcomputer Based System Design", second edition, CRC Press, 1995.
2. Ramesh S.Gaonkar, "Microprocessor, Architecture Programming and application", fifth edition Prentice Hall, 2002.
3. Douglas V. Hall, "Microprocessor and interfacing, Programming and Hardware", second edition, Glencoe, 1992.

Reference Books:
1. A. Nagoor Kani, "8085 Microprocessor and Its Application", third edition McGraw-Hill Education Pvt. Ltd 2012.
2. S. Mathur, "Microprocessor 8085 and Its Interfacing", Prentice-Hall of India learning Pvt. Ltd, 2013.
3. M. Morris, "Computer System Architecture", third edition, Pearson Education, 2008.

LABORATORY OUTCOMES:

The students will be able to:

1. Design an interface to connect to Memory.
2. Develop capability for designing and documenting simple programs to implement algorithms of engineering problems.
3. Illustrate the various applications of microprocessors.
4. Give professional presentation to discuss the progress of the project.

S. No.	Name of Experiment	CO	PO	BTL
1	Design of Memory Interfacing	CO1	1,2,3,4,5,10,1	
	2.1 Write a Program Using 8085 & Verify for Addition of Two 8-Bit Numbers. 2.2 Write a Program Using 8085 & Verify for Addition of Two 16-Bit Numbers. (With Carry) 2.3 Write a Program Using 8085 & Verify for Subtraction of Two 8-Bit Numbers. (Display Of Borrow) 2.4 Write a Program Using 8085 & Verify for Subtraction of Two 16-Bit Numbers. (Display Of Borrow) 2.5 Write a Program Using 8085 & Test for Typical Data Multiplication of Two 8-Bit Numbers By Bit Rotation Method 2.6 Write a Program Using 8085 & Test for Typical Data Division of Two 8-Bit Numbers by Repeated Subtraction Method 2.7 Write a Program Using 8085 for Finding Square-Root of a Number & Verify. 2.8 Write a Program to Move a Block of Data Using 8085 & Verify. 2.9 Write a Program to Arrange Number in Ascending Order Using 8085 & Verify. 2.10 Write a Program to Check Number of 1's and 0's in Given Number Using 8085 & Verify. 2.11 Write a Program to Find GCD Of Two Numbers Using 8085 & Verify. 2.12 Write a Program to Find LCM Of Two Numbers Using 8085 & Verify. 2.13 Write a Program to Add 'N' Two Digit BCD Numbers Using 8085 & Verify.	CO2	1,2,3,4,5,10,12	4
3	Poster Presentation	CO3	1,2,3,4,6,7 ,9,10,12	4
4	Lab Project Assignment	CO4	1,2,3,4,5,6,7, 8,9,10,11,12	5

ASSESSMENT:

A. Continuous evaluation of laboratory journals with a weight-age of 40%. It includes lab attendance as well as experiments performed in the lab.

B. The end-term practical examination weight-age is 60%.

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)
EE 32007: POWER ELECTRONICS-I

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	2	-	3	1	-	30	70	40	60	200

PRE- REQUISITE: Basic knowledge of Electronics and semiconductor devices.

COURSE OBJECTIVE:

1. To provide students a deep insight in to the operational behavior of practical power switching devices with respect to their static and dynamic characteristics
2. To learn the working principle of classified topologies of Thyristor based AC/DC and AC/AC converters.
3. To design and analyze the operation of above converters considering their applications.
4. To understand design of firing circuits for Thyristor based line commutated converters.

COURSE OUTCOME:
Students will be able to:

EE32007(T).1: Recognize and apply fundamental concepts of static switches in design of switching converters.
EE32007(T).2: Classify topologies of single phase and three phase line commutated power converter circuits, analyse their performances and apply in selection of appropriate converter for field problem.
EE32007(T).3: Apply the knowledge of synchronization, isolation and firing pulse generation in developing firing schemes for line commutated converters.
EE32007(T).4: Demonstrate the knowledge of Dual Converters technology in applying speed control schemes of DC machines.
EE32007(T).5: Identify the topologies of cyclo-converters and AC voltage controllers, compare their performances for real time applications.

COURSE CONTENTS:

THEORY

S.NO.	CONTENT
1	**UNIT: 1** Structure and operation of semiconductor power devices, their static and dynamic characteristics, series and parallel operation of devices, heat removal, ratings, snubber circuits, device data sheet interpretation.
2	**UNIT: 2** Power converters: Classification of single phase and three phase converters, types of load on converters, steady state analysis of controlled converters and evaluation of performance parameters, transfer characteristics, effect of load inductance, back emf, freewheel diode, overlap and its effects, harmonic analysis.

3	**UNIT: 3** Control circuits, firing circuit requirements for line commutated converters, synchronization, isolation, pulse transformer, opto-coupler, UJT, PUT, BJT, TCA-785 based firing circuit.
4	**UNIT: 4** Dual converters: Operation in circulating and non-circulating mode, line loading, sub harmonic, control problems, four quadrant operation, and power circuit.
5	**UNIT: 5** Cycloconverter-Operation, control problems, various power circuits, AC power controller-fully controlled and semi-controlled circuits, harmonic analysis, integral cycle control.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. M H Rashid, "Power Electronics Circuits, Devices, and Applications", third edition Pearson/Prentice Hall, 2009.
2. Ned Mohan, "Power Electronics: Converters, Applications, and Design", third edition, John Wiley & Sons Inc, 2007.
3. Joseph Vithayathil, "Power Electronics Principles and applications", Tata McGraw-Hill, 1995.

REFERENCES BOOKS:

1. C. M. Pauddar, "Semiconductor Power Electronics (Devices and Circuits)", first edition, Jain Brothers New Delhi, 1999.
2. M. H. Rashid, "Handbook of Power Electronics", Pearson Education India, 2008.
3. M. D. Singh, K. B. Khanchandani, "Power Electronics", Tata McGraw-Hill, 2008.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	1	-	-	-	-	-	-	-
CO2	-	3	3	1	1	-	-	-	-	-	-	-
CO3	3	3	-	-	1	-	-	-	-	-	-	-
CO4	3	3	3	1	1	-	-	-	-	-	-	-
CO5	3	3	3	-	1	-	-	-	-	-	-	-
Average	3	3	3	1	1	-	-	-	-	-	-	-

LABORATORY:

OBJECTIVES: Following are the objective of the course:

1. Show awareness about operating behaviour of various static switches used in converters.
2. Understand the basic requirements in design of power converters.
3. Analyse performance parameters of various power converters.

LABORATORY OUTCOMES:

Students will be able to
EE32007(P).1: Recognize the functions of CRO, identify and select proper instruments to observe and record performance on different experimental set ups of power electronics LABORATORY .
EE32007(P).2: Establish wiring and device connections to assemble experiments of static switches, line commutated converters and record their performances.
EE32007(P).3: Analyze and compare the performance of various firing pulse generation circuits for triggering of SCR.
EE32007(P).4: Apply professional quality textual and graphical tools to sketch and computing results, incorporating accepted data analysis and synthesis methods, mathematical software, and word-processing tools.
EE32007(P).5: Group activities in terms of mini projects to demonstrate the creativity and ability to interact effectively on a social and interpersonal level, divide up and share task responsibilities to complete assignments.

S. No.	Objective
1.	Measurement of voltage, current and phase angle using CRO.
2.	To understand the switching characteristics of controlled power semiconductor devices such as SCR, GTO, TRIAC, BJT, MOSFET and IGBT as a power electronic switch.
3.	Evaluate the performance of single-phase AC voltage controller using TRIAC-DIAC combination. Record the waveforms of input supply voltage, output voltage, TRIAC voltage, DIAC voltage and capacitor voltage under different firing angles.
4.	Design a R and RC circuits to be used as a firing circuit for single-phase phase controlled rectifiers.
5.	Design a relaxation oscillator circuit using Uni-junction Transistor (UJT) to be used as a firing circuit for single-phase phase controlled rectifiers.
6.	Observe the performance of a TCA-785 based triggering circuit used for single phase controlled converter.
7.	Evaluate the performance of single-phase Uncontrolled rectifiers with R and RL loads. Trace the waveforms of input AC voltage, input current, output voltage, output current, switch voltage and current with different rectifier configurations and determine form factor, ripple factor, and displacement power factor. Also plot a graph V_0 v/s firing angle.
8.	Evaluate the performance of single-phase controlled rectifiers with R and RL loads. Trace the waveforms of input AC voltage, input current, output voltage, output current, switch voltage and current with different rectifier configurations and determine form factor, ripple factor, and displacement power factor. Also plot a graph V_0 v/s firing angle.

9.	Design and evaluate the performance of switching aid circuits (Turn-Off and Turn-On). Obtain the trace of device voltage and currents during turn-on time and turn-off time with and without switching aid circuits. Comment on rating of passive elements used in switching-aid circuits.
10.	Measurement of latching and holding current of SCR.
11.	Minor Project

ASSESMENT:

A. Continuous evaluation of LABORATORY journals with a weightage of 30%. It includes lab attendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 70%.

CO-PO MAPPING:

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

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)
EE32008: ELECTRICAL MACHINES-II

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	2	-	3	1	-	30	70	40	60	200

PRE- REQUISITE: Fundamentals of electrical engineering and Electrical Machines-I.

COURSE OBJECTIVE:

1. To provide basic understanding of salient pole synchronous machines. Study of short circuit ratio, sequence reactance and slip test.
2. To provide the basic knowledge about working of two alternators in parallel and load sharing.
3. Study of three phase induction machine with unbalanced and non –sinusoidal supply
4. To provide deep insight of special motors, fractional kilowatt motors.
5. Basic understanding of an induction motor working as an induction generator and induction regulator.

COURSE OUTCOME:

After completing this course, the student will be able to:

EE32008 (T).1: Differentiate salient pole and cylindrical rotor synchronous machine on the basis of their circuit model, phasor diagram and power angle characteristics, and control the active reactive power of parallel connected units.

