Four-Year Undergraduate Programme

Bachelor of Technology

Electrical Engineering

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

Faculty of Engineering & Technology

Bachelor of Technology in Electrical Engineering

1. Vision of the Department

To be a premier department providing competent and ethical Electrical Engineers capable of finding solutions to problems related to technological and scientific advancement.

2. Mission of the Department

M1 To create graduates possessing sound fundamental knowledge with practical Engineering skills.

M2 To create manpower for contributing effectively towards societal development with Electrical Engineering aspects.

M3 To motivate faculty and students to do impactful research on industrial needs with ethics to society.

3. Program Educational Objectives

The statements below indicate the career and professional achievements that the B.Tech Electrical Engineering curriculum enables graduates to attain.

PEO 1	To develop technical skills (critical investigation, communication, analytical and computer) and human relations skills (group dynamics, team building, organization and delegation) to enable students to transform the acquired knowledge into action.
PEO 2	To inculcate critical analysis and communication skills into students to effectively present their views, both in writing and through oral presentations.
PEO 3	To provide an environment for exploring the Research & Development attitude, to help the students in Research and Development field.

4. Program Learning Outcomes

Program Learning outcomes are statements conveying the intent of a program of study.

PLO 1	**Engineering knowledge:**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PLO 2	**Problem analysis**	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.
PLO 3	**Design/development of solutions:**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PLO 4	**Conduct investigations of complex problems:**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PLO 5	**Modern tool usage:**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PLO 6	**The engineer and society:**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PLO 7	**Environment and sustainability:**	Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PLO 8	**Ethics:**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PLO 9	**Individual and team work:**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PLO 10	**Communication:**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make

effective presentations, and give and receive clear instructions.

PLO 11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PLO 12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

5. Program Specific Learning Outcomes

PSO 1 **Demand as per recent development** Design the solutions as per the recent industrial demand objective.

PSO 2 **Software skill** Test any apparatus and system with appropriate usage of software tools, and gather data for modeling system.

6. Credit Framework

Semester wise Credit distribution of the programme	
Semester-1	22
Semester-2	19
Semester-3	22
Semester-4	20
Semester-5	25
Semester-6	23
Semester-7	19
Semester-8	17
Total Credits:	**167**

Category wise Credit distribution of the programme	
Category	**Credit**
Major Core	103
Minor Stream	0
Multidisciplinary	28
Ability Enhancement Course	9
Skill Enhancement Courses	5
Value added Courses	4
Summer Internship	4
Research Project/Dissertation	14
Total Credits:	**167**

7. Program Curriculum

Semester 1						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106101	Basic Electrical Engineering	4	3	2	0
2	303105102	Programming for Problem Solving	4	3	2	0
3	303109101	Engineering Graphics	4	2	4	0
4	303191101	Mathematics -I	4	4	0	0
5	303192102	Engineering Physics - II	4	3	2	0
6	303193103	Communication Skills	2	0	0	2
Total			**22**	**15**	**10**	**2**
Semester 2						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
7	303104105	Environmental Science	Audit	1	0	0
8	303107153	Electronic Workshop	1	0	2	0
9	303106151	Digital Electronics Circuits	4	3	2	0
10	303107151	Basic Electronics	4	3	2	0
11	303109102	Elements of Mechanical Engineering	4	3	2	0
12	303191151	Mathematics-II	4	4	0	0
13	303193152	Advanced Communication & Technical Writing	2	0	0	2
Total			**19**	**14**	**8**	**2**
Semester 3						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
14	303106201	Fundamentals of Signals & Systems	2	2	0	0

15	303106202	Fundamentals of Signals & Systems Lab	1	0	2	0
16	303106203	Electrical Machines - I	3	3	0	0
17	303106204	Electrical Machines - I Lab	1	0	2	0
18	303106205	Electrical Circuit Analysis	3	3	0	0
19	303106206	Electrical Circuit Analysis Lab	1	0	2	0
20	303106207	Analog Electronics Circuits	3	3	0	0
21	303106208	Analog Electronics Circuits Lab	1	0	2	0
22	303191203	Mathematics III	4	4	0	0
23	303193203	Professional Communication Skills	2	0	0	2
24	303106213	Product Realisation	1	0	2	0
Total			**22**	**15**	**10**	**2**
Semester 4						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
25	303106251	Control System Engineering	3	3	0	0
26	303106252	Control System Engineering Lab	1	0	2	0
27	303106253	Electrical Machines-II	3	3	0	0
28	303106254	Electrical Machines-II Lab	1	0	2	0
29	303106255	Power Electronics - I	3	3	0	0
30	303106256	Power Electronics - I Lab	1	0	2	0
31	303106257	Electromagnetic	3	3	0	0
32	303106258	Electromagnetics Lab	1	0	2	0
33	303106259	Power Plant Engineering	3	3	0	0
34	303193252	Professional Grooming & Personality Development	1	0	0	1
Total			**20**	**15**	**8**	**1**
Semester 5						

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
35	303106301	Microcontroller and its Application	3	3	0	0
36	303106302	Microcontroller and its Application Lab	1	0	2	0
37	303106303	Electrical Measurements & Instrumentation	3	3	0	0
38	303106304	Electrical Measurements & Instrumentation Lab	1	0	2	0
39	303106305	Power System - I	3	3	0	0
40	303106306	Power System - I Lab	1	0	2	0
41	303106307	Power Electronics - II	3	3	0	0
42	303106308	Power Electronics - II Lab	1	0	2	0
43	303193304	Professionalism & Corporate Ethics	1	0	0	1
44	303106309	Summer Internship - I	2	0	0	0
45		Open Elective 01	2	2	0	0
46		PEC 01-LAB	1	0	2	0
47		PEC 01	3	3	0	0
Total			**25**	**17**	**10**	**1**
PEC 01						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106331	High Voltage Engineering	3	3	0	0
2	303106333	Industrial Electrical Systems	3	3	0	0
PEC 01-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106332	High Voltage Engineering Lab	1	0	2	0
2	303106334	Industrial Electrical Systems Lab	1	0	2	0
Open Elective 01						

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	303101346	Basic Aircraft Science	2	2	0	0
2	303104311	Disaster Preparedness and Planning	2	2	0	0
3	303105304	Cyber Security	2	2	0	0
4	303107346	Fundamentals of Communication Engineering	2	2	0	0
5	303105305	Internet of Things	2	2	0	0
6	303109346	Renewable Energy Sources	2	2	0	0
Semester 6						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
48	303106351	Power System-II	3	3	0	0
49	303106352	Power System-II Lab	1	0	2	0
50	303106354	Industrial Machines	3	3	0	0
51	303106355	Industrial Machines Lab	1	0	2	0
52	303106356	Minor Project	1	0	2	0
53	303193353	Employability Skills	1	0	0	1
54		Open Elective 02	2	2	0	0
55		Open Elective 03	3	3	0	0
56		PEC 02	3	3	0	0
57		PEC 02-LAB	1	0	2	0
58		PEC 03	3	3	0	0
59		PEC 03-LAB	1	0	2	0
Total			**22**	**16**	**10**	**1**
PEC 02						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106381	Electrical Machine Design	3	3	0	0

2	303106383	Electro Magnetic Waves	3	3	0	0
PEC 02-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106382	Electrical Machine Design Lab	1	0	2	0
2	303106384	Electro Magnetic Waves Lab	1	0	2	0
PEC 03						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106385	Power System Protection	3	3	0	0
2	303106387	HVDC Transmission System	3	3	0	0
PEC 03-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106386	Power System Protection Lab	1	0	2	0
2	303106388	HVDC Transmission System Lab	1	0	2	0
Open Elective 02						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303100351	Life Science	2	2	0	0
2	303100352	Biology for Engineers	2	2	0	0
3	303100353	Engineering Geology	2	2	0	0
4	303100354	Landscape Planning and Design	2	2	0	0
5	303100355	Fundamentals of Management	2	2	0	0
6	303100356	Corporate Social Responsibility	2	2	0	0
7	303100357	Innovation and Entrepreneurship	2	2	0	0
8	303100359	Cyber Law & Ethics	2	2	0	0
Open Elective 03						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**

1	303106353	Industrial Safety	2	2	0	0
Semester 7						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
60	303106401	Summer Internship - II	2	0	0	0
61	303106402	Project - I	6	0	12	0
62	303106403	Industrial Automation	3	3	0	0
63	303106404	Industrial Automation Lab	1	0	2	0
64		PEC 04	3	3	0	0
65		PEC 04-LAB	1	0	2	0
66		PEC 05	3	3	0	0
66		PEC 05-LAB	1	0	2	0
Total			**20**	**8**	**18**	**0**
PEC 04						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106431	Electrical Energy Conservation & Audit	3	3	0	0
2	303106433	Power System Dynamics & Control	3	3	0	0
3	303106435	Line-commutated and Active PWM Rectifiers & Inverters	3	3	0	0
4	303106437	Electrical Drives	3	3	0	0
PEC 04-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106432	Electrical Energy Conservation & Audit Lab	1	0	2	0
2	303106434	Power System Dynamics & Control Lab	1	0	2	0
3	303106436	Line-commutated and Active PWM Rectifiers & Inverters Lab	1	0	2	0

4	303106438	Electrical Drives Lab	1	0	2	0
PEC 05						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106439	Power System Operation & Control	3	3	0	0
2	303106441	Computational Electromagnetics	3	3	0	0
PEC 05-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106440	Power System Operation & Control Lab	1	0	2	0
2	303106442	Computational Electromagnetics Lab	1	0	2	0
Semester 8						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
67	303106451	Electrical Installation, Maintenance & Testing	3	3	0	0
68	303106456	Project - II	6	0	12	0
69	303106453	Power Quality & FACTs	3	3	0	0
70	303106454	Power Quality & FACTs Lab	1	0	2	0
71		PEC 06	3	3	0	0
72		PEC 06-LAB	1	0	2	0
Total			**17**	**9**	**16**	**0**
PEC 06						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106481	Wind and Solar Energy Systems	3	3	0	0
2	303106483	Electrical Hybrid Vehicles	3	3	0	0
3	303106485	Advanced Electrical Drives	3	3	0	0
4	303106487	Digital Signal Processing	3	3	0	0

5	303106489	Advance Controller	3	3	0	0
PEC 06-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303106482	Wind and Solar Energy Systems Lab	1	0	2	0
2	303106484	Electrical Hybrid Vehicles Lab	1	0	2	0
3	303106486	Advanced Electrical Drives Lab	1	0	2	0
4	303106488	Digital Signal Processing Lab	1	0	2	0
5	303106490	Advance Controller lab	1	0	2	0
Total			**167**			

8. Detailed Syllabus

Semester 1

a. **Course Name:** Basic Electrical Engineering

b. **Course Code:** 303106101

c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level

d. **Rationale:** Basic Electrical Engineering knowledge is fundamental as it provides a strong foundation for various engineering disciplines, promotes problem-solving skills, supports innovation, and opens doors to diverse career opportunities.

e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLOBJ 2	Solve problems related to Alternating current, alternating voltage, etc, Demonstrate a clear understanding of Pure R, L C circuit and combination of RLC, Series and Parallel combination of R, L and C, etc
CLOBJ 3	Acquire knowledge of the resistor, capacitor, and inductor and their performance characteristics for series and parallel connections.
CLOBJ 4	Understand different single phase and three phase circuits.
CLOBJ 5	Demonstrate a clear understanding of the basic concepts, working principles and applications of transformer, DC machines and AC machines.
CLOBJ 6	Study the use of LT SwitchGear, Fuse, MCB, ELCB etc

f. **Course Learning Outcomes:**

CLO 1	Understand electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLO 2	Solve basic electrical circuit problems using various laws and theorems
CLO 3	Understand the role of resistor, capacitor and inductor and their performance characteristics for series and parallel connections.
CLO 4	Discuss three phase balanced circuits.
CLO 5	Understanding the basic concepts and working principles of transformers, DC machines and AC machines.
CLO 6	Acquire knowledge about electrical installations

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	2	4	20	20	20	60	30	150

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**DC Circuits** Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff current and voltage laws, Mesh and Node analysis, Simplifications of networks using series and parallel combinations and star-delta conversions. Superposition, Thevenin and Norton Theorems.	22%	10
2	**AC Circuits** Sinusoidal voltages and currents, their mathematical and graphical representation, Concept of instantaneous, peak (maximum), average and R.M.S. values, frequency, cycle, period, peak factor and form factor, phase difference, lagging, leading and in phase quantities and phasor representation. Rectangular and polar representation of phasors, examples based on theory. Study of A.C. circuits consisting of pure resistance, pure inductance, pure capacitance and corresponding voltage-current phasor diagrams and waveforms. Development of the concept of reactance, the study of series R-L, R-C, R-L-C circuit and resonance, study of parallel R-L, R-C and R-L-C circuit, concept of impedance, admittance, conductance and susceptance in case	33%	15

Sr. No.	Content	Weightage	Teaching Hours
	of above combinations and relevant voltage-current phasor diagrams, the concept of active, reactive and apparent power and power factor, examples based on theory. Concept of three-phase supply and phase sequence. Voltages, currents and power relations three-phase have balanced star-connected loads and delta-connected loads along with phasor diagrams, Power and power factor measurement in balanced three-phase circuits (one, two and three wattmeter methods), examples based on theory.		
3	**Transformers** Magnetic effect of an electric current, right-hand thumb rule, Concept of m.m.f., flux, flux density, reluctance, permeability and field strength, their units and relationships, comparison between electrical and magnetic parameters. Fleming's left-hand rule. self and mutual inductance, Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.	20%	9
4	**Electrical Machines** Construction, working and application of DC Motor and Generator. Generation of 3 phase rotating magnetic fields, Construction and working of a three-phase and Single phase induction motor and its types. Construction and working of Synchronous generators.	15%	7
5	**Electrical Installations** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries.	10%	4

i. Text Book and Reference Book:

1. Electrical Engineering Fundamentals, by V. D. Toro, Prentice Hall India, Pub. Year 1989
2. Basic Electrical Engineering, by D. C. Kulshreshtha, McGraw Hill, Pub. Year 2009
3. Fundamentals of Electrical Engineering, by Leonard S. Bobrow, Oxford University Press, Pub. Year 1996
4. Electrical and Electronics Technology, by E. Hughes Pearson, Pub. Year 2010
5. Basic Electrical Engineering, by D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, Pub. Year,

2010

6. A textbook of Electrical Technology Volume 1&2, by B. L. Theraja, S. Chand Publication

j. List of Experiments:

Sr. No.	Experiment List
1	To Study about Various Electrical and Electronics Symbols and demonstrate various measuring instruments used in Basic electrical Engineering laboratory
2	To Perform and Solve Electrical Networks with Series and Parallel Combinations of Resistors Using Kirchhoff ’s Laws
3	To Obtain Inductance, Power and Power Factor of the Series RL Circuit With AC Supply Using Phasor Diagram.
4	To Obtain Capacitance, Power and Power Factor of the Series RC Circuit With AC Supply Using Phasor Diagram.
5	To Obtain Inductance, Capacitance, Power and Power Factor of the Series R-L-C Circuit With AC Supply Using a Phasor Diagram.
6	Verification of superposition theorem with dc source
7	Verification of Thevenin's theorem with dc source
8	Verification of Norton's theorems in dc circuits.
9	Verification of Current and Voltage Relations in Three Phase Balanced Star and Delta Connected Loads.
10	Find out the Efficiency and Voltage Regulation of Single Phase Transformer by Direct Load Test.

a. Course Name: Programming for Problem Solving

b. Course Code: 303105102

c. Prerequisite: Requires Basic Knowledge of Computer

d. Rationale: This course is designed to provide basic ideas of computer programming. This course also helps to understand programming languages. It will help to develop their logical abilities.

e. Course Learning Objective:

CLOBJ 1	Recognize and recall fundamental principles and organizations of computers, demonstrating a foundational understanding of computer architecture and design.
CLOBJ 2	Comprehend the concepts of computer programming languages, illustrating a grasp of syntax, semantics, and the essential components of programming languages.
CLOBJ 3	Develop algorithms for solving basic engineering problems, demonstrating the ability to apply theoretical knowledge to practical problem-solving scenarios.
CLOBJ 4	Demonstrate proficiency in the practical application of C programming by writing, compiling, and debugging programs, showcasing the ability to implement and troubleshoot code effectively.
CLOBJ 5	Evaluate and analyse complex computational programs written in C, demonstrating the capacity to assess and understand intricate solutions to computational challenges.
CLOBJ 6	Develop simple projects using the C programming language, showcasing creativity and application of learned principles to produce functional and practical software solutions.

f. Course Learning Outcomes:

CLO 1	Recognize the computer's basic principles and organizations.
CLO 2	Understand Concepts of Computer Programming Language.
CLO 3	Develop the algorithm for solving basic Engineering Problems.
CLO 4	Write, Compile and debug program with C Programming.
CLO 5	Analyse the Solved, Complex Computational Program written in C.
CLO 6	Develop simple projects using C Language.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	2	4	20	20	20	60	30	150

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Topics	Weightage	Teaching Hours
1	Number System: Introduction and type of Number system, Conversion between number system, Arithmetic operations on number system, Signed and unsigned number system Software, Computer Languages and Computer Program	2%	3
2	Introduction to 'C' Programming: Features of C language, structure of C Program, Flow Charts and Algorithms Types of errors, debugging, tracing/stepwise execution of program, watching variables values in memory.	3%	3
3	Constants, Variables and data Types: Character Set, C tokens, Keywords and Identifiers, Constants, Variables, Data types, Declaration of Variables, Assigning values to variables, typedef, and Defining symbolic constants.	5%	2
4	Operators and Expression: Introduction to Operators and its types, Evaluation of expressions, Precedence of arithmetic operators, Type conversions in expressions, Operator precedence and associativity.	10%	3
5	Management Input and Output Operators: Introduction, reading a character, writing a character, formatted input, formatted	5%	2

Sr. No.	Topics	Weightage	Teaching Hours
	output.		
6	Control structure in C: Decision Making & branching: Decision making with If &If Else statements, If Else statements (Nested .... Ladder), The Switch &goto statements, The turnery (?:) Operator Looping: The while statement, The break statement & The Do.. While loop, The FOR loop, Jump within loops – Programs	15%	4
7	Array: Introduction, One-dimensional arrays, Two-dimensional arrays, arrays, Concept of Multidimensional arrays.	10%	4
8	String: string , string storage , Built-in-string functions	10%	3
9	User-Defined Functions: Concepts of user defined functions, prototypes, definition of function, parameters, parameter passing, calling a function, recursive function, Macros, Pre-processing.	10%	5
10	Structure and Unions: Introduction, Structure definition, declaring and initializing Structure variables, Accessing Structure members, Copying & Comparison of structures, Arrays of structures, Arrays within structures, Structures within Structures, Structures and functions, Unions	10%	5
11	Pointers: Basics of pointers, pointer to pointer, pointer and array, Pointer to array, array of pointers , functions returning a pointer	10%	5
12	Dynamic memory allocation: Introduction to Dynamic memory allocation, malloc(), calloc(), free(), realloc()	5%	2
13	File Management in C:Introduction to file management and its functions	5%	1

i. Text Book and Reference Book:

1. Programming in ANSI C (TextBook), by E. Balaguruswamy , Tata McGraw-Hill
2. C Programming: Test Your Skills, by Ashok Kamthane

3. Computer Fundamentals, by P.K.Sinha and Priti Sinha , BPB Publications , 4th Edition
4. Star C Programming, STAR Certification , C Certification Exam
5. Programming with C, by byron Gottfried , Tata McGraw Hill Education
6. C The Complete Reference, by Herbert Schildt
7. Let Us C, by Yeshavant Kanetkar , BPB Publications

j. Experiment List

Sr. No.	Experiment List
1	Write a program to print HELLO FRIENDS!
2	Write a program that reads two nos. from keyboard and gives their addition, subtraction, multiplication, division and modulo.
3	Write a program to calculate the area of a circle,use Ω as symbolic constants.
4	Write a program to convert days into months and days.
5	Write a program which calculates the summation of three digits from the given 3 digit number.
6	Write a program to demonstrate enumerated data types.
7	Write a program to compute Fahrenheit from centigrade.
8	Write a program to calculate simple interest. Read the price of the item in decimal form e.g. 12.50 and separate Rs and Paise from the given value e.g. 12 rupees and 50 paise.
9	Write a program to find the largest of the three nos. using a Nested-If-Else statement.
10	Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol.
11	Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol.
12	Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol.
13	Write a program to read marks from keyboard and your program should display equivalent grade according to following table. Marks Grade 100-80 Dist 60-79 First Class

Sr. No.	Experiment List
	Second Class
14	Write a program to read marks of a student from keyboard whether the student id pass (if).
15	Write a program to find the sum of first N odd numbers.
16	Write a program using a while loop construct which finds the factorial of a given integer number.
17	Write a C program using do«while and for loop constructs to reverse the digits of the number.
18	Write a program to demonstrate use of Switch- Break Statement.
19	Write a program to find out all the numbers divisible by 5 and 7 between 1 to 100.
20	Check for Armstrong number. A number is Armstrong if sum of cube of every digit is same as the original number. E.g. 153=13+53+33=153
21	Write a program to print the output of bellow series. 1!+2!+3!+4!+..... n!
22	Write a program to print the following outputs using for Loop. 1 * 12 ** 123 ***
23	Write a program to print the following outputs using for Loop. (a) 1 (b) 321 21 21 321 1
24	Write a program which sorts 10 numbers into ascending order.
25	Write a program to find the maximum element from a 1-D array.
26	Write a program to find the number of odd and even elements from the 1-D array.
27	Write a program to add two 2x2 matrices.
28	Write a program to count the number of positive, negative and zero elements from a 3x3 matrix.
29	Write a function for the following operations on string: Copy one string to another Comparing two strings Adding a string to the end of another.