EE32008 (T).2: Distinguish between sub transient, transient and steady state and discriminate between various reactances and time constants offered by a synchronous machine under different states.

EE32008 (T).3: Analyze performance of three phase induction motor supplied with non-sinusoidal and unbalanced supply, estimate derating of induction motor and discuss functioning of slip power recovery schemes.

EE32008 (T).4: Select suitable special motor for a given application based on their characteristics and possible control techniques

EE32008 (T).5: Evaluate the performance of an induction machine operating as a generator and regulator.

COURSE CONTENTS:

THEORY

S.NO.	CONTENT
1	**<u>UNIT: 1</u>** Salient pole machine- Two reaction theory, analysis of phasor diagram, power angle characteristics, parallel operation of alternators, Synchronization of alternators, Effect of changing mechanical torque and excitation. Load sharing between two alternators, Capability curve
2	**<u>UNIT: 2</u>** Hunting, damper windings, various sequence reactance of a synchronous machine. Direct and quadrature axis transient and sub transient reactance. Negative sequence reactance and zero sequence reactance and their utility, Slip test
3	**<u>UNIT: 3</u>** Operation of induction motor on unbalanced supplies and Non- Sinusoidal supplies, Production of time and space harmonics and their effect, harmonic torques, motor de-rating, Slip-power recovery
4	**<u>UNIT: 4</u>** Single phase induction motor operation, methods of starting, Double revolving field theory, Equivalent circuit, Principle and working of stepper motors, various construction techniques, control of stepper motors, static and dynamic characteristics, Constructional features, analysis and operation of AC series motor, application of AC series motor, Universal Motor
5	**<u>UNIT: 5</u>** Constructional features, operating principle, characteristics and applications of: Induction generator, doubly fed Induction Generator, Self-excited induction generator, Induction regulator

ASSESSMENT:

A. Continuous evaluation through two mid-term tests with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. Nagrath & Kothari, “Electric Machines”, fourth edition, Tata McGraw-Hill Education, 2010.
2. P S Bimbhra, “Generalized Theory of Electrical Machines”, fifth edition, Khanna Publication, 1995.
3. Vincent Del Toro, “Electromechanical devices for energy conversion and control systems”, Prentice-Hall, 1968.
4. P. C. Sen, “Principles of Electrical Machines and Power Electronics”, second edition, John Willey & Sons, 2008

REFERENCES BOOKS:

1. A.E. Fitzgerald, Charles Kingsley,"Electric Machinery", Tata McGraw-Hill, 2009.
2. Wildi Theodore, "Electrical Machines, Drives and Power Systems", sixth edition Pearson Prentice-Hall, 2007.
3. Harry Cotton, "Alternating Current Machines", second edition MacMillan, 1960.

CO-PO MAPPING:

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

LABORATORY :

OBJECTIVES: The Electrical Machines-II laboratory is designed:-

1. To provide the student with the knowledge of various electrical machines, measuring instruments, equipment such as dc motors, three phase and single phase induction motors, generators and transformers etc with proficiency.
2. In this lab, students are expected to get hands-on experience of operating large electrical machines and in interpreting the results of measurement operations.
3. To develop communication skills through LABORATORY notebook with written descriptions of procedure, result and analysis.
4. To compare theoretical prediction with experimental results and to determine the source of any apparent differences.

LABORATORY OUTCOMES:

1. Compare the ZPF and MMF method for the determination of voltage regulation of synchronous alternators.
2. Determine the equivalent circuit parameters by conducting blocked rotor test and light run test on three phase induction motor also Judge the performance of three phase induction motor feeded with unbalanced supply.
3. Demonstrate the operation of an induction machine as a grid connected and isolated induction generator.
4. Illustrate the techniques of synchronization of alternators and develop the v curves of synchronous machines.
5. Estimate the performance of a single phase induction motor by conducting a light run test and blocked rotor test.
6. Summarize the process of determination of quadrature and direct axis reactances of a synchronous machine.

S. No.	LIST OF EXPERIMENTS
1	To determine the equivalent circuit parameters for three phase induction motors.
2	To calculate the voltage regulation of an alternator by synchronous impedance method
3	To calculate the voltage regulation of an alternator by ZPFC and MMF methods.
4	To synchronize two alternators
5	To find the direct axis and quadrature axis reactance of alternator.
6	To determine "V and "inverted V" curves of an auto synchronous motor.
7	To determine the performance of a three phase induction motor on an unbalanced supply.
8	To determine the equivalent circuit parameter of a single phase induction motor using the double revolving theory.
9	To determine the performance characteristics of a three phase induction generator as a grid connected induction generator.
10	To determine the performance characteristics of a three phase induction generator as an isolated (self-excited) induction generator

ASSESSMENT:

A. Continuous evaluation of Laboratory Journals with a weightage of 30%. It includes lab attendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 70%.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	2	-	2	1	-	-	-	3	3	-	3
CO2	1	2	-	2	-	1	-	-	2	2	-	2
CO3	-	2	2	2	2	2	2	-	2	2	-	2
CO4	-	1	-	1	-	1	-	-	1	1	-	1
CO5	1	1	-	1	-	-	-	-	1	1	-	1
CO6	-	1	-	-	1	1	-	-	1	1	-	1
Average	1	2	2	2	1	2	1	-	2	2	-	2

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)
EE32452: POWER APPARATUS DESGIN

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
-	4	-	-	2	-	-	-	40	60	100

PRE- REQUISITE: Basic knowledge of Electrical Machines**.**

COURSE OBJECTIVES:
1. To acquaint students with the basic design requirements of an electrical machine.
2. To introduce concept of output equation and its parameters.
3. To teach the students magnetic circuit and cooling concepts for electrical machines.
4. To elucidate the design procedure for conventional machines and permanent magnet machines.
5. To explain optimization in machine design and techniques.

COURSE OUTCOMES:

After completing this course, the student will be able to

EE32452(P).1: Familiarize with detailed design aspects of transformer, induction motor, inductor design, electric vehicles.
EE32452(P).2: Will have knowledge of selection criteria of insulating, conducting and magnetic materials.
EE32452(P).3: Will be capable of developing electric, magnetic and thermal equivalent circuits of machines.
EE32452(P).4: Understand the basic operating points of Electric Machines.
EE32452(P).5: Get acquainted with the optimization concept in the Machine design.

COURSE CONTENTS:

THEORY:

UNIT: 1 **Introduction:** Design factors, limitations, output equation, concept of magnetic and electric loading in the electrical machine design. Magnetic circuit design- basics, topologies of flux direction, Carter's coefficient, calculation of mmf. Thermal equivalent circuit- heat losses, heat removal techniques, types of coolants.
UNIT: 2 **Materials**: High conductivity materials, types of magnetic material, insulating materials, causes of insulation failures.
UNIT: 3 **Inductor design:** Introduction to high frequency and medium frequency inductor design, calculations to obtain dimensional parameters of inductor.

<u>UNIT: 4</u> **Induction Machine design:** Construction types, output equation, choice of loading, design of three phase induction motor in details: design of stator, rotor, air-gap length, flux density in stator tooth, calculation of losses, efficiency and temperature rise, performance evaluation.
<u>UNIT: 5</u> **Optimal Design of Electric Vehicle Motor:** Introduction to permanent magnets, their design, characteristics, magnetization, operating point, PM rotor types- surface mounted, interior, features of PMSM, PMBLDC motors, introduction to design of PMBLDC motor in electric vehicle. Optimal problem formulation- design variables, constraints, objective functions. Introduction to optimization techniques- Particle Swarm Optimization (PSO).

ASSESMENT:

A. Continuous evaluation of laboratory journals with a weightage of 40%. It includes lab attendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 60%.

TEXT BOOKS RECOMMENDED:

1. A. K. Sawhney, A. Chakrabarti, "Course in Electrical Machine Design", Sixth Edition, Dhanpat Rai, 2010.
2. M. G. Say, " Performance & Design of AC machine", 2002.

REFERENCES BOOKS:

1. V.S. Nagarajan, V. Rajni, "Design of Electrical Machine" , Pearson Publishers Distribuors, 2018.
2. K.T. Chau, "Electric Vehicle Machines And Drives", Johnwiley & Sons Singapore Pte. Ltd., 2015
3. Seref Soylu, "Electric Vehicles- Modelling And Simulations", In Tech., 2011
4. V. N. Mittle, " Design of Electrical Machines" , Standard Publishers Distributors, 2005.
5. R. K. Agrawal, "Design Of Electrical Machine", Kataria & Sons.

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)
ELECTIVE-I
EE32281: UTILIZATION OF ELECTRICAL ENERGY

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Fundamentals of Electrical Engineering and Machine.

COURSE OBJECTIVE:

1. To impart knowledge about AC and DC electric drives, their characteristics, control and operational strategies with different types of loads, evaluation of heating and cooling curves.
2. Be acquainted with the main concept and laws of illumination and its design approach.
3. To comprehend the different issues and advantages related to electric heating & welding and its practical applications.
4. To comprehend knowledge of modern electric traction, technical specifications, mechanics of train movement, problem solving for different scenarios.
5. To estimate and evaluate power, energy and tractive-effort drawn by the electric train.
6. To explain characteristics and features of AC, DC traction motors, to elucidate speed control methods, electric braking and problem solving.

COURSE OUTCOME:

After completing this course, the student will be able to

EE32281(T).1: Interpret the concepts of utilization of electrical energy and will be able to chose a proper drive and select the motor power rating for the specific application.
EE32281(T).2: Have the ability to design heating and welding elements.
EE32281(T).3: Perform analysis and designing of illumination systems for various applications.
EE32281(T).4: Develop understanding of electric traction, geometric analysis of train movement and estimation of energy consumption, power drawn.
EE32281(T).5: Identification of types of traction motors for various practical application and their speed control.

COURSE CONTENTS:

THEORY

S.NO.	CONTENT
1	UNIT: 1 Industrial electric motors: individual and group drive, revised study of speed torque characteristics of DC and AC motor, size and rating of motors, continuous & intermittent rating, temperature rise calculation, speed time relations, load equalization motor enclosures, plugging and rheostatic braking.
2	UNIT: 2 Electric heating & welding: electric heating, resistance heating, induction heating, high frequency eddy current heating, the arc furnace, electric welding, resistance welding, electric arc welding, electric welding equipment, comparison between resistance and arc welding, comparison between AC and DC welding.
3	UNIT: 3 Illumination: introduction, different terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, schedules of light, comparison between tungsten filament lamps and fluorescent tubes of lighting schemes, factory lighting methods of lighting, method of lighting calculations, street lighting, flood lighting.
4	UNIT: 4 Traction systems of Electrical Traction, methods of supplying power to electric trains technical aspects of railway electrification, operating voltage, mechanics of train movement, speed time and distance time curves, tractive effort, train resistance and adhesion weight, power and energy output from the driving axles specific energy consumption, transmission of power from motor to wheel gearing overhead equipment, negative booster.
5	UNIT: 5 DC & AC traction motors, choice of voltage frequency and phase characteristics control of traction motors, field control, and series parallel control, electric braking, regenerative braking of DC and AC machines and problems.

ASSESSMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

REFERENCES BOOKS:

1. H. Pratap: An science of Utilization of Electrical Energy
2. N.N. Hanock, Electric Power utilization Wheeler publishing.
3. E. Openshaw Taylor, Utilization of Electric energy, Orient Longman.
4. C.L. Wadhwa, Generation Distribution and Utilization of Electrical Energy New Age
5. Balbir Singh, Electric Utilization

CO-PO MAPPING:

CO’s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	-	1	-	1	3	-	-	-	-	1	1
CO2	3	1	-	-	1	3	-	-	-	-	1	1
CO3	3	1	-	-	1	3	-	-	-	-	1	1
CO4	3	1	-	-	1	3	1	-	-	-	1	-
CO5	3	-	-	-	1	3	1	-	-	-	1	1
Average	3	1	1	-	1	3	1	-	-	-	1	1

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)
ELECTIVE-I
EE32XXX: RELIABILITY ENGINEERING

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Basic knowledge of Network Theory, Control system and Mathematics

COURSE OBJECTIVE:
1. Encourage understanding and appreciation of learning probability and reliability theory.
2. Evolve the efficacy to develop reliability models of electrical systems.
3. Learn Modern simulation tools aiding in reliability analysis.
4. Explain the possible causes of poor reliability and suggest appropriate reliability tests and the associated failure analysis methods.
5. Apply reliability theory to assessment of reliability in engineering design.

COURSE OUTCOME:

After completing this course, the student will be able to

EE32XXX(T).1: Demonstrate an understanding of the concepts of reliability engineering and various failure distributions.

EE32XXX(T).2: Identify importance of statistical distributions for modelling failure data and the physical meanings of different parameters.

EE32XXX(T).3: Evolve the efficacy to develop reliability models of complicated systems and be able to analyze and interpret the data to infer reliability indices from the data.

EE32XXX(T).4: Estimate model mean time to failure and demonstrate an understanding of steady state and time-dependent probabilities.

EE32XXX(T).5: Estimate reliability and parameters for failure laws from the test data.

COURSE CONTENTS:
THEORY

S.NO.	Course Contents
1	**UNIT: 1** Introduction to reliability and indices. Review of probability theory. Density and distribution function of continuous and discrete random variable.
2	**UNIT: 2** Component reliability, hazard function, failure laws, exponential failure law, wear in period and its importance. Safety and reliability, replacement, methods of reliability improvement.
3	**UNIT: 3** Reliability evaluation of series, parallel, and series–parallel network. Complex network reliability evaluation using event, space, decomposition, tie-set, cut-set and Monte carlo simulation technique, convergence in Monte carlo simulation. Stand by system and load sharing system, multi state models.
4	**UNIT: 4** Markov process, State diagram, Availability and unavailability function. Evaluation of time dependent and limiting state probabilities. MTTF calculation. Concept of frequency and durations. State enumeration method for evaluating failure frequency, MUT, MDT, frequency balance approach.
5	**UNIT: 5** Reliability testing, estimation of reliability function, failure function and MTTF from grouped and ungrouped datas, censoring and accelerations, parametric methods.

ASSESMENT:
A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. R. Billinton, R. N. Allan, “Reliability evaluation of engineering system: concept and techniques”, second edition Springer US 1992.
2. C. E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill2004.
3. E. E. Lewis, “Introduction to Reliability Engineering”, second edition Wiley 1995.

REFERENCES BOOKS:

1. David J. Smith, “Reliability, Maintainability and risk”, fourth edition Elsevier 2013.
2. Joel A. Nachlas, “Reliability Engineering: Probability Model and maintenance methods”, Taylor and Francis 2005.

CO-PO MAPPING:

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

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)
ELECTIVE-I
EE 32282: BASIC ELECTRICAL DRIVE SYSTEM

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Basic knowledge of Electronics and semiconductor devices.

COURSE OBJECTIVE:

1. To expose students to the operation, application and control of power conversion systems employing electric drive to cater to industrial needs.
2. To familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications.
3. To provide strong foundation to asses performance of different industrial drives considering issues such as, energy efficiency, power quality, economic justification, environmental issues, and practical viabilities

COURSE OUTCOME:

EE32282(T).1: Examine various applications in industrial and domestic areas where use of electric drives are essential
EE32282(T).2: Classify types of electric drives systems based on nature of loads, control objectives, performance and reliability
EE32282(T).3: Combine concepts of previously learnt courses such as, electrical machines, Control and power electronics to cater to the need of automations in industries.
EE32282(T).4: Select most suitable type and specification of motor drive combination for efficient conversion and control of electric power
EE32282(T).5: Design and justify new control and power conversion schemes for implementing alternative solutions considering the critical and contemporary issues.

COURSE CONTENTS:

THEORY

S.NO.	Course Contents
1	**UNIT: 1** Electrical Drives – definition & concept, block diagram, main components, classification, comparison with conventional drives, advantages, factors which affect the selection of drives, components used for obtaining signals for interlocking, sequencing operations and protection.

2	**<u>UNIT: 2</u>** Dynamics of electrical drives – types of loads, speed-torque characteristics and multi-quadrant operation, equivalent values of drive parameters, dynamics of motor-load combination, determination of moment of inertia, steady state and transient stability of an electrical drives, load equalization.
3	**<u>UNIT: 3</u>** Control of electrical drives – modes of operation, speed control, closed-loop control of drives, speed sensing, current sensing. Selection of motor power rating – thermal model of motor for heating & cooling, frame size, NEMA standards, classes of motor duty, determination of motor rating, fluctuating loads, short-time, intermittent and continuous duty.
4	**<u>UNIT: 4</u>** DC motor drives – DC motors & their performance, starting, braking, transient analysis, speed control methods, Ward Leonard drives, AC to DC converter fed dc drives, control of fractional hp motors, supply side harmonics analysis, power factor & ripple in supply current, converter ratings & closed-loop control.
5	**<u>UNIT: 5</u>** AC motor drives – Induction motor & their performance, starting, braking, speed control methods, AC voltage controllers for speed control, soft starter and energy saver, cyclo converter fed induction motor drives, slip power recovery scheme, synchronous motor operation from fixed frequency supply, synchronous motor variable speed drive, self-controlled synchronous motor drive employing a cyclo converter

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS:

1. G. K. Dubey, “Fundamentals of Electrical Drives”, second edition Alpha Science International ltd.,2002
2. J. M. D. Murphy, “Thyristor control of A.C. motors”, Pergamon Press, 1973.
3. B. K. Bose, “Modern Power Electronics and AC Drives”, Prentice-Hall 2007.
4. W. Leonhard, “Control of Electric Drives”, third edition, Springer, 2001.

REFERENCE BOOKS:

1. V Subrahmanyam, “Electric Drives Concepts and Applications”, Tata McGraw Hill Publishing Company Ltd, 1996.
2. S. K. Pillai, “A First Course on Electrical Drives”, New Age International Pvt. Ltd, 2004.
3. P. C. Sen, “Thyristor DC Drives”, John Wiley & Sons, 1981.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	3	3	2	-	-	-	-	-	-	-
CO2	2	3	3	3	2	-	-	-	-	-	-	-
CO3	2	3	3	3	2	-	-	-	-	-	-	-
CO4	2	3	3	3	2	-	-	-	-	-	-	-
CO5	2	3	3	3	2	-	-	-	-	-	-	-
Average	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)
ELECTIVE-I
EE32283: DATA STRUCTURE AND EMBEDDED SYSTEM PROGRAMMING CONCEPT

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

Pre-Requisite: Basics of C programming, Basics of microprocessor

COURSE OBJECTIVE:

1. Teach to write the advance program in C.
2. Learn to develop the data structure tools for specific applications.
3. Explain the performance of efficient sorting and searching.
4. Guide to investigate the software development platform.
5. Instruct to create the embedded system for real world.

Course Outcomes (COs):

After completing the course, student will able to:

EE32283(T).1: Write advance program in C with use of dynamic memory allocation techniques.
EE32283(T).2: Develop data structure tools (stack, queue, tree & graph) for specific application.
EE32283(T).3: Perform efficient sorting and searching on a large data set.
EE32283(T).4: Explore software development platform along with code optimization and resource management.
EE32283(T).5: Create embedded system for real world with low interrupt latency and suitable software architecture.