Sr. No.	Experiment List
30	Write a program to count vowels from an entered String.
31	Write a program which finds whether a string is a palindrome or not.
32	Write a program to find the factorial of a number using recursion.
33	Write a program that uses the user defined function Swap ( ) and interchange the value of two variables.
34	Write a function to return 1 if the number is prime otherwise return 0.
35	Define a structure type, personal that would contain a person name, date of joining and salary.
36	Define a structure called cricket that will describe the following information: Player name Team name Batting average
37	Write a program to add two numbers using pointers.
38	Write a program to swap two numbers using pointer
39	Write a program to illustrate reading files contents.
40	Write a program to illustrate the use of fgets( )

a. **Course Name:** Engineering Graphics

b. **Course Code:** 303109101

c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level

d. **Rationale:** **"**Engineering Graphics" course Provide students with a comprehensive foundation in the fundamental principles and concepts that form the backbone of mechanical engineering for various Engineering disciplines.

e. **Course Learning Objective:**

CLOBJ 1	Identify and name common drafting tools and their uses.
CLOBJ 2	Interpret engineering drawings and symbols.
CLOBJ 3	Demonstrate the ability to create accurate engineering drawings using industry-standard software.
CLOBJ 4	Solve engineering design problems by applying geometric and spatial concepts.
CLOBJ 5	Generate accurate and professional engineering drawings independently.
CLOBJ 6	Design and create 3D models of engineering components using computer-aided design (CAD) tools.

f. **Course Learning Outcomes:**

CLO 1	Identify and recall common drafting tools and their uses.
CLO 2	Interpret and explain engineering drawings and symbols.
CLO 3	Demonstrate the application of industry-standard software to create accurate engineering drawings.
CLO 4	Solve engineering design problems by applying geometric and spatial concepts.
CLO 5	Generate accurate and professional engineering drawings independently.
CLO 6	Design and create 3D models of engineering components using computer-aided design (CAD) tools.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	

2	**0**	**2**	**4**	**20**	**20**	**20**	**60**	**30**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION TO ENGINEERING GRAPHICS Scope of Engineering Drawing in all Branches of Engineering, Uses of Drawing Instruments and Accessories, Introduction to Drawing Standards BIS-SP-46, Representative Fraction, Types of Scales (Plain and Diagonal Scale), Dimensioning Terms and Notations, Types of Arrowheads, Lines, Lettering, Numbering and Dimensioning	5%	0
2	ENGINEERING CURVES: Classification of Engineering Curves, Application of Engineering Curves, Constructions of Engineering Curves - Conics, Spirals, Involutes and Cycloids with Tangents and Normal	10%	5
3	PRINCIPLES OF PROJECTIONS: Types of Projections - Oblique, Perspective, Orthographic and Isometric Projections; Introduction to Principal Planes of Projections, Projections of Points located in all four Quadrants; Projections of lines inclined to one of the Reference Plane and inclined to two Reference Planes.	10%	4
4	PROJECTIONS OF PLANES: Projections of various planes – Polygonal, Circular and Elliptical shape inclined to one of the Reference Plane and inclined to two Reference Planes; Concept of Auxiliary Plane of Projections.	10%	4
5	PROJECTIONS OF SOLIDS AND SECTIONS OF SOLIDS: Classifications of basic Solids, Projections of Solids - Right Regular Prism, Pyramid, Cone, Cylinder, Tetrahedron and Cube inclined to one of the Reference Plane and inclined to two Reference Planes; Frustum of Prism, Pyramid and Cone inclined to one of the Reference Plane; Types of Cutting Planes - Auxiliary Inclined Plane, Auxiliary Vertical Plane, Horizontal Cutting Plane, Profile Cutting Plane; Sections of Solids resting	20%	10

Sr. No.	Content	Weightage	Teaching Hours
	on H.P/V.P and Inclined to only one of the Reference Planes; Sectional Views, True Shape of the Sections		
6	DEVELOPMENT OF SURFACES: Methods of Development of Lateral Surfaces of Right Regular Solids, Parallel Line Development and Radial Line Development, Applications of Development of Surfaces.	10%	5
7	ORTHOGRAPHIC PROJECTIONS: Projections on Principal Planes from Front, Top and Sides of the Pictorial view of an Object, First Angle Projection and Third Angle Projection method; Full Sectional Orthographic Views – Side and Front, Offset Cutting views	15%	0
8	ISOMETRIC VIEW/DRAWING AND ISOMETRIC PROJECTIONS: Conversion of Orthographic Views into Isometric Projection, View or Drawing; Isometric Scale.	15%	0
9	OVERVIEW OF COMPUTER AIDED DRAFTING TOOL: Introduction to Computer Aided Drafting Software; Preparation of Orthographic Projections and Isometric Views Using Drafting Software	5%	0

i. Text Book and Reference Book:

1. Engineering Drawing N.D. Bhatt & V.M. Panchal; Charotar Publishing House
2. ENGINEERING GRAPHICS P. J. Shah; S. Chand & Co., New Delhi Publications.
3. Graphic Science and Design French, T.E. Vierck, C.J & Foster; Tata McGraw Hill Publications.
4. Fundamentals of Engineering Drawing Luzadder; W. J & Duff Prentice Hall Publications.
5. Engineering Drawing and Graphics Venugopal k; New Age International Private Limited Publishers.

j. Experiment List:

Sr. No.	Experiment List

1	Introduction to Engineering Graphics: Types of lines, Letterings, Drawing Symbols, Numberings, Dimensioning Terms and Notations, Title Block, Geometric Constructions etc.
2	Drawing Sheet on Engineering Curves.
3	Drawing Sheet on Projections of Points and Lines.
4	Drawing Sheet on Projections of Planes.
5	Drawing Sheet on Projections of Solids and Sections of Solids.
6	Drawing Sheet on Development of Surfaces.
7	Drawing Sheet on Orthographic Projections.
8	Drawing Sheet on Isometric Projection/View or Drawing.
9	Prepare 2D Drawings using AutoCAD.
10	Prepare Isometric Views using AutoCAD.

a. **Course Name:** Mathematics-I

b. **Course Code:** 303191101

c. **Prerequisite:** Knowledge of Mathematics up to 12th science level

d. **Rationale**: The Mathematics I syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and matrix algebra, preparing students for engineering challenges with optimized problem-solving skills.

e. **Course Learning Objective:**

CLOBJ 1	Develop a comprehensive understanding of definite and improper integrals, including the application of integration techniques to find areas and volumes in both Cartesian and Polar coordinates.
CLOBJ 2	Utilize differential equations to model and solve practical scenarios, demonstrating proficiency in various solution techniques.
CLOBJ 3	Analyse the convergence and divergence of sequences and series, employing tests such as the Alternating Series Test and Ratio Test
CLOBJ 4	Analyse matrix operations and determinants, exploring their properties and applications in solving systems of linear equations.
CLOBJ 5	Apply Fourier series for representing periodic functions, verifying Dirichlet's conditions.
CLOBJ 6	Solve optimization problems using multivariable calculus concepts, such as Lagrange's multiplier.

f. **Course Learning Outcomes:**

CLO 1	Develop understanding of fundamental mathematical concepts
CLO 2	Formulate and solve mathematical models for real-world engineering problems,
CLO 3	Integrate knowledge from different mathematical topics to analyze and solve complex engineering problems
CLO 4	Critically analyze mathematical results, interpret their engineering significance, and make informed decisions based on mathematical outcomes, fostering a deeper understanding of the subject.
CLO 5	Clearly and effectively communicate mathematical ideas, solutions, and reasoning, both in written and oral formats, demonstrating effective communication skills.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Improper Integral & Application of Definite Integral: Evaluation of definite and improper integrals, Beta and Gamma functions and their properties Area bounded by curves in Cartesian and Polar form, Area of a region bounded by function, Area of a region bounded by curves in Parametric form, Volume by slicing, Volume of solid by revolution.	8%	5
2	First order Ordinary Differential equation: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type, Applications	15%	9
3	UNIT 3 Matrices: Matrices & Determinants with Properties, Linear Independence, Rank of Matrix, System of Linear Equations, Consistency of System, Solution of system of Linear Equations by Gauss Jordan and Gauss-Elimination Method, Eigenvalues, Eigenvectors, Symmetric, Skew-symmetric, and orthogonal Matrices, Eigen bases, Diagonalization, Cayley Hamilton Theorem and its Applications, Diagonalization, Orthogonal Transformation, Quadratic form.	25%	15
4	Sequences and Series: Basic of Sequences, Bounded and Monotonic Sequences, Series, Convergence of sequence and series, Geometric series, P- series, Cauchy's Integral Test, Comparison Test, Alternating Series, Absolute and	17%	10