COURSE CONTENTS:

S. No.	Unit
1	**Unit- I** Basic Concept of C programming : Overview Data structure tools : Array , Link list , Pointers and structure , Dynamic memory allocation , Recursion
2	**Unit -II** Stack and Queue : operation and application Tree: Binary tree, representation, applications Graph: Types of graph, representation of graph, Adjacency matrix.
3	**Unit –III** Sorting Algorithms: Bubble sort, Insertion sort, Selection sort, merse sort, quick sort. Searching : Sequential search, Binary search, Hashing.
4	**Unit- IV** Embedded software development cycle: Compiling, Linking, debugging, overloading, Memory management, I/ O or peripheral management, Code optimization.
5	**Unit-V** Basic hardware concept : microprocessor , architecture . Interrupt basic : share data, problem , Interrupt latency .Software architecture : RR ,RR with interrupts , FQS architecture, Real time operating system architecture .

Programming Assignment	
A.	**Sample Programming in C :** 1. Array: Stack, Queue 2. Link list: stack, Queue 3. Sorting: Bubble sort, Insertion sort, Selection sort, merse sort, quicksort 4. Searching: Hashing 5. Tree: infix, prefix, postfix **6.** Graph: DFS, BFS.

B.	**Mini project :** 1. Software design, 2. Hardware design, 3. Implementation : programming in C, fabrication/ assembly ofhardware, **4.** Testing.

ASSESSMENT:

1. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
2. The end-term theory examination weightage is70%.

REFERENCES BOOKS:

1. Aaron M. Tenenbaum, Yedidyah Langsam and MosheJ.Augenstein "Data Structures Using C and C++", PHI Learning Private Limited, Delhi India.
2. Horowitz and Sahani, "Fundamentals of Data Structures", Galgotia Publications Pvt Ltd Delhi India
3. Lipschutz, "Data Structures" Schaum's Outline Series, Tata McGraw-Hill Education (India) Pvt.Ltd
4. R. Kruse et.al, "Data Structures and Program Design in C", Pearson Education
5. David E. Simon, "An Embedded Software Primer", Addison Wesley1999.
6. Michael Barr, "Programming Embedded Systems in C and C++", SPD & O'Reilly1999.

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	1	3	-	-	3	2	1	-	-
CO2	-	-	2	1	3	-	-	3	1	2	-	-
CO3	-	-	2	-	3	-	-	3	1	1	-	2
CO4	1	1	-	3	3	-	1	3	2	2	3	1
CO5	3	1	2	1	2	3	3	3	3	3	3	3
Average	**2**	**1**	**2**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**1.5**	**1**

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR (4 YDC)
EE32499: MINOR PROJECT I

<table>
<tr><th colspan="3">HOURS PER WEEK</th><th colspan="3">CREDITS</th><th colspan="5">MAXIMUM MARKS</th></tr>
<tr><th rowspan="2">T</th><th rowspan="2">P</th><th rowspan="2">TU</th><th rowspan="2">T</th><th rowspan="2">P</th><th rowspan="2">TU</th><th colspan="2">THEORY</th><th colspan="2">PRACTICAL</th><th>TOTAL MARKS</th></tr>
<tr><th>CW</th><th>END SEM</th><th>SW</th><th>END SEM</th><th rowspan="2">100</th></tr>
<tr><td>-</td><td>4</td><td>-</td><td>-</td><td>2</td><td>-</td><td>-</td><td>-</td><td>40</td><td>60</td></tr>
</table>

<u>COURSE OUTCOME:</u>

After completing the Minor Project Phase I, the student will able to:

EE32499(1): Select problem of a selected area in engineering domain.

EE32499(2): Explore the state of art solution of the selected problem.

EE32499(3): Apply software/hardware solution methodologies for implementation of proposed design.

EE32499(4): Practice social and professional ethical standards and work in team for developing leadership quality.

EE32499(5): Summarize the findings in terms of technical report.

CRITERIA AND RUBRICS

INTERNAL ASSESSMENT:

Maximum Marks: 40 Marks
Student will be judged using following criteria and rubrics:

S. No.	Criteria	Marks	CO
1	Selection of Problem	5	CO1
2	Literature survey	10	CO2
3	Proposed Design	10	CO1,CO3,CO4
4	Impact on Society	5	CO4
5	Report	10	CO5

EXTERNAL ASSESSMENT

Maximum Marks: 60 Marks
Student will be judged using following criteria and rubrics:

S. No.	Criteria	Marks	CO
1	Presentation	10	CO1, CO2,CO3
2	Organization of Thesis	20	CO5
3	Learning Outcome	10	CO3
4	Ethical Practice	5	CO4
5	Results	10	CO1,CO2, CO3
6	Confidence	5	CO1, CO4

CO-PO MAPPING:

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

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM A (4 YDC)

EE32481: EVALUATION OF INTERNSHIP-I

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
-	-	-	-	3	-	-	-	40	60	100

COURSE OUTCOME:

After completing the Industrial Internship and seminar, student will able to:

EE32481(1): Select the industry and construct the company profile in terms of structure, product, services offered with brief history and key achievement.
EE32481(2): Asses their strength, weakness and opportunity in the selected industry.
EE32481(3): Apply theoretical knowledge in practical situation by completing the task in given time period.
EE32481(4): Apply time management skill to complete the task and prepare draft report of the findings.
EE32481(5): Analyze the functioning of industry and suggest the changes for improvement of their services.

CRITERIA AND RUBRICS

INTERNAL ASSESSMENT:

Maximum Marks: 40 Marks
Student will be judged using following criteria and rubrics:

S. No.	Criteria	Marks	CO
1	Learning Outcome	10	CO1, CO3, CO4
2	Time line	5	CO4
3	Leadership Developed	10	CO2, CO4
4	Organization of Report	15	CO4, CO5

EXTERNAL ASSESSMENT:

Maximum Marks: 60 Marks
Student will be judged using following criteria and rubrics:

S. No.	Criteria	Marks	CO
1	Future Goals	5	CO5
2	Presentation	10	CO3
3	Technical Knowledge	20	CO1, CO2
4	Organization of Report	20	CO3
5.	Confidence	5	CO4, CO5

CO-PO MAPPING:

CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	3	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	3	3	3	3	-	-	-	-	-	-	-
CO4	-	-	-	-	3	-	-	-	-	-	3	2
CO5	-	-	-	-	-	1	-	-	3	3	3	
Average	2.5	3	3	3	3	1	-	2	3	3	3	2

ELECTRICAL ENGINEERING DEPARTMENT

B. Tech.

III YEAR SEM B

EE32511: Signals & Systems

Subject Code	Subject Name	L	T	P	Th. Credits	Pr. Credits	Maximum Marks				
							TH	CW	SW	Pr	Total
EE32511	Signals & Systems	4	4	0	3	0	70	30	0	0	100

PRE-REQUISITE:

Basic knowledge of mathematics, including complex numbers, partial fractions, and sketching waveforms.

COURSE OBJECTIVES:

1. Understanding the basic characteristics of signals & systems.
2. Evaluate signals & systems in terms of both the time and transform domains.
3. Utilize mathematical tools to solve problems involving convolution, sampling, and transformations.

COURSE OUTCOMES (COs):

After completing this course, students will be able to:

EE 32511(T).1: Understand signal classification, system properties, LTI systems, Fourier series, and CTFT along with their key characteristics.

EE 32511(T)2 : Analyze discrete-time signals using DFS, apply the sampling theorem, and reconstruct continuous-time signals from samples..

EE 32511(T).3: Utilize Laplace and Z-Transforms to study system behaviour , ROC, poles, zeros, and assess continuous and discrete-time LTI systems.

EE 32511(T).4: Examine rectangular signals, assess linear/nonlinear distortions, and evaluate thermal noise effects in system design..

EE 32511(T).5: Explore the use of correlation functions in signal-system analysis and conceptualize signals as vectors to enhance signal processing and optimize system behavior.

COURSE CONTENTS:

Theory:

Unit	Syllabus	CO	PO	BTL
1.	**Fundamentals**: Classification of signals, Elementary signals, Concept of system, Properties of systems - Stability, inevitability, time invariance, Linearity, Causality, Memory. Convolution, Impulse response, Representation of LTI systems, Fourier series Continuous-Time Fourier Transform (CTFT), Properties of CTFT.	**1**	**1,2,3**	**3**
2.	**Discrete Fourier Analysis and Sampling:** Fourier representation of discrete-time signals - Discrete Fourier Series (DFS) and its properties. Sampling: The sampling theorem, reconstruction of signals from their samples, sampling in the frequency domain, and sampling of discrete-time signals.	**2**	**1,2,3**	**3**
3.	**Application of Laplace and Z-Transforms:** Definition, inverse, existence conditions, Region of Convergence (ROC), properties, and significance of poles and zeros. Application of Laplace Transform in analyzing continuous-time LTI systems and Z-Transform for discrete-time LTI systems.	**3**	**1,3**	**4**
4.	**Rectangular Signal Analysis and System Design**: The features of rectangular shape as a signal and as a transfer function of a system. Linear and nonlinear distortions experienced by signals and their implications in system design. Thermal noise signal and its characteristics.	**4**	**1,2**	**4**
5.	**Correlation and Vector Representation of Signals**: Correlation functions and their applications to signal-system analysis. Representation of signals as vectors and its applications.	**5**	**1,2**	**3**

COURSE ASSESSMENT:

A. Continuous evaluation through two mid-term tests with a weightage of 30% of the total marks. It includes attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXTBOOKS RECOMMENDED:

1. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
2. Allen V. Oppenheim, A.S. Willsky, and I.T. Young, "Signals and Systems", Prentice Hall, 1983.

REFERENCE BOOKS:

1. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.
2. S. Palaniammal, "Probability and Random Processes", PHI Learning, 2012.
3. A.Bruce Carlson , Paul Crilly "Communication Systems " McGraw-Hill Education - Europe

CO-PO MAPPING:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS0 1	PS0 2	PS0 3
CO 1	3	2											3		
CO 2	3	2	1	1									3	2	1
CO 3	3		1										3	1	1
CO 4	3	2	1										3		
CO 5	2		1										2		
Ave rage	3	2	1	1									3	2	1

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM B (4 YDC)
EE32510: HYBRID ENERGY SYSTEMS

<table>
<tr><th colspan="3">HOURS PER WEEK</th><th colspan="3">CREDITS</th><th colspan="5">MAXIMUM MARKS</th></tr>
<tr><th rowspan="2">T</th><th rowspan="2">P</th><th rowspan="2">TU</th><th rowspan="2">T</th><th rowspan="2">P</th><th rowspan="2">TU</th><th colspan="2">THEORY</th><th colspan="2">PRACTICAL</th><th rowspan="2">TOTAL MARKS</th></tr>
<tr><th>CW</th><th>END SEM</th><th>SW</th><th>END SEM</th></tr>
<tr><td>3</td><td>2</td><td>-</td><td>3</td><td>1</td><td>-</td><td>30</td><td>70</td><td>40</td><td>60</td><td>200</td></tr>
</table>

PRE- REQUISITE: Basic knowledge of science

COURSE OBJECTIVE:

1. Assess the seriousness of the current and future energy scenario and the role played by hybrid energy in modifying it.
2. Develop basic understanding of solar, wind, bio-gas and fuel cell energy systems.
3. Learn fundamentals of different types of energy storage systems.
4. Design the hybrid energy system in standalone and grid connected configuration.

COURSE OUTCOME:

After completing this course, the student will be able to

EE32510(T).1: Illustrate the sustainable future energy scenario and the role played by hybrid energy in modifying it and compare various energy storage techniques.
EE32510(T).2: Utilize electrical characteristics and interconnection employing MPPT in solar Photovoltaic energy systems.
EE32510(T).3: Elucidate the wind power output characteristics and grid connection of various generators for wind energy conversion system.
EE32510(T).4: Analyze and compare the state of the art energy solutions for Microgrid like PHES and biomass.
EE32510(T).5: Develop skills to design hybrid energy system configuration and estimate its component ratings.

COURSE CONTENTS:

THEORY

S.NO.	Course Contents
1	**UNIT: 1** Introduction, Fossil fuel based systems, Impact of fossil fuel based systems, environmental effects, greenhouse gas emission, Non-conventional energy – seasonal variations and availability, Renewable energy – sources and features, Hybrid energy systems, Distributed energy systems and dispersed generation (DG), Energy storage systems.
2	**UNIT: 2** Solar radiation spectrum, Technologies, Applications such as heating, cooling, drying, power generation, Solar Photovoltaic systems, Operating principle, Photovoltaic cell concepts, Cell, module, array, Series and parallel connection, electrical models, efficiency limits, Maximum power point tracking, Impact of temperature, applications, grid tied and stand-alone systems.
3	**UNIT: 3** Wind patterns and wind data, Site selection, Types of wind mills, Power in the wind, Betz limit, wind turbine electrical systems, constant and variable speed models, Characteristics of wind generators, Maximum power point tracking, interfacing to the grid, grid tied and stand-alone systems.
4	**UNIT: 4** Operating principle, Components of a microhydel power plant, Types and characteristics of turbines, Selection and modification, Load balancing. Operating principle of biomass, Combustion and fermentation, anaerobic digester, Wood gassifier, Pyrolysis, application in combustion engine, stand-alone plants.
5	**UNIT: 5** Hybrid Energy Systems, block diagram, Need for Hybrid Energy Systems, Range and type of Hybrid Energy systems, Wind-solar Hybrid stand-alone Energy Systems, Wind-Hydro Hybrid stand-alone Energy Systems.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. S. N. Bhandra, D. Kastha and S. Banerjee, "Wind Electric Systems," Oxford University Press, New Delhi, 2004.
2. Thomas Ackermann, "Wind Power in Power Systems," John Wiley & Sons, Ltd., 2005.

REFERENCES BOOKS:

1. M. G. Simoes and F. A. Farret, "Renewable Energy Systems," CRC Press, Florida, 2004.
2. M.R. Patel, "Wind and solar power systems," CRC Press, Boca Raton, 1999.

CO-PO MAPPING:

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

LABORATORY :

OBJECTIVES: The Hybrid Energy System LABORATORY is designed

1. To provide the student with the knowledge to use design software like MATLAB with proficiency.
2. In this lab, students are expected to get hands-on experience in using the solar panels, data logger, measuring instruments and illumination sources.
3. To develop communication skill through laboratory note book with written descriptions of model, code, result and analysis.
4. To get exposure for various renewable energy sources and their output characteristics.

LABORATORY OUTCOMES:

The students will be able to:

1. Mathematically model simple solar and wind energy systems.
2. Analyze the effect of various parameters on solar and wind energy systems.
3. Determine the solar and wind power outputs under various environmental conditions.
4. Develop capability for designing and documenting simple solar and wind systems with MPPT controllers.
5. Get acquainted with the current renewable energy scenario of India and its challenges. Various schemes of government for promoting renewable energy are also explored.

S. No.	LIST OF EXPERIMENTS
1	Development of mathematical model of solar cell and plot of I-V characteristics using Matlab Script
2	Development of mathematical model of solar cell and plot of P-V characteristics using Matlab Script.
3	Studying the effect of temperature on solar cell and plot of I-V characteristic using Matlab Script.
4	Studying the effect of temperature on solar cell and plot of P-V characteristic using Matlab Script.
5	Studying the power output of Photovoltaic generator using Matlab Script.
6	Studying the power output of WECS generator using Matlab Script.
7	Development of mathematical model of solar panel output under both Full & Partial Illumination.
8	Simulation of Boost type DC-DC converter for MPPT in solar module.
9	Experimentally determine the Voltage-Current (V-I) and Power-Voltage (P-V) characteristics of 37 W solar panel under different illumination conditions and shading.
10	Study of current renewable energy scenario in India.

ASSESMENT:

A. Continuous evaluation of laboratory journals with a weightage of 30%. It includes lab attendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 70%.

CO-PO MAPPING:

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

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM B (4 YDC)
EE 32509: POWER ELECTRONICS-II

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
3	2	-	3	1	-	30	70	40	60	200

PRE- REQUISITE: Power Electronics-I

COURSE OBJECTIVE:

1. To understand design of SCR commutation circuits for choppers and inverter systems.
2. To learn the principle of working of quadrant based choppers, switching regulators, resonant mode switching, and single-phase / three-phase inverters.
3. To explore control techniques employs for above converters and its applications.
4. To define characteristics and classifications of gate/base driver circuits for Power BJT, MOSFET and IGBTs.

COURSE OUTCOME:
Students should be able to

EE32509(T).1: Describe the operating characteristics of various silicon based controlled switches, compare, illustrate them in distinguished choppers investigations for field applications.
EE32509(T).2: Write the performance parameters of single phase and three-phase inverters, explain operating principles, list applications and solve field problems .
EE32509(T).3: Discuss limitations of linear power supply, explain switch mode power supply, classify topologies, examine performances of switching regulators and apply in field problems.
EE32509(T).4: Name common disturbances in commercial supply, outline UPS, write its applications, Outline its types and modes of operation and describe BES.
EE32509(T).5: Explain the need and importance of driver circuit, Identify the challenges in driving half bridge inverter, Classifications of driver circuit and their design.

COURSE CONTENTS:

THEORY

S.NO.	CONTENT
1	**UNIT: 1** Inverter grade SCRs, Commutation techniques for SCR, self commutated switches and its impact, Power BJT, MOSFET, IGBT, Junction structure, switching characteristics, safe operating areas, chopper circuits – step down chopper, step up chopper, two quadrant and four quadrant operation, principle of operation, applications, multiphase chopper, design considerations and performance evaluation.
2	**UNIT: 2** Inverters, principle of operation, applications, voltage sourced inverters (VSI), half bridge, full bridge and push pull configurations, operation on inductive loads, voltage and frequency control, Single pulse width control, selective pulse and sinusoidal pulse width modulation, three phase inverters, 180^0 and 120^0 mode of operation, voltage control, Macmurray commutated single phase VSI, Current sourced inverter, principle of operation, classifications, waveform synthesis, harmonics analysis and elimination techniques, design problems.
3	**UNIT: 3** Limitations of linear power supplies, switch mode power supplies, switching regulators – non-isolated and isolated topologies, buck, boost, buck-boost, Cuk topologies, performance analysis, concept of soft switching, and electromagnetic compatibility, design problems.
4	**UNIT: 4** Common disturbances in commercial supply, uninterruptable power Supplies (UPS): need, applications, classifications, block diagram, Specifications, modes of operation, Battery storage system, rating considerations, control Schemes, design problems.
5	**UNIT: 5** Driver circuits, need and importance, challenges in driving half bridge switches, classification of the drive circuits for IGBT and MOSFET, IR2112 IC driver circuit, switching regulator IC SG3524 etc, design problems.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. Joseph Vithayathil, “Power Electronics Principles and applications”, Tata McGraw-Hill, 1995.
2. Ned Mohan, Tore M. Undeland “Power Electronics: Converters, Applications, and Design”, third edition, John Wiley & Sons Inc, 2007.
3. Daniel W. Hart, “Power Electronics”, Tata McGraw-Hill Edition, edition 2011.

REFERENCE BOOKS:

1. C. M. Pauddar, “Semiconductor Power Electronics (Devices and Circuits)”, first edition, Jain Brothers New Delhi, 1999.
2. M. D. Singh, K. B. Khanchandani, “Power Electronics”, Tata McGraw-Hill New Delhi, 2008.
3. M H Rashid, “Handbook of Power Electronics”, Pearson Education India, 2008.

CO-PO MAPPING:

CO’s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	1	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**

LABORATORY :

OBJECTIVES: Following are the objective of the course:

1. Show awareness about operating behavior of various static switches used in converters.
2. Understand the basic requirements in design of power converters.
3. Analyze performance parameters of various power converters.