	Conditional convergence, Ratio test, Cauchy's Root Test, Power series, Taylor's and Maclaurin's series.		
5	Fourier Series: Fourier Series of 2 periodic functions, Dirichlet's conditions for representation by a Fourier series, Fourier Series of a function of period 2, Fourier Series of even and odd functions, Half range series.	10%	6
6	Multivariable Calculus (Differentiation): Functions of Several Variables, Limit, Continuity, Partial Derivatives, Homogeneous function, Euler's Theorem for homogeneous function, Modified Euler's Theorem, Chain Rule, Implicit function, Jacobian, Tangent plane and Normal line, Maximum and Minimum Values, Lagrange's Multiplier, Taylor's and Maclaurin's Series for functions of two variables.	25%	15

i. Text Book and Reference Book:

1. Calculus and Analytic Geometry (TextBook), by G.B. Thomas and R.L. Finney, Addison Wesley
2. Calculus with early transcendental functions, by James Stewart, Cengage Learning
3. Higher Engineering Mathematics, by B. S. Grewal, Khanna Publications
4. Elementary Linear Algebra (TextBook), by Howard Anton, Chris Rorres, Wiley India Edition, 9th Edition
5. Advanced Engineering Mathematics (TextBook), by Erwin Kreyszig, Wiley India Education
6. A textbook of Engineering Mathematics, by N.P. Bali and Manish Goyal, Laxmi Publications

a. **Course Name:** Engineering Physics-II

b. **Course Code:** 303192102

c. **Prerequisite:** Knowledge of Physics and some basic concepts in Mathematics like differentiation, integration, limit, differential equation, vector calculus up to 12^{th} science level.

d. **Rationale**: Knowledge of physics is essential for all Engineering branches because physics is the foundation subject of all the branches of engineering and it develops the scientific temperament and analytical capability of engineering students. Comprehension of basic physics concepts enables the students to solve engineering problems logically and develop scientific approaches.

e. **Course Learning Objective:**

CLOBJ 1	Understand the basics of quantum mechanics, including Schrödinger's equations and the physical significance of wave functions..
CLOBJ 2	Apply the Schrödinger equation to analyze particles in one-dimensional potential boxes, emphasizing practical implications and tunneling effects.
CLOBJ 3	Master concepts of energy bands, semiconductor classification, E-k diagrams, and semiconductor device analysis including P-N junction diodes.
CLOBJ 4	Comprehensively understand material classification, focusing on magnetic materials, nanomaterials, and analyzing physical, thermal, electrical, optical, and magnetic properties.
CLOBJ 5	Gain expertise in laser principles, types, and applications, as well as fiber optics principles and applications. Understand optoelectronic devices, their functionalities, and practical applications.

f. **Course Learning Outcomes:**

CLO 1	Formulate and conceptualize various theoretical aspects and the physical phenomena at atomic level
CLO 2	Analyse the optical transition processes in semiconductors and identify the materials useful in optoelectronic devices.
CLO 3	Understand the fabrication and applications of low dimensional semiconductor devices.
CLO 4	Acquire proficiency in experimental techniques used for studying nanoscale systems, including microscopy and spectroscopy.
CLO 5	Master the principles of quantum mechanics and their application to nanoscale systems.

g. Teaching Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	2	4	20	20	30	60	20	150

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I: Modern Physics Introduction about quantum Mechanics, Schrodinger's equations, Time dependent and Time Independent Wave Equation, Physical Significance of the wave Function, Application of Schrodinger equation in particles in One Dimensional Potential Box and Tunneling effects.	20%	9
2	UNIT-II: Band theory & Semiconductors Energy bands in solids, Classification of Materials into, Semiconductors & Insulators, Density of state, E-k diagram, Kronig-Penny model (to introduce origin of band gap), Effective mass. Direct and indirect band gap. Carrier Concentration in semiconductors, Fermi Level inIntrinsic and Extrinsic Semiconductors, P-N junction diode, Ohmic and Schottky Junction.	20%	9
3	UNIT-III: Materials Classification of materials: Magnetic materials, Nanomaterials based on semiconductors and metal oxides, Basic characteristic properties of nanomaterials, Novel Materials. Physical, Thermal, Electrical, Optical and Magnetic properties of materials.	20%	9

4	UNIT-IV: Laser and Fiber Optics Lasers: Interaction of radiation with Matter, Absorption, Spontaneous and Stimulated emission, Characteristics of Lasers, Types of Lasers: Ruby Laser, Helium-Neon Laser, Semiconductor Diode Laser, Applications of Lasers. Fiber Optics: Principle and Structure of Optical Fiber, Numerical Aperture of fiber, Types of Optical Fibers, Attenuation in Optical Fibers, Applications of Optical Fibers.	20%	9
5	UNIT-V: Devices Optoelectronic Devices: Photoconductive cell, photovoltaic cell, Photodiode, Phototransistor, LED, IR emitters, Opto coupler, X-ray diffractometer, Quantum devices and their applications.	20%	9

i. Text books:

1. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., (2007)
2. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995)
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4. Engineering Physics — HK Malek and A. K. Singh- McGraw Hill Publication
5. Semiconductor Optoelectronic Devices- P. Bhattacharya-Prentice Hall of India
6. Fundamentals of Physics- Halliday, Resnick and Walker

j. Experiment List

Sr. No.	Experiment List
1	Determination of Velocity of ultrasonic waves in water.
2	Determination of Dielectric constants of Dielectric samples.
3	Measurement of Band gap of semiconductor material.
4	Measurement of Planck's constant using LED.
5	Measurement of wavelength of laser light using diffraction grating.
6	Measurement of Numerical aperture of an optical Fiber.
7	Determine Moment of Inertia of a flywheel.
8	Measurement of power loss in an optical fibre.
9	Measurement of the size of a Lycopodium powder.

a. **Course Name:** Communication Skill

b. **Course Code:** 303193103

c. **Prerequisite:** Knowledge of English Language studied till 12th standard

d. **Rationale:** : Basic Communication Skills are essential for all Engineers.

e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLOBJ 2	Solve problems related to Alternating current, alternating voltage, etc, Demonstrate a clear understanding of Pure R, L C circuit and combination of RLC, Series and Parallel combination of R, L and C, etc
CLOBJ 3	Acquire knowledge of the resistor, capacitor, and inductor and their performance characteristics for series and parallel connections.
CLOBJ 4	Understand different single phase and three phase circuits.
CLOBJ 5	Demonstrate a clear understanding of the basic concepts, working principles and applications of transformer, DC machines and AC machines.
CLOBJ 6	Study the use of LT SwitchGear, Fuse, MCB, ELCB etc

f. **Course Learning Outcomes:**

CLO 1	Understand the importance of creative and critical thinking.
CLO 2	Expand vocabulary with proper pronunciation.
CLO 3	Comprehend the basics of English grammar.
CLO 4	Read & write effectively for a variety of contexts.
CLO 5	Develop confidence in speaking skills.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**2**	**0**	**2**	**-**	**100**	**-**	**-**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**-

Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Crazy Scientist: The students will be taught the importance of invention and innovation using some examples that changed the world the way it worked.	5%	2
2	Phonetics: • IPA Introduction (listening tracks) • Phonic Sounds • Pronunciation Practice including transcription	10%	4
3	Vocabulary Building & Word Formation Process: • Compounding, clipping, blending, derivation, creative respelling, coining and borrowing • Prefixes & suffixes, synonyms & antonyms, standard abbreviations (related activities will be provided)	10%	2
4	Speaking Activity : Role play on Critical Thinking (Life boat) • This activity topic gears towards making students do role play based on various scenarios. • It involves giving them a scenario and asking them to further develop the idea in a very interesting manner, then going on to enact it. • It aims to improve students' convincing skills.	10%	4
5	Picture Description & Picture Connector • Enable students to use vocabulary and useful expressions to describe the picture. • In this class the students will be trained to form logical connections between a set of pictures which will be shared with them. • This is geared towards building creativity and presentation skills.	15%	2
6	Mine Activity: Usage of Preposition: • Students will learn to use proper prepositions by active participation in the activity.	8%	2

Sr. No.	Content	Weightage	Teaching Hours
7	Worksheets on Identifying Common Errors in Writing:: • Sentence structure • Punctuations • Subject-Verb Agreement • Noun-Pronoun Agreement	12%	2
8	Reading Skills: • The art of effective reading and its various strategies to be taught to the learners and practice exercises be given on reading comprehension.	10%	2
9	Speech and spoken Exchanges; Extempore: • Students will learn the correct usage of spoken language as different from the written form. It will help the students in extempore speech. • This will be done by making the students give a variety of impromptu speeches in front of the class: 1 minute talk on simple topics. • To change the average speakers in the class to some of the best Orators.	10%	4
10	Book Review: • The learners will identify the central idea of the book, author's style and approach towards the book. • This will enable the learners to express their point of view and hone their creativity and writing skills.	10%	4
11	Activity Session • This will enhance the creative thinking among students. • To develop their interpersonal communication skills.	0%	2

i. Reference Books:

1. Understanding and Using English Grammar Betty Azar & Stacy Hagen; Pearson Education
2. Business Correspondence and Report Writing SHARMA, R. AND MOHAN, K.
3. Communication Skills, Kumar S and Lata P; New Delhi Oxford University Press
4. Technical Communication : Principles And Practice, Sangeetha Sharma, Meenakshi Raman; Oxford University Press

5. Practical English Usage MICHAEL SWAN, A Remedial English Grammar for Foreign Student F.T. WOOD
6. On Writing Well. William Zinsser; Harper Paperbacks, 2006; 30th anniversary edition
7. Oxford Practice Grammar,John Eastwood; Oxford University Press

Semester-2

a. Course Name: Environmental Science

b. Course Code: 303104105

c. Prerequisite: Knowledge of Physics, Chemistry and Mathematics up to 12th science level and Biology up to 10th science level

d. Rationale: Basic knowledge of the environment is essential for all human beings for a good life and sustainable existence

e. Course Learning Objective

CLOBJ 1	Apply systems thinking to analyze the city as a system, demonstrating application
CLOBJ 2	Evaluate the role of smart citizens and approaches for citizen engagement
CLOBJ 3	Identify sources and stressors of water resources, demonstrating understanding
CLOBJ 4	Analyze the causes, effects, and control measures of population explosion

f. Course Learning Outcomes:

CLO 1	Understand the interrelation and interdependence of organisms and their interactions with the environment
CLO 2	Identify eco-friendly measures in engineering projects
CLO 3	Understand preventive steps for environmental protection.
CLO 4	Act as a responsible individual who is aware of efficient usage of resources and securing sustainable development

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
1	**0**	**0**	**Audit**	**-**	**50**	**-**	**-**	**-**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**ENVIRONMENTAL HEALTH, ECOLOGY AND QUALITY OF LIFE** Environmental education: Objective and scope, Impact of technology on the environment, Environmental disasters: Case studies, Global environmental awareness to mitigate stress on the environment, Structure and function of an ecosystem, Ecological pyramids, Pyramid of number, Pyramid of energy and pyramid of biomass.	25%	7
2	**POLLUTION PREVENTION** Air & Noise pollution - Sources & their Effects, Case studies of Major Catastrophes, Structure and composition of the atmosphere, Water, Soil, Marine, Thermal & Marine Pollution: The story of fluoride contamination, Eutrophication of lakes, control measures, Measuring water quality: Water quality index, Waste water treatment (general) primary, secondary and tertiary stages, Municipal Solid waste management: Sources and effects of municipal waste, Biomedical waste, Hazardous waste	20%	6
3	**POPULATION GROWTH, GLOBAL ENVIRONMENTAL CHALLENGES & LATEST DEVELOPMENTS** Population Explosion - Causes, Effects and Control, an International initiative in population-related issues, Urbanization, Growth of the world's large cities, Water resources: Sources of water, Stress on water resources, Climate Change, Global Warming and GreenHouse Effect, Acid Rain, Depletion of Ozone layer, Variation in concentrations of GHG gases in ambient air during last millennium, Role of Environmental Information System (ENVIS) in India and similar programs run by EPA(USA), Role of soft tools like Quantum GIS, Autodesk Building Information Modeling (BIM) and City Finance Approach to Climate-Stabilization Targets (C- FACT), Life Cycle Assessment, Bioinformatics and Optimization tools for sustainable development.	25%	7
4	**SMART CITIES** Introduction to smart cities - about smart cities, what is a smart city, world urbanization, case studies of Songdo, Rio De	30%	10

Sr. No.	Content	Weightage	Teaching Hours
	Janeiro, what makes cities smart. City as a system of systems – Introduction, systems thinking, Milton Keynes Future Challenges, Rich picture as city challenges, Wicked problems, Development of smart city approach – core elements, open data, sustainability, privacy and ethics, development processes. Smart Citizens – their role, engaging citizens, IES Cities, Energy systems, Approaches for Citizen Engagement, co-creating smart cities, cities unlocked, living labs, city problems, crowdsourcing ideas, redesigning cities for citizens, all age-friendly cities, mobility on demand, motion maps, Infrastructure, Technology and Data – urban infrastructure and its technology, future of lighting, IoT, connected objects, sensing the city, NOx eating paints and air quality sensors, safest, smart citizen kit, sensing your city, Sensored City, Cyber security for data power, open, shared and closed data, satellite data, open data revolution, Smart City Project Data Innovation – smart innovations, smart city ecosystem, data-driven innovations for smart cities Standards and Capacity Building – the role of Standard, BSI smart city Standards, HyperCat, ITU Smart Sustainable cities, Smart City Readiness, Lessons Learnt from Amsterdam Smart Measurements - metrics and indicators, city indicators, WCCD data portal, value proposition, integrated reporting, smart city learning and education, urban data school.		

i. Text Book and Reference Book:

1. Textbook of Environmental Studies For Undergraduate Courses (TextBook), by Dr Erach Bharucha, Orient BlackSwan, Second Edition, Pub. Year 2013
2. Basics of Environmental Studies, by U K Khare, Tata McGraw Hill
3. Environmental Studies, by Anindita Basak, Dorling Kindersley(India)Pvt. Ltd Pearson
4. Environmental Sciences, by Daniel B Botkin & Edward A Keller, John Wiley & Sons
5. Air Pollution, by M N Rao , H .V N Rao, McGraw Hill Publishing Company Limited, New Delhi
6. Environmental Engineering, by Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, McGraw-Hill

a. **Course Name:** Digital Electronics Circuits

b. **Course Code:** 303106151

c. **Prerequisite:** Basic Electronics or Analog Electronic Circuits.

d. **Rationale:** Digital circuits are part of any electronic design today. This also happens to be one of the core subjects for the undergraduate students in Electronics, Electrical and Computer Engineering. It forms the basis of many of the next level courses. The proposed course on digital circuits will cover all the fundamental concepts in digital design.

e. **Course Learning Objective:**

CLOBJ 1	Understand binary systems, logic gates, and Boolean algebra in digital electronics.
CLOBJ 2	Design and analyze combinational and sequential logic circuits using various components.
CLOBJ 3	Perform binary arithmetic operations and grasp the principles of signed number representation.
CLOBJ 4	Explore processor architecture, digital communication principles, and gain proficiency in industry-standard design tools
CLOBJ 5	Develop digital systems using hardware description languages, focusing on optimization and efficient design practices.
CLOBJ 6	Describe characteristics of RAM, ROM, and EEPROM, and design basic memory circuits.

f. Course Learning Outcomes:

CLO 1	Acquire an idea about digital electronics and its applications.
CLO 2	To learn the fundamentals of number systems and codes and code conversion techniques.
CLO 3	To study about the Boolean algebra and basic logic gates along with their digital design procedure using elementary logic gates.
CLO 4	To learn about the different combinational and sequential logic circuits and their use in digital electronics applications.
CLO 5	To learn various types of components-ADC and DAC, and also the different logic families involved in the digital system.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**2**	**4**	**20**	**20**	**20**	**60**	**30**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Number Systems and Codes** Decimal Number System, Binary Numbers System, Octal Number System, Hexadecimal Numbers System, Numbers Conversions, Gray Code, Excess-3 Code, BCD Code, Hamming Code, Code Conversion, BCD to 7-Segment Decoder: Error Detection and Correction Codes - error detection by parity checking, Principle of error correction	**16%**	**7**

Sr. No.	Content	Weightage	Teaching Hours
2	**Boolean Algebra and Logic Gates** Binary arithmetic, Binary Addition, Binary Subtraction, Binary Multiplication, Binary Division, 1's Complement, 2's Complement, Signed Binary Number. Introduction to Logic Gates, Basic Logic Gate Operations, Universal Gates, Realization of logic gates using switches. Demorgan's Theorem, SOP/POS forms, Minimization of logical function, Algebraic method, Karnaugh Map method.	**22%**	**10**
3	**Combinational Circuits** Half and full adder; half and full subtractor, n- bit comparator, parity bit generator and parity bit checker, code converter, encoders and decoders, multiplexers and de-multiplexers.	**18%**	**8**
4	**Sequential Circuits** Basic storage elements, Latches (SR, D, JK), Flip Flops (JK, T, D), Counters, Asynchronous and synchronous counter designs, registers and various types of registers	**22%**	**10**
5	**A/D & D/A Converter** Need for Data conversion, Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), and data conversion and acquisition techniques	**11%**	**5**
6	**Logic family** Integrated Circuits, Characteristics of digital circuits, Logical Families, Digital IC terminology, Diode Logic (DL), Resistor Transistor Logic (RTL), Diode Transistor Logic (DTL), and Transistor Transistor Logic (TTL).	**11%**	**5**

i. Text Book and Reference Book:

1. Fundamentals of Digital Circuits by Anand Kumar, Prentice-Hall of India Private Limited, New Delhi (2006)
2. Digital Logic and Computer Design by Morris Mano, Prentice-Hall of India Private Limited, New Delhi (2006)
3. Digital Fundamentals by Thomas L Floyd, Pearson
4. DIGITAL ELECTRONICS by G.K. Kharate, Oxford, Pub. Year 2010

a. **Course Name:** Basic Electronics

b. **Course Code:** 303107151

c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level

d. **Rationale:** The course provides introductory treatment of the field of Basic of Electronics to the students of various branches of engineering.

e. **Course Learning Objective:**

CLOBJ 1	To study basics of semiconductor & devices and their applications in different areas.
CLOBJ 2	Compare design issues, advantages, disadvantages and limitations of basic electronics components.
CLOBJ 3	To study and analyze different biasing techniques to operate transistor.
CLOBJ 4	Study the DC regulated power supply with different voltage regulator ICs.
CLOBJ 5	Study the use of sensors and transducers.

f. **Course Learning Outcomes:**

CLO 1	Ability to analyze PN Junctions diode under various conditions.
CLO 2	Ability to describe the behavior of special purpose diodes.
CLO 3	Ability to design and analyze BJT under various conditions.
CLO 4	Ability to design voltage regulators for various applications.
CLO 5	To understand fundamentals of sensors and transducers

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**2**	**4**	**20**	**20**	**30**	**60**	**20**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	Diode Theory and Its ApplicationsIntroduction to Ideal Diode, Effect of temperature Ideal diodes, unbiased diode and Forward and reverse bias of Diode. PIV, surge current, Diode as Uncontrolled switch. Rectifiers: Half wave, Full wave and bridge wave. IDC, VDC and Irms Measurements. Ripple factor, PIV rating. Choke and Capacitor input filter rectifiers, Clipper and Clamper circuits, Voltage multiplier: Half wave voltage doubler and full wave voltage doubler	15%	10
2	Special Purpose DiodesConstruction of Zener diode, Characteristics of Zener diode, Application of Zener Diode as Voltage Regulator, load line, Optoelectronic devices (LED and Photo Diode), Seven Segment Display, Schottky diode and its Application, Varactor Diode and its Application, Understanding Datasheets.	15%	6
3	Transistor Fundamentals and its Biasing techniquesConstruction of BJT, working principle of BJT, Characteristics & specifications of BJT (PNP & NPN transistors), Biased and unbiased BJT, Configuration of transistor, concept of gain & BW, Operation of BJT in cut-off, saturation & active regions (DC analysis), BJT as switch, Transistor as an amplifier, Voltage divider bias and analysis, VDB load line and Q point.	30%	15
4	DC Regulated Power SupplyVoltage Regulator-Basic series and shunt regulator, Types of voltage regulator IC: Fixed and adjustable positive and negative linear voltage regulator, IC linear fixed voltage regulator (78XX, 79XX, LM340 Series), Linear Adjustable Regulator (IC LM317, LM337, and IC 723 IC regulator), DC Regulated Power supply, Switched mode power supply (SMPS).	20%	6
5	Introduction to Sensors and Transducers Introduction to sensors and Transducers, Comparison between sensors and Transducers, Applications of Sensors and Transducers, Types of Electronic sensors, Types of Transducers.	20%	6

i. Text Book and Reference Book:

1. Electronic Principles, by A. P. Malvino, Tata McGraw Hill Publication New Delhi
2. Electronic Devices and Circuits, by Jacob Millman and Halkias, Tata McGraw Hill Publication New Delhi.