LABORATORY OUTCOMES:

EE32509(P).1: Design converters and demonstrate the knowledge for sustainable & secured development.
EE32509(P).2: Establish wiring and device connection for DC-DC & DC-AC experiment setup to record, synthesis and analyze their performances.
EE32509(P).3: Design and development of commutation circuits of SCR applying electrical engineering fundamentals, observing the effect of change in passive components.
EE32509(P).4: Apply professional quality textual and graphical tools to sketch and formulate results, incorporating accepted data analysis and synthesis methods, mathematical software, and word-processing tools.

EE32509(P).5: Ability to work in individual and in group following engineering practices. Ability to interact effectively on a social and interpersonal level, divide up and share task responsibilities to complete assignments.

Experiment no.	Objective
1.	Design a step down chopper circuit with R and RL loads. Observe and analyze its performance under change in duty cycle and switching frequency.
2.	Design a current commutation circuit for SCR. Observe and analyze its performance under change in passive components and load parameters.
3.	Design a voltage commutation circuit for SCR. Observe and analyze its performance under change in passive components and load parameters.
4.	Study and design of a buck-boost converter circuit and observe performance under change in duty cycle.
5.	Study and design of a boost converter circuit and observe performance under change in duty cycle.
6.	Explore switched mode DC power supply to identify its various component blocks.
7.	Study on comparison of switched mode power supply and linear power supply.
8.	Analyze the performance of single phase voltage source inverter with R & RL loads.
9.	To understand the working of DC-DC converter in different quadrants.
10.	To design BJT driver circuit on bread board using IC: SG 3524

ASSESMENT:

A. Continuous evaluation of LABORATORY journals with a weightage of 30%. It includes lab attendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 70%.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	3	3	3	3	-	-	-
CO2	3	2	3	3	3	3	3	3	3	-	-	-
CO3	3	2	3	3	3	3	3	3	3	1	-	-
CO4	3	2	3	3	3	3	3	3	3	1	-	-
CO5	3	2	3	3	3	3	3	3	3	1	-	-
Average	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**-**	**-**

ELECTRICAL ENGINEERING DEPARTMENT
B. TECH III YEAR SEM B(4YDC)
EE 32571: POWER SYSTEM-I

<table>
<tr><th colspan="3">Lectures/Week</th><th colspan="3">CREDITS</th><th colspan="5">MAXIMUM MARKS</th></tr>
<tr><th rowspan="2">Th</th><th rowspan="2">Pr</th><th rowspan="2">Tut</th><th rowspan="2">Th</th><th rowspan="2">Pr</th><th rowspan="2">Tut</th><th colspan="2">THEORY</th><th colspan="2">PRACTICAL</th><th>TOTAL MARKS</th></tr>
<tr><th>CW</th><th>END SEM</th><th>SW</th><th>END SEM</th><th rowspan="2">200</th></tr>
<tr><td>3</td><td>2</td><td>-</td><td>3</td><td>1</td><td>-</td><td>30</td><td>70</td><td>40</td><td>60</td></tr>
</table>

PRE- REQUISITE: Fundamentals of Electrical Engineering & Network Theory

COURSE OBJECTIVES:

1. Represent elements of a power system including generators, transmission lines, and transformers.
2. Analyze transmission line parameters for single and three-phase systems.
3. Evaluate the performance of various transmission lines.
4. To study mechanical overhead line mechanics, grounding, corona, and insulator performance.
5. To study cable characteristics and analyze voltage drop in AC/DC distribution systems.

COURSE OUTCOMES:

After completing this course student will able to:

EE 32571(T).1: Awareness of general structure and components of the power network.

EE 32571(T).2: Elucidate the concepts of transmission line parameters and its calculations for single and three phase lines.

EE 32571(T).3: Evaluate the performance of different types of transmission lines

EE 32571(T).4: Articulate the mechanical design aspect of transmission line and examine the corona effect on overhead transmission system.

EE 32571(T).5 Impart the knowledge of insulation resistance and capacitance of single and three core underground cables.

COURSE CONTENTS:

THEORY:

Course Contents	CO	PO	BTL
UNIT:1 General background, structure and components of power network. Power generation – conventional, non-conventional, distributed generation, Comparison of HVAC & HVDC. Effect of transmission voltage on power system economy. Selection of size of feeder. Comparison of isolated versus interconnected power systems. Problems associated with modern large interconnected power systems. Power Plant Economics - Load curves, base load, peak load, load factor, demand factor, diversity factor, capacity factor, utilization factor, cost of electricity, capital cost, fuel and operation cost, comparison of cost in various types of power plants, Depreciation and present worth, Annual cost and system efficiency.	1	1,2,4,6,7	2
UNIT: 2 Transmission line parameters, calculation of inductance of single and three phase transmission lines Using GMD method. Capacitance calculation of single and three phase transmission line, Effect of earth on capacitance. Inductance and capacitance of double transmission line	2	1,2,3,4	4
UNIT: 3 Model of the transmission line 'T' and 'Pi' models. Exact analysis of long transmission lines. Evaluation of voltage regulation and efficiency. Surge impedance loading. Line load ability. ABCD constants and their evaluation by measurements. Ferranti effect. Power flows along the transmission line. Power flow equations at sending end and receiving end. Circle diagrams and their utility. Series and shunt compensation. Q/V and P/delta decoupling. Concept of real and reactive power control.	3	1,2,3,4	3
UNIT: 4 Mechanical characteristics of overhead transmission lines. Sag-Tension relationship. Construction and utility of Sag-template and stringing chart. Tower height calculation. Ruling span, earth wire, Neutral earthing. Effective grounding, resistance, reactance and resonant earthing. Corona and corona loss. Critical disruptive voltage. Disadvantages of Corona, overhead line insulators. Types of insulators. Potential distribution over a string of suspension insulators. String efficiency, method to improve string efficiency.	4	1,2,3,4,67	4
UNIT: 5 Insulated cables, types of cables. Insulation resistance of cables, capacitance of single and three core cables. Distribution system. Primary and secondary distribution system. Voltage drop calculation in DC and AC single phase distributors with point and uniform loading. Ring main distributor.	5	1,2,3,4,6,7	4

COURSE ASSESSMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes attendance as well as assignments on the course topics.

B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. W.D. Stevenson, "Power System Analysis", fourth edition McGraw Hill, 1994.
2. C.L.Wadhwa "Electrical Power System", New Age International edition 2009.
3. I.J.Nagrath and D.P.Kothari, "Modern Power System Analysis", fourth edition, Tata McGraw Hill, 2011.

REFERENCES BOOKS:

1. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Edition 2002.
2. D. Das "Electrical Power Systems", New Age International Publishers, 2006.

CO-PO MAPPING:

CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	-	2	2	-	-	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-	-
CO4	3	2	2	3	-	2	2	-	-	-	-	-
CO5	3	1	0	1	-	1	1	-	-	-	-	-
AVERAGE	**3**	**1.8**	**1.33**	**2**	**0**	**1.67**	**1.67**	**0**	**0**	**0**	**0**	**0**

ELECTRICAL ENGINEERING DEPARTMENT
B. TECH III YEAR SEM B(4YDC)
EE 32571: POWER SYSTEM-I LABORATORY

LABS/WEEK	PRACTICAL CREDITS	PRACTICAL		TOTAL MARKS
		SW	END SEM	
2	1	40	60	100

LABORATORY:

OBJECTIVES: The Power System-I Laboratory is designed:

1. To equip students with practical knowledge of 33/11 kV distribution and high voltage systems for real-world power system applications.
2. Develop software skills and gain proficiency in using standard tools for analysis, simulation, planning, operation, and control of power systems.
3. Acquire hands-on expertise in using the Transmission Line Training System for practical applications.
4. To understand the structural and electrical design aspects of transmission line towers and insulators.
5. To share knowledge and insights on various types of power generation plants through poster presentations.

LABORATORY OUTCOMES:

The students will be able to:

EE32571(P).1: Gain practical understanding of 33 kV distribution substations.

EE32571(P).2: Develop skills in using software tools for power system analysis and simulation.

EE32571(P).3: Learn the operation and functionality of various power system equipment.

EE32571(P).4: Analyze transmission line parameters and perform power flow studies using the Transmission Line Training System.

EE32571(P).5: Students will gain the ability to select suitable types and specifications of insulators based on different voltage levels.

EE32571(P).6: Students will understand and present various power plant operations and current global research trends in power generation.

S.No	List of Experiment	CO	PO	BTL
1	To analyse the structure, operation, and performance of a 33/11 kV distribution system at SGSITS, Indore (M.P).	1	1,2, 4,56,10	2
2	To explore and understand the operation, testing, and safety procedures involved in high voltage equipment at the High Voltage Laboratory, SGSITS, Indore (M.P.).	1	1,2,6,7,10	2
3	To calculate the transmission line parameters manually for a practical understanding of their determination and analysis. (iii) Design earth wire for the line and suggest the location on the tower.	3	1,2, 4,6,10,12	4
4.	To calculate and verify the transmission line using MATLAB for a given transmission line.	2	1,2, 4,6,10,12	3
5.	Determination of ABCD parameters of short transmission line.	3	1,2,3,4	4
6.	Determination of ABCD parameters of medium transmission line.	3	1,2,3, 4	4
7.	Determination of ABCD parameters of long transmission line.	3	1,2,3, 4	4
8.	Measurement of the receiving end voltage of each line under no-load conditions to understand the Ferranti effect.	3	1,2,3, 4	4
9.	Understand the performance of a long transmission line under different loads, including varying resistive and inductive loads at different steps.	3	1,2,3, 4	4
10.	Design sheet of Transmission line towers and Insulators.	4	1,2,3,4,6, 10	4
11.	Poster Presentation on different power generation Plants.	5	1,2,3,4,6, 10,12	4

Assessment:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

B. The end-term theory examination weightage is 70%.

CO-PO Mapping:

CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3		2				2		
CO2	3	3	3	3		2	2			2		
CO3	3	3	3	3		2	2			2		3
CO4	3	3	3	3		2	2			2		3
CO5	3	3	2	2		2	2			2		3
Average	3	3	3	3		2	2			2		3

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM B (4 YDC)
ELECTIVE-II
EE32XXX: DIGITAL CONTROL SYSTEMS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
3	2	-	3	1	-	30	70	40	60	200

PRE- REQUISITE: Basic knowledge of LTI control system, discrete time system and Z- transformation.

COURSE OBJECTIVE:

1. To introduce the basic concepts of discrete time control system and explain the motivation, model formation and stability of digital control system .
2. To teach about the designing of digital controllers and familiarize with basics of discrete time state space equations.
3. To explain the designing concepts of observer and familiarize with MIMO system.
4. To describe the concepts of PID tuning and introduce the basic concepts of Robust control system. To impart the basic idea of PLC.

COURSE OUTCOME:

After completing this course, the student will be able to

EE32XXX[T1]. Identify the discrete time control system and will find out stability of any digital controller.

EE32XXX[T2]. Explain the SISO and MIMO control system for various applications.

EE32XXX[T3]. Understand the basics of designing the digital controllers and optimal controllers for power engineering applications.

EE32XXX[T4]. Analyze the basic idea of tuning the controllers and will be skilled to tune PID controllers.

EE32XXX[T5]. List the fundamentals of robust control system for various fields like industries, aviation, automobiles etc.

S.NO.	COURSE CONTENT
1	**UNIT: 1** Introduction of Digital Control system: Introduction, Discrete time system representation, Sample data Systems, mathematical modeling of sampling process, Data reconstruction. Modeling of discrete-time control system : Revisiting Z-transforms, Mapping of s-plane to z-plane, Pulse Transfer Function, transfer function model of closed loop system, Sampled signal flow graph.
2	**UNIT: 2** Stability analysis of discrete time systems: Jury stability test, Stability analysis using Bilinear Transformation. Nyquist stability criteria. Time response of discrete time system: Transient and steady state response, Time response parameters of a prototype second order system
3	**UNIT: 3** Design of Discrete-time Control system: Root locus method, Design of controller based on root locus method in the z-plane, Design of PID Controller based on frequency response methods. Design of lag, lead compensator using Bode plot, lag lead compensator design in frequency domain.
4	**UNIT: 4** Discrete state space model: Introduction to state variable models, various canonical forms, state transition matrix, solution to discrete state equation. Controllability, Observability and stability of discrete state space model.
5	**UNIT: 5** State feedback design: Pole placement by state feedback, Full order observers, reduced order observers/estimators. Deadbeat response design: Practical issues with deadbeat response, Design of digital control system with deadbeat response

ASSESSMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

REFERENCES BOOKS:

1. K. Ogata, “Modern Control Engineering”,Ninth edition, PHI Publication 2016.
2. Krishnakant “ Industrial Instrumentation”, PHI Publication, Delhi, 2015.
3. Fadali and Visioli, Digital Control Engineering, 2nd Edition, Academic Press.
4. M. Gopal, “Digital control and state variable methods”, Tata Mc Graw Hill, 1997.
5. G. Jacquot, “Modern Digital Control Systems”, Marcel Decker, New York, 1995.
6. Benjamin C Kuo, “Digital Control Systems”, 2nd Edition, Saunders College publishing, Philadelphia, 1992.

CO-PO MAPPING:

CO's	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	3	-	-	-	-	-	-	-	-	-
CO2	-	3	3	-	-	-	-	-	-	-	-	-
CO3	-	-	3	3	2	-	-	-	-	-	-	-
CO4	2	3	3	-	-	-	-	-	-	-	-	-
CO5	-	3	3	3	2	-	-	-	-	-	-	-
Average	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM B (4 YDC)
ELECTIVE-II
EE 32603: POWER SYSTEM PLANNING

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	2	-	3	1	-	30	70	40	60	200

PRE- REQUISITE: Power System Analysis, Electric Power Generation, Transmission and Distribution.

COURSE OBJECTIVE:
1. The course is designed to teach load forecasting, power system planning, and power quality issues in power system.
2. It aims to arm the students with the concepts of evaluation of generation, transmission and distribution system and their impacts on system planning.
3. This course will provide the background material to prepare the student for analyzing various elements that constitute the power system planning function.
4. Analyze and evaluate an electric power system for generation planning and load forecasting.
5. Execute production costing analysis and long term generation expansion plans.

COURSE OUTCOMES: After completing the subject student will be able to:

EE32603(T).1: Use tools to analyze power system planning and load forecasting.
EE32603(T).2: Evaluate the significance of generation planning for power system reliability.
EE32603(T).3: Develop plan for design and calculation of distributed power system.
EE32603(T).4: Evaluate the requirement for interconnected system and expansion of power system under cost consideration and expansion obligations.
EE32603(T).5: Determine load model for reactive power planning of distributed generation system.

THEORY:

S.NO.	Course Contents
1	**Unit-1: INTRODUCTION OF POWER PLANNING** National and regional planning, structure of power system, planning tools, Stages in planning and design, power system planning issues, Load forecasting, forecasting techniques, modeling, Electricity consumption pattern, Peak demand and energy forecasting by trend and economic projection methods.

2	**Unit-2: GENERATION PLANNING** Integrated power generation, co-generation / captive power, power pooling and power trading, Probabilistic models of generating units, Growth rate, Rate of generation capacity, Outage performance and system evaluation of loss of load and loss of energy indices, Power supply availability assessment.
3	**Unit-3: DISTRIBUTION PLANNING** Development of a distribution plan, types of distribution systems arrangements, primary distribution design, secondary distribution design, calculation of distributor sizes, Optimal conductor selection, Capacitor placement, Reconfiguration, Substation planning.
4	**Unit-4: INTERCONNECTED SYSTEMS AND OPTIMAL POWER SYSTEM EXPANSION PLANNING** Multi area reliability analysis, Power pool operation and power exchange energy contracts, Quantification of economic and reliability benefits of pool operation. Power System expansion planning: optimal Power system expansion planning, generation expansion, transmission and distribution expansion, cost consideration and expansion obligations, Regulatory Incentives.
5	**Unit-5: VAR AND DISTRIBUTED GENERATION PLANNING:** Static and dynamic resource allocation and sizing, modeling and economic issues pertaining to reactive power planning, distributed generation planning from the distributed power system performance, effect of load model in distributed generation planning, research trends in power system planning.

ASSESMENT:
A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:
1. Electric power system planning: issues algorithms and solution by HOSSEIN SEIFI AND MOHAMMAD SADEGH SEPASIAN, springer, 2011
2. Power System Planning Technologies and Applications: Concepts, Solutions, and Management by FAWWAZELKARMI, NAZIH ABU-SHIKHAH, engineering science reference, 2012

REFERENCES BOOKS:

1. Modern Power System Planning – X. Wang & J.R. McDonald, McGraw Hill Book Company.
2. Electrical Power Distribution A.S. Pabla, Tata McGraw Hill Publishing Company Ltd.
3. Economics & Planning – T.W.Berrie, Peter Peregrinus Ltd., London

CO-PO MAPPING:

CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	1	1	-	-	-	-	-	-
CO2	3	2	-	-	-	1	1	-	-	-	-	1
CO3	3	2	1	-	1	-	-	-	-	-	-	-
CO4	3	2	1	-	-	1	1	-	-	-	1	1
CO5	3	2	-	-	1	-	-	-	-	-	1	-
Average	**3**	**2**	**1**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**1**	**1**

LABORATORY OBJECTIVE:

1. Study of various methods use in power system planning.
2. Understanding the principal of various power generating system.
3. Study of different forecasting method and implement them in excel.
4. Designing of basic power system model using MATLAB.

LABORATORY OUTCOMES:

1: Summarize the concept of power system planning using different method.
2: Develop the concept of various power plant and their comparison on the performance basis.
3: Evaluate the peak demand and energy requirements of system using forecasting technique with the help of IT tools.
4: Design different bus system using MATLAB simulation.
5: Create model for the expansion of substation.

List of Experiments

Experiment No.	**Objective**
1	Make use of flow chart for generation, transmission and distribution system planning.
2	Compare various power plants on the basis of cost, site selection, generation capacity, efficiency etc.
3	By using Exponential smoothing model determine forecast for given data in MS Excel.
4	By using Halt's method determine forecast for given data in MS Excel.
5	By using seasonal model determine forecast for given data in MS Excel.
6	To design a 3-bus system model using MATLAB.
7	To design a model for substation expansion using MATLAB.

Lab Assessment: Students will be assessed on

(a) Continuous evaluation of laboratory journals with a weightage of 40% of the total marks. It includes lab attendance as well as experiments performed in the lab.
(b) The end-term practical examination weightage is 60%.

CO-PO MAPPING:

CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	1	-	1	-
CO3	-	3	-	-	3	-	-	-	-	-	-	-
CO4	-	3	-	-	3	-	-	-	-	-	-	-
CO5	-	3	-	-	3	-	-	-	-	-	-	-
Average	**2**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**1**	**-**	**1**	**-**

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM B (4 YDC)
ELECTIVE-II
EE32604: ENERGY AUDIT AND CONSERVATIONS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
3	2	-	3	1	-	30	70	40	60	200

PRE- REQUISITE: Basics of Electrical machines, Fundamentals of Electrical Engineering

COURSE OBJECTIVE:
The objectives include are as follows:
1. To provide basic understanding of conducting energy audit and energy management.
2. To foster the students with an attitude of conservation of energy in every field.
3. To explore various latest energy efficient methodologies in industrial, buildings and domestic applications.
4. To learn different standards, initiatives and policies in achieving energy conservations.