3. Electronic Devices and Circuits, by Robert L. Boylestad and Louis Nashelesky, Pearson, Prentice Hall.
4. Electronic Devices, by Thomas L. Floyd, Pearson, Prentice Hall
5. Linear Electronic Circuits and Devices, by James Cox,, Delmar Publication.
6. Electronic Devices and Circuits, by David A. Bell, Oxford Publication

j. Experiment List

Sr. No.	Experiment List
1	To Plot V-I characteristics Diodes. (a) PN junction diode Characteristic, (b) Zener Diode characteristics.
2	To Observe Rectifier Circuit (a) Half wave Rectifier without filter, (b) Full wave rectifier without filter, (c) Half wave Rectifier with (L,C) filter, and (d) Full wave Rectifier with (L,C) filter and measure DC voltage regulation and ripple factor for various load currents in case of filtered output.
3	Designing of power supply using IC regulator circuit. (a) Designing of +5 Volt DC Power Supply using 7805, (b) Designing of -5 Volt DC Power Supply using 7905, (c) Designing of +12 Volt DC Power Supply using 7812, and (d) Designing of -12 Volt DC Power Supply using 7912.
4	To Observe Response of Clipping and Clamping circuits using diodes (a) Diode Positive Clipper without and with Biased clipper, (b) Diode Negative Clipper without and with Biased clipper, (c) Biased Positive Negative Clipper(Combinational Clipper), and (d) Positive Clamper, and Negative Clamper.
5	(a) To Plot and Study input-output characteristics of Common Base (CB) configuration of Transistor, and (b) To Plot and Study input-output characteristics of Common Emitter (CE) configuration of transistors.
6	To study Voltage divider bias circuit: (a) To observe the effect of change in base current on Q-operating point, and (b) To set the Q point for operation of the transistor amplifier in the linear region.
7	Optoelectronic devices:

Sr. No.	Experiment List
	(a) To plot characteristics of LED, (b) To plot Characteristic of Photodiode, and (c) To observe isolated control of optocoupler.
8	To plot characteristics of Schottky and Varactor diode.
9	Designing of Linear Adjustable Regulator using IC LM317.
10	Introduction to Sensors and Transducers.

a. **Course Name:** Electronic Workshop

b. **Course Code:** 303107153

c. **Prerequisite:** Knowledge of Physics and basic electronics up to 12th science level

d. **Rationale:** The use of workshop practices in day to day industrial as well domestic life helps to solve the problems. Further, it also deals with basic introduction of system components of electrical and electronic systems, and provides hands-on practice in assembling, interconnecting, testing, and repairing such systems by making use of various tools used in electrical and electronic workshops. Electronic systems are built on a printed circuit board (PCB) and breadboard. One needs to use source instruments (power sources and signal sources), and appropriate measuring instruments to study behavior of a system.

e. **Course Learning Objective:**

CLOBJ 1	Study about different wiring techniques
CLOBJ 2	Study about Types of passive elements and identification: Resistors, capacitors, Inductors and their power ratings, Value identification through color Coding
CLOBJ 3	Study about Operating principle of Power supply, Operating principle of Multimeter measuring various parameters like voltage, current, continuity, resistance, capacitance.
CLOBJ 4	Study about different types of active components and symbolic representations.
CLOBJ 5	Learning about Function Generator and CRO.
CLOBJ 6	Study about electrical wiring, types of wiring, Staircase wiring, Double Staircase wiring, GODown Wiring, Demonstration of Fuse, MCB along its operation and study of ELCB, Demonstration of different types of cables, wires, probes, connectors

f. **Course Learning Outcomes**

CLO 1	Gain ability to understand working of Active and Passive Components
CLO 2	Ability to understand the operation of various testing and measurement instrumentation.
CLO 3	Ability to learn electrical wiring
CLO 4	Ability to design electronic circuits for specific applications.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	50	-	50	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Electrical Component, Types of switches, relays, fuses, MCB, ELCB. Types of wires and Gauges, Sockets and Earthings, lamp Load.	14%	4
2	Basic Passive Components Types of passive elements and identification: Resistors, capacitors, Inductors and their power ratings, Value identification through color Coding	14%	4
3	Power Supply and Multimeter Operating principle of Power supply, Operating principle of Multimeter measuring various parameters like voltage, current, continuity, resistance, capacitance etc.	14%	4
4	Active components Types of active components and symbolic representations, Interpreting data sheet of various active components like PN junction diode, Zener diode, BJT, Power Transistor, Fixed voltage IC Regulators etc., Identification and measurement.	16%	4
5	Function Generator and CRO Basics of Function Generator, Specifications of Function Generator and operating ranges of various parameters of available functions, operating principle of CRO, Specifications of CRO and Operating ranges of various parameters	16%	4
6	Basic Electrical & Electronics parameter, Measurement of voltage, current, frequency, phase, and Power	10%	2
7	Electrical Wiring Introduction to electrical wiring, types of wiring, Staircase wiring, Double Staircase wiring, GO- Down Wiring, Demonstration of Fuse, MCB along its operation and study of ELCB, Demonstration of different types of cables,	16%	4

	wires, probes, connectors		

i. Experiment List

Sr. No.	Experiment List
1	Identification and symbolic representation of basic passive components.
2	Study of Digital Multimeter and Measurement of voltage, current, frequency, phase difference, power, power factor for single phase supply using Digital Millimeter.
3	Understanding of working and specifications of CRO and Function generator.
4	Identification, symbolic representation and testing of various electronics components.
5	To understand working and specifications of DC regulated Power supply.
6	Study of different types of cables, wires, probes, connectors.
7	To perform staircase wiring, double staircase wiring, and Go-down wiring.
8	Demonstration of Fuse, MCB along its operation and study of ELCB.

a. **Course Name:** Elements of Mechanical Engineering

b. **Course Code:** 303109102

c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level

d. **Rationale:** Elements of Mechanical Engineering Course Provide students with a comprehensive foundation in the fundamental principles and concepts that form the backbone of mechanical engineering for various Engineering disciplines.

e. **Course Learning Objective:**

CLOBJ 1	Identify basic mechanical components such as gears, bearings, Pumps, Compressor, boiler, I.C Engines.
CLOBJ 2	Understand various laws and behaviour of fluid at different conditions.
CLOBJ 3	Illustrate the operational mechanisms through diagrams, models, or practical demonstrations.
CLOBJ 4	Demonstrate construction and working principles of diverse mechanical devices, such as engines, pumps, and compressors.
CLOBJ 5	Evaluate basic problems related to I.C engine, pumps, compressors and fluids.
CLOBJ 6	Analyse and discuss the interactions and relationships between various mechanical elements within a system

f. **Course Learning Outcomes:**

CLO 1	Identify basic mechanical components and their functions.
CLO 2	Understand basic Properties and behaviour of various fluids.
CLO 3	Understand Construction and working of various mechanical devices
CLO 4	Apply fundamental principles to solve basic mechanical engineering problems

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**2**	**4**	**20**	**20**	**20**	**60**	**30**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Basics of Thermodynamics** Prime Movers - Meaning and Classification; Concept of Force, Pressure, Energy, Work, Power, System, Heat, Temperature, Specific heat capacity, Internal Energy, Enthalpy, Specific Volume; Thermodynamics – Definition: Change of State, Path, Process, Cycle, Thermodynamic systems, Statement of Zeroth Law, First Law and Second Law of Thermodynamics and its Applications.	**10%**	**5**
2	**Properties of Gases** Gas Laws, Boyle's law, Charles law, Combined gas law; Gas Constant, Relation between Cp and Cv Constant Volume Process; Constant Pressure Process; Isothermal Process; Adiabatic Process; Poly-tropic Process. Examples based on the above topics.	**15%**	**6**
3	**Properties of Steam** Types of Steam and Steam formation; Specific Enthalpy; Specific Volume; Dryness Fraction of Steam; Measurement of Dryness Fraction; Steam Table. Examples based on the above topics.	**15%**	**6**
4	**Heat Engines** Definition of Heat Engine; Classification of Heat Engine; Carnot Cycle, Rankine Cycle, Otto Cycle and Diesel Cycle. **Internal Combustion Engines:** Two Stroke Petrol and Diesel Engine; Four Stroke Petrol and Diesel Engine; Measurement of Indicated Power and Brake Power: Numerical on calculation of Mechanical, Thermal and Volumetric Efficiency. Examples based on the above topics.	**20%**	**10**
5	**Energy Conversion Devices** **Steam Generators:** Definition and Classification; Cochran, Lancashire, Locomotive, Babcock and Wilcox Boiler: Construction and Working; Boiler Mounting and Accessories.	**20%**	**5**

Sr. No.	Content	Weightage	Teaching Hours
	Refrigeration and Air Conditioning: Meaning of Refrigeration; Vapor Compression Refrigeration Cycle; Vapor Absorption Refrigeration Cycle; Air conditioning; Window Air Conditioning and Split Air Conditioning.		
6	**Pumps And Air Compressors Pumps** Definition, Classification and Application of Pumps; Types and Operation of Rotary pump, Reciprocating Pump, Centrifugal Pump. **Air Compressors** Definition, Classification and Application of Compressors; Types and Operation of Rotary and Reciprocating Air Compressor.	**10%**	**5**
7	**Motion And Power Transmission Devices** Shaft and Axle; Belt Drive; Chain Drive; Friction Drive; Gear Drive; Clutch, Coupling and Brake.	**5%**	**3**
8	**Conventional And Non-Conventional Energy Sources** Introduction and Classification of Energy Sources; Conventional Energy Sources E.g. Solid, Liquid, Gaseous and Nuclear fuels; Calorific Value of Fuels; Non-Conventional Energy Sources E.g. Solar Energy, Wind Energy, Hydro Power, Biomass and Biomass Energy; Comparison of Conventional & Non-Conventional Energy Sources.	**5%**	**3**

i. Text Book and Reference Book:

1. Elements of Mechanical Engineering, by S.B. Mathur, S. Domkundwar, Dhanpat Rai & Sons Publications.
2. Thermal Engineering, by R.K Rajput, Laxmi Publications.
3. Thermal Science and Engineering, by Dr. D. S. Kumar, S. K. Kataria and sons Publishers.
4. Basic Mechanical Engineering, by T. S. Rajan, Wiley Eastern Ltd
5. Fundamental of Mechanical Engineering, by G. S. Sawhney, PHI Publication New Delhi.