COURSE OUTCOME:

After completing this course, the student will be able to

EE32604 (T).1: Acquire knowledge about basics of energy policies and conservation initiatives.
EE32604 (T).2: Realize the requirement of energy audit and analyze detailed process of auditing with exploration of various equipments to perform audit.
EE32604 (T).3: Nurture the capability to apply effective energy management in heavy industries and organizations.
EE32604 (T).4: Develop skills of utilizing different energy efficient techniques in electrical equipments, buildings and industrial entities.
EE32604 (T).5: Choose and identify energy conservation opportunities in commercial buildings with exposure to green building concept.

COURSE CONTENTS:

THEORY:

S.NO.	COURSE CONTENTS
1	**UNIT: 1** **Energy Conservation:** Energy scenario- Demand and supply, commercial, non commercial energy production, energy pricing, Electricity tariff structure, security, strategy for future. Energy conservation in India- Need, opportunities, techniques. Conservation act, Indian standards, projects, initiatives, policies.
2	**UNIT: 2** **Energy Audit:** General philosophy of audit, need, types, audit process Energy flow diagram, audit tools and instruments, data gathering, facility inspection, Energy conservation measures, Benchmarking, Energy performance, Implementation of audit recommendation.
3	**UNIT: 3** **Energy Management:** Effective and smart energy management system, Objectives of energy management, Material balance and energy balance, Energy Action planning, energy management skills and strategy, role- responsibilities, duties of energy manager
4	**UNIT: 4** **Energy conservation in Electrical Utilities**: Techniques for maximum energy efficiency, maximum cost effectiveness in Induction motor, transformer, Lighting system. Optimization of Distribution, transmission, commercial losses, Energy efficient technologies: Automatic power factor controllers, Capacitor banks, soft starters, Variable speed drives, energy savers, efficient motors and transformers, star labeling program
5	**UNIT: 5** **Smart and Green Building:** Green building management, Energy Conservation in Buildings, Energy conservation building codes, Compliance approach, Guidelines on Building envelope, Lighting, electrical power, energy saving opportunities, Star rating of Buildings

ASSESMENT:

A. Continuous evaluation through two mid-term tests with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. Energy management handbook by Wayne C. Turner School of industrial engineering and management, Oklahoma state university.
2. Energy Management and conservation handbook by Frank Keith, D. Yogi Goswami.
3. Handbook of Energy Audit by Sonal Desai.
4. Handbook of Energy Audits by Albert Thumann, Terry Niehus, William J. Younger.

REFERENCES BOOKS:

1. General aspects of energy management and energy audit, Guide book for National Certification Examination, BEE.
2. Guide to Energy Management, by Barney L. Caphart, Wayne C. Turner, William J. Kennedy
3. Energy Audit of Building Systems by Moncef Krarti.
4. Energy Efficiency in Electrical Utilities, Guide book for National Certification Examination, BEE.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	-	-	-	3	3	-	-	-	-	3
CO2	-	-	-	-	-	3	3	-	-	3	-	3
CO3	-	-	-	1	-	-	3	-	-	3	1	3
CO4	3	-	-	-	3	3	3	-	-	-	-	-
CO5	3	-	-	-	3	3	3	-	-	-	-	-
Average	**3**	**1**	**-**	**1**	**3**	**3**	**3**	**-**	**-**	**3**	**1**	**3**

LABORATORY :

OBJECTIVES:

1. To motivate students with an attitude to conserve energy with positive environmental impacts.
2. To utilize different methodologies and solve basic calculations for estimation of energy efficiency of various equipments.
3. Relate the need of standards and labeling program of home appliances and electrical machines with global energy demands and energy security.
4. Examine and understand the energy audit report thoroughly and thereby applying various recommendations.
5. To develop communication skill and enhance report writing through proper organization of LABORATORY note book with written mathematical analysis.

LABORATORY OUTCOMES:

EE32604 (P).1: Get an exposure to various energy efficient practices in electrical machines, lighting systems, HVAC for various application areas.

EE32604 (P).2: Selection of appropriate energy conservation measure as recommendation by energy audit report and able to estimate cost benefits and payback period.

EE32604 (P).3: Estimation of reduction in power consumption and energy efficiency by replacement of conventional devices with various efficient devices**.**

EE32604 (P).4: Ability to enhance approach to practical energy audit by analyzing different case studies in industries.
EE32604 (P).5: Identify and choose most efficient devices for various industries and domestic applications with the help of star rating program for different equipments and appliances.

S. No.	LIST OF EXPERIMENTS
1	To design a luminarie layout for interiors and calculation of illuminances using zonal cavity method.
2	To estimate the payback period and reduction in power consumption by replacement of lamps in a classroom/ LABORATORY / other lighting schemes.
3	To study Automatic power factor controllers and calculation of reactive power required in order to improve power factor in any industry/ utility
4	To study terminology in Industrial energy bill, estimate the payback period, annual reduction in maximum demand charges, and energy charge component by improving power factor.
5	Case study of a textile industry for energy conservation measure. To estimate payback period and energy saving by fuel substitution measure.
6	To study the energy saving opportunities in Fans and blowers. To estimate static fan efficiency of a fan in a process plant.
7	To estimate energy savings and payback period by replacing a 3 phase induction motor by an energy efficient motor in an industry.
8	To study standards and labeling of Room Air conditioners and estimate energy efficiency of case study of Efficient room air conditioner.
9	Case study: Application of VFD of cooling tower fan in a manufacturing plant. To estimate cooling tower capacity using energy audit observations.
10	To study Star rating program and energy saving measures for the energy efficient buildings and estimate parameters for an efficient building.

ASSESMENT:

A. Continuous evaluation of LABORATORY journals with a weightage of 30%. It includes lab attendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 70%.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	-	3	3	3	-	-	3	-	3
CO2	3	-	-	-	3	3	3	-	-	3	-	-
CO3	3	-	-	-	3	-	3	-	-	3	-	-
CO4	3	-	-	-	3	3	3	-	-	3	-	-
CO5	3	-	-	-	3	3	3	-	-	3	-	3
Average	**3**	**-**	**3**	**-**	**3**	**3**	**3**	**-**	**-**	**3**	**-**	**3**

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. THIRD YEAR SEM B (4 YDC)
ELECTIVE-II
EE32605: EMBEDDED SYSTEM DESIGN

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	2	-	3	1	-	30	70	40	60	200

PRE-REQUISITE: Microprocessor and Operating System

COURSE OBJECTIVE:

1. To enable the skill of embedded system design for domestic and industrial applications.
2. To develop the knowledge for system level programming for hardware interfacing.
3. To develop skill for enhance performance of the embedded system using various optimization techniques

COURSE OUTCOME:

After completing this course students will able to:

EE 32605(T).1: Explain design philosophy of an embedded system.

EE 32605(T).2: Select and identify hardware and software requirement like CPU specification, Memory size, I/O interfacing, Operating system, scheduling policies, IPC etc.

EE 32605(T).3: Apply optimization techniques to improve performance of the embedded system in terms of program size, power consumption, speed etc.

EE 32605(T).4: Develop embedded system for distributed architectures, network based and Internet enabled.

S.NO.	CONTENT
1	**Unit-I** Complex system and Microprocessors, Embedded system design process: Requirement, Specifications, Architecture design, system integration, structural description, behavioral description.
2	**Unit-II** CPU bus, Memory devices, I/O devices , component interfacing, Development, debugging and testing.
3	**Unit-III** Programs design and analysis: Program design, Models of program , assembly and linking , compilation techniques ,analysis and optimization of program size , execution time, power and energy , program validation and testing .
4	**Unit-IV** Process and operating System: Multiple task and multiple processes , Context switching ,process scheduling policies , inter process communication .
5	**Unit-V** Distributed embedded architecture, network for embedded system , Network based design , Internet enabled system, Design examples .

ASSESSMENT:

1. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
2. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. Wolf,Wayan,“ComputerasComponent,PrinciplesofEmbeddedComputingSystem Design”, Morgan Kaufman, Academic Press.
2. VahidF,Givargis.T,“EmbeddedSystemDesign,AUnifiedHardware/SoftwareIntroduction,WileyIndiaPublication”
3. Marwedal P, “Embedded System Design, Kluwer Academic Publishers”.

REFERENCE BOOKS:

1. Prasad.KVKK,“Embedded/RealTimeSystems:Concept,Design,andProgramming”, Dreamtech Press
2. Barr. M, “Programming Embedded Systems”, O'Reilly
3. Sriram. S, Bhattacharyya S.S, “Embedded Multiprocessors, Scheduling and Synchronization”, Marcel Dekker,Inc.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	1	-	-	1	-	-	1
CO2	2	3	3	2	3	-	-	1	-	-	-	1
CO3	3	1	2	2	2	1	-	1	-	-	-	-
CO4	1	3	2	1	3	-	-	1	1	-	-	-
Average	**2**	**3**	**2**	**2**	**2**	**1**	**-**	**1**	**1**	**-**	**-**	**1**

LABORATORY :

OBJECTIVES: The Embedded System design Lab is designed.

This Lab emphasizes on comprehensive treatment of embedded hardware and real time operating systems along with case studies, in tune with the requirements of Industry. The objective of this Lab is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions.

LABORATORY OUTCOMES:

1: Perform market survey and user requirement analysis .

2: Design hardware and software architecture of real life problem .

3: Write technical report of the project and user manual for read reference for end users.

Lab Work :

Lab work
Design Phase : Simulation of application in Lab
Hardware design: Selection of components interconnection / interfacing circuit diagram , PCB design , fabricating and testing in Lab .
Software design: Writing program in modules and discuss the interfacing and interconnections of different modules and with Hardware.

ASSESMENT:

A. Continuous evaluation of LABORATORY journals with a weightage of 40%. It includes lab attendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 60%.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	3	-	2	1	1	2	3	1	3
CO2	3	3	3	3	2	1	-	2	1	3	3	1
CO3	1	-	-	3	3	-	-	3	1	3	1	2
Average	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**2**	**2**