j. Experiment List

Sr. No.	Experiment List
1	Demonstration and study of construction and working of Petrol Engine Model.
2	Demonstration and study of construction and working of Diesel Engine Model.
3	Determination of brake thermal efficiency of an I. C. Engine.
4	Demonstration and study of construction and working of various types of boiler Models.
5	Study of construction and working of different boiler mountings and accessories.
6	Demonstration on construction and working of different types of pumps.
7	Demonstration on construction and working of different types of air compressors.
8	Demonstration on vapour compression refrigeration cycle and vapour absorption refrigeration cycle.
9	Demonstration on construction, working and applications of different types of coupling, clutch and brake.
10	Demonstration on construction, working and applications of motion and power transmission devices.

a. **Course Name:** Mathematics-II

b. **Course Code:** 303191151

c. **Prerequisite:** Knowledge of Mathematics up to 12th science level

d. **Rationale**: The Mathematics I syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and vector calculus, preparing students for engineering challenges with optimized problem-solving skills.

e. **Course Learning Objective:**

CLOBJ 1	Define and identify ordinary differential equations of higher order. Classify ODEs based on homogeneity and linearity. Solve homogeneous linear ODEs of higher order with constant coefficients, and variable coefficients.
CLOBJ 2	Solve homogeneous linear ODEs of higher order with constant coefficients, variable coefficients
CLOBJ 3	Apply the Method of Undetermined Coefficients to solve nonhomogeneous ODEs. Utilize the Solution by Variation of Parameters for solving nonhomogeneous ODEs. Explore applications of ODEs in real-world scenarios.
CLOBJ 4	Understand power series solutions for ordinary points and regular singular points. Explore properties and applications of Legendre polynomials and Bessel functions.
CLOBJ 5	Define Laplace transform and its inverse. Understand the linearity property of Laplace transforms. Solve ordinary differential equations using Laplace transforms.
CLOBJ 6	Define Fourier Integral and its applications. Explore Fourier Cosine and Sine Integrals.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate the ability to translate physical or engineering problems into mathematical equations and solve them.
CLO 2	Develop analytical and critical thinking skills through the process of solving complex mathematical problems.
CLO 3	Understand and interpret mathematical solutions in the context of the given problems.
CLO 4	Communicate mathematical concepts and solutions clearly and effectively, both in written and verbal forms.
CLO 5	Present mathematical arguments and solutions in a logical and organized manner.
CLO 6	Lay a solid foundation for more advanced courses in mathematics and related disciplines.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT 1 Higher order ordinary differential equations: Ordinary differential equations of higher orders, Homogeneous Linear ODEs of Higher Order, Homogeneous Linear ODEs with Constant Coefficients, Euler–Cauchy equations, Nonhomogeneous ODEs, Method of Undetermined Coefficients, Solution by Variation of Parameters, Applications	8%	5
2	UNIT 2 Power Series: Power series solutions at ordinary point and regular singular point; Legendre polynomials, Bessel functions of the first kind and their property	15%	9
3	UNIT 3 Laplace Transform: Laplace Transform and inverse Laplace transform, Linearity, First Shifting Theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, UNIT Step Function (Heaviside Function), Second Shifting Theorem (t-Shifting), Laplace transform of periodic functions, Short Impulses, Dirac's Delta Function, Convolution, Integral Equations, Differentiation and Integration of Transforms, Solution of ordinary differential equation by Laplace transform	25%	15
4	UNIT 4 Fourier Integral: Fourier Integral, Fourier Cosine Integral and Fourier Sine Integral	17%	10
5	UNIT 5 Vector Calculus:	10%	6

	Gradient of scalar field, Directional Derivative, Divergence and curl of Vector field, Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.		
6	UNIT 6 Multivariable Calculus (Integration): Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Triple integrals (Cartesian)	25%	15

i. Text Book and Reference Book:

1. Calculus and Analytic Geometry (TextBook), by G.B. Thomas and R.L. Finney, Addison Wesley
2. Calculus with early transcendental functions, by James Stewart, Cengage Learning
3. Higher Engineering Mathematics, by B. S. Grewal, Khanna Publications
4. Elementary Linear Algebra (TextBook), by Howard Anton, Chris Rorres, Wiley India Edition, 9th Edition
5. Advanced Engineering Mathematics (TextBook), by Erwin Kreyszig, Wiley India Education
6. A textbook of Engineering Mathematics, by N.P. Bali and Manish Goyal, Laxmi Publications

a. **Course Name:** Advanced Communication & Technical Writing

b. **Course Code:** 303193152

c. **Prerequisite:** Knowledge of English language studied till 12th standard

d. **Rationale:** Communication confidence laced with knowledge of English grammar is essential for all engineers**.**

e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLOBJ 2	Solve problems related to Alternating current, alternating voltage, etc, Demonstrate a clear understanding of Pure R, L C circuit and combination of RLC, Series and Parallel combination of R, L and C, etc
CLOBJ 3	Acquire knowledge of the resistor, capacitor, and inductor and their performance characteristics for series and parallel connections.
CLOBJ 4	Understand different single phase and three phase circuits.
CLOBJ 5	Demonstrate a clear understanding of the basic concepts, working principles and applications of transformer, DC machines and AC machines.
CLOBJ 6	Study the use of LT SwitchGear, Fuse, MCB, ELCB etc

f. **Course Learning Outcomes:**

CLO 1	Develop four basic skills
CLO 2	Construct grammatically correct sentences.
CLO 3	Develop and deliver professional presentation skills
CLO 4	Develop the skills of critical thinking.
CLO 5	Compare different types of written communication.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	

0	**2**	**0**	**2**	**-**	**100**	**-**	**-**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Developing Effective Listening Skills**: To help students understand the meaning and importance of good listening skills, learning the traits of being a good listener through activity and listening to audio tracks.	10%	2
2	**Error analysis**: To provide insights into the complicated processes of language development as well as a systematic way for identifying, describing and explaining errors. (Tenses, Voices, Reported speech)	10%	4
3	**Delivering different types of speeches:**: Students will understand and use the different patterns for structuring speeches • Welcome / Introductory speech • Vote of Thanks speeches • Farewell speeches	10%	2
4	**Professional Presentations**: Students will learn • Combating stage fright • Preparing powerpoint presentation • Delivering PPT	10%	5
5	**Essay writing**: Students will overcome the common pitfalls in the task of essay writing by understanding • Basics of Paragraph development and paragraph jumble • Types of essays • Characteristic features of essays • Guiding Principles	10%	4

Sr. No.	Content	Weightage	Teaching Hours
6	**Reading Comprehension**: • Employing Different Reading Skills • Activity • Practice	10%	2
7	**Project Proposal**: • To equip students with the various elements required to prepare a winning proposal.	5%	2
8	**Misplaced Modifiers**: Students will understand how to place the improperly separated word, phrase or clause from the word it describes.	5%	1
9	**Movie Review**: • A movie show followed by writing a review. • To provide an exposure to students how to express their opinions about some film or documentary with an unbiased and objective approach.	10%	2
10	**Narrative Writing**: • Narrative writing helps them explore different characters and settings. • To help students clarify their thinking, and teach them to express that in writing in an organized way.	5%	2
11	**Writing Reports**: • Process of writing • Order of writing • Final draft & checklist for reports • Sample reports: Memorandum Letter report	10%	2
12	**Critical Thinking**: • Need, relevance and Significance of Critical Thinking • Logic in problem solving and decision making(activities) • Moral Reasoning (Case Studies)	5%	1

Sr. No.	Content	Weightage	Teaching Hours
13	**Activity Session (Presentation)** • An activity where the scene of a press conference is created in the class. • Students are encouraged to ask sharp questions and in turn are invited to assume roles of famous personalities, thus answering the questions posed.	0%	1

i. Reference Books:

1. Business Correspondence and Report Writing, Sharma, R. And Mohan, K.
2. Communication Skills, Kumar S and Lata P; New Delhi Oxford University Press
3. Practical English Usage MICHAEL SWAN
4. A Remedial English Grammar for Foreign Student, F.T. Wood
5. On Writing Well, William Zinsser; Harper Paperbacks,2006; 30th anniversary edition
6. Oxford Practice Grammar, John Eastwood; Oxford University Press
7. Technical Communication : Principles And Practice, Sangeetha Sharma, Meenakshi Raman; Oxford University Press

Semester 3

a. Course Name: Fundamentals of Signals & Systems

b. Course Code: 303106201

c. Prerequisite: Inclination to learn mathematics, basic knowledge of differential equations and difference equations, electrical circuits and networks

d. Rationale: The course will provide a strong foundation on signals and systems which will be useful for creating the foundation of communication and signal processing. The students will learn basic continuous time and discrete time signals and systems. Students will understand the application of various transforms for analysis of signals and systems both continuous time and discrete time.

e. Course Learning Objective:

CLOBJ 1	Develop a comprehensive understanding of signals, including continuous-time and discrete-time signals, analog and digital signals, and their characteristics such as amplitude, frequency, and phase.
CLOBJ 2	Analyze signals in the time domain by performing operations such as addition, multiplication, differentiation, and integration. Understand the concept of linearity and time-invariance in systems.
CLOBJ 3	Apply Fourier analysis to decompose signals into their frequency components. Perform frequency domain operations like convolution and filtering.
CLOBJ 4	Learn to transform signals from the time domain to the complex frequency domain using Laplace and Z-transforms. Analyze the stability and system behavior in the transformed domains.
CLOBJ 5	Understand the characteristics of linear, time-invariant (LTI) systems. Compute and interpret the impulse response of systems.
CLOBJ 6	Grasp the fundamentals of sampling and the Nyquist theorem.

f. Course Learning Outcomes:

CLO 1	Understand the concepts of continuous time and discrete time signal & systems and its operation.
CLO 2	Analyze different transformation techniques for continuous time and discrete time signals.
CLO 3	Understand sampling theorem and its implications.
CLO 4	Understand about various types of systems, classify them, analyze them and understand their response behaviour.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
2	0	0	2	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Introduction to Signals and Systems:** Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties, Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift invariance, causality, stability, reliability. Examples.	**29%**	**13**
2	**Behaviour of continuous and discrete-time LTI: systems** Impulse response and step response, convolution, input/output behaviour with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations	**27%**	**12**
3	**Fourier, Laplace and Z- Transforms:** Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT). Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behaviour. The zTransform for discrete	**33%**	**15**

	time signals and systems, system functions, poles and zeros of systems and sequences, z domain analysis.		
4	**Sampling and Reconstruction:** The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero- order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.	**11%**	**5**

i. Text Book and Reference Book:

1. Signals and Systems by Alan V. Oppenheim and Alan S. Willsky.
2. Signals and Systems by Simon Haykin and Barry Van Veen.
3. Signals and Systems: Analysis Using Transform Methods & MATLAB by M.J. Roberts.
4. Linear Systems and Signals by B.P. Lathi.
5. Fundamentals of Signals and Systems, by Govind Sharma,Michael J. Roberts

a. **Course Name:** Fundamentals of Signals & Systems Lab

b. **Course Code:** 303106202

c. **Prerequisite:** Knowledge of Signals and Systems, Basic Signals, Convolution

d. **Rationale:** The "Fundamentals of Signals and Systems Lab" is vital as it offers hands-on experience, reinforcing theoretical knowledge by applying signal processing concepts, fostering practical skills essential for engineering disciplines.

e. **Course Learning Objective:**

CLOBJ 1	Identify and describe different types of signals, such as continuous-time, discrete-time, analog, and digital signals.
CLOBJ 2	Apply mathematical operations, such as scaling, shifting, time-reversal, integration, and differentiation to manipulate signals.
CLOBJ 3	Analyse linear time-invariant (LTI) systems and understand their properties.
CLOBJ 4	Analyse signals and systems in the frequency domain using techniques like Fourier series and Fourier transforms.
CLOBJ 5	Demonstrate the conversion of continuous-time signals to discrete-time signals and vice versa.

f. **Course Learning Outcomes:**

CLO 1	Generate and characterize various continuous and discrete time signals.
CLO 2	Development of the mathematical skills to solve problems involving convolution, modulation and sampling.
CLO 3	Design and analyze linear time-invariant (LTI) systems and compute its response.
CLO 4	Carry simulation on signals and systems for observing effects of applying various properties and operations.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	

0	**0**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. Signals and Systems, by Alan V. Oppenheim and Alan S. Willsky.
2. Signals and Systems, by Simon Haykin and Barry Van Veen.
3. Signals and Systems: Analysis Using Transform Methods & MATLAB, by M.J. Roberts.
4. Linear Systems and Signals, by B.P. Lathi.

i. List of Experiment:

Sr. No.	Experiment List
1	Familiarize with MATLAB software, general functions and signal processing toolbox functions.
2	Write a MATLAB program to generate and plot common continuous time signals.
3	ToWrite a MATLAB program to generate and plot common discrete time signals.
4	Write a MATLAB program to Perform various operations on the signals using computational software.
5	Write a MATLAB program to perform delaying and advancing of signals.
6	Write a MATLAB program to perform reversal operation in time domain.
7	Write a MATLAB program to generate even and odd part of signals.
8	Write a MATLAB program to find the convolution of two signal.
9	Write a MATLAB program to find Impulse Response of a CT-LTI system.
10	Write a MATLAB program for observing the effects of lower sampling rate and higher sampling rate on continuous time signal**.**
11	Design and implement simple filters, such as low-pass and high-pass filters, using analog and digital filter design techniques.

j. Laboratory Equipment: MATLAB software

a. **Course Name:** Electrical Machine-I

b. **Course Code:** 303106203

c. **Prerequisite:** Knowledge of basics of electrical engineering and mathematics.

d. **Rationale:** The course will impart the knowledge of magnetic circuits, various fundamentals of D.C. machines & Transformers.

e. **Course Learning Objective:**

CLOBJ 1	Magnetic circuit analysis
CLOBJ 2	Constructional details, Principle of operation, performance of Single phase and three phase transformers.
CLOBJ 3	Working principle of electrical machines based on energy conversion principle.
CLOBJ 4	Construction, working and performance of DC Generator and DC motor.
CLOBJ 5	Various losses take place in DC machines and transformers.

f. **Course Learning Outcomes:**

CLO 1	Understand the fundamental concept of magnetic circuit and analyze the magnetic-circuits.
CLO 2	Understand constructional details and principle of operation and analyze the performance of DC machines and Transformers under various operating conditions using their various characteristics.
CLO 3	Choose an appropriate DC machine and transformer for industrial application.
CLO 4	Control the speed of the DC Shunt motor.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**Magnetic fields and magnetic circuits:** Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil -through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.	**17%**	**8**
2	**Electromagnetic force and torque:** Brief idea of B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular Position of a rotating element. Singly Excited Magnetic System and Doubly Excited Magnetic system. Physical concept of torque production; Electromagnetic torque and Reluctance torque	**20%**	**9**
3	**DC Machine:** Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation, Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.	**17%**	**8**
4	**DC machine - motoring and generation:** Armature circuit equation for motoring and generation, Types of field excitations − separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed	**15%**	**7**

Sr. No.	Content	Weightage	Teaching Hours
	characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines.		
5	**Transformers:** Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, brief knowledge about losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers. Modeling of practical transformer, Vector Group of 3 phase transformer, Open Delta and Zigzag connection of three phase transformer.	**31%**	**13**

i. Text Book and Reference Book:

1. Electrical Machinery, by A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, Mcgraw Hill
2. Performance and design of DC machines by by A. E. Clayton and N. N. Hancock, CBS publishers, Pub. Year 2004
3. Performance and Design of AC Machines, by M. G. Say, CBS Publisher.
4. Electrical Machinery, by Dr P.S. Bhimbra, Khanna Publishers.
5. Electric Machines, by I. J. Nagrath and D. P. Kothari, McGraw Hill Education, Pub. Year 2010.
6. Electrical Technology (Vol-II), by B L Theraja & A K Theraja, S Chand

a. **Course Name:** Electrical Machine-I Lab

b. **Course Code**: 303106204

c. **Prerequisite:** Knowledge of basics of electrical engineering and mathematics.

d. **Rationale:** The course will impart the knowledge of magnetic circuits, various fundamentals of D.C. machines & Transformers.

e. **Course Learning Objective:**

CLOBJ 1	Demonstration of construction Electrical Machines.
CLOBJ 2	Connect the circuit to perform experiments, measure, analyze the observed data & come to a conclusion.
CLOBJ 3	Prepare a report based on results received.
CLOBJ 4	Perform various tests on DC machine and transformer to validate their performance.

f. **Course Learning Outcomes:**

CLO 1	Interpret various characteristics of DC Machines.
CLO 2	Estimate various parameters after conducting different tests on the DC machine.
CLO 3	Assess the performance of transformers.
CLO 4	Control the speed of the DC Shunt motor.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Text Book and Reference Book:**

1. Electrical Machinery, by A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, Mcgraw Hill
2. Performance and design of DC machines by by A. E. Clayton and N. N. Hancock, CBS publishers, Pub. Year 2004

3. Performance and Design of AC Machines, by M. G. Say, CBS Publisher.
4. Electrical Machinery, by Dr P.S. Bhimbra, Khanna Publishers.
5. Electric Machines, by I. J. Nagrath and D. P. Kothari, McGraw Hill Education, Pub. Year 2010.
6. Electrical Technology (Vol-II), by B L Theraja & A K Theraja, S Chand

i. List of Experiment:

Sr. No.	Experiment List
1	Obtain Magnetizing Characteristics, Internal & External Characteristics of Self Excited DC Shunt Generator. Also obtain the critical field resistance of the machine from magnetizing characteristics.
2	Obtain Internal & External Characteristics of DC Cumulative Compound Generator
3	Obtain Internal & External Characteristics of DC Differential Compound Generator.
4	Obtain Speed-Torque characteristics of DC Series Motor and DC Shunt Motor.
5	Perform Break test on DC machines.
6	Determine the efficiency of two similar shunt machines by regenerative method. (Hopkinson's Test).
7	Perform field test on DC series motor.
8	Speed control of DC Shunt Motor using a) Armature control and b) field control methods. Also perform Swinburne's test on DC Shunt Motor.
9	Conduct open circuit and short circuit test on a three phase three winding transformer and determine the equivalent circuit parameters.
10	Conduct Sumpner test on two identical single phase transformers and determine their efficiency at various loads.
11	Make Scott connection of two single phase transformers and to verify the current relation by drawing phasor diagrams for (a) Balanced and (b) Unbalanced resistive loads.

j. Laboratory Equipment: DC Generator, DC Motor, single-phase Transformer, Three-phase Transformer, Multimeters, Analog voltmeter & Ammeter, Rheostat.

a. **Course Name:** Electrical Circuit Analysis

b. **Course Code:** 303106205

c. **Prerequisite:** Knowledge of basics of electrical engineering and mathematics

d. **Rationale:** The course will impart the knowledge of various network theorems, analysis of transient analysis of series-parallel R-L, RC, R-L-C , two-port network and network topology.

e. **Course Learning Objective:**

CLOBJ 1	To employ a methodical approach to problem-solving in electrical circuit networks, effectively identifying and analysing complex problems to find solutions.
CLOBJ 2	To apply various theorems to simplify electrical networks, demonstrating the ability to simplify complex circuits using theorem-based techniques.
CLOBJ 3	Use differential equations and Laplace transforms for network analysis.
CLOBJ 4	To understand two-port network parameters and be able to evaluate and manipulate them to obtain network functions for electrical circuits.
CLOBJ 5	Apply graph theory to solve circuits.

f. **Course Learning Outcomes:**

CLO 1	To provide a methodical approach to problem solving.
CLO 2	Apply the knowledge of various theorems to simplify networks.
CLO 3	Infer and evaluate the expression of first and second order networks using differential equation and Laplace transforms.
CLO 4	Evaluate two-port network parameters and obtain network functions of circuits.
CLO 5	Employ graph theory for solving electrical circuit networks.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**Network Theorems:** Super mesh and Super node, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem, Tellegen's theorem, Millman's theorem. Analysis with dependent current and voltage sources.	**29%**	**13**
2	**Solution of First and Second order networks:** Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.	**27%**	**12**
3	**Electrical Circuit Analysis Using Laplace Transforms:** Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots).	**22%**	**10**
4	**Two Port Network and Network Functions:** Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port Networks.	**11%**	**5**
5	**Graph Theory and Network Topology:** Introduction, graph of network, tree, co-tree, loop incidence matrix, cut set matrix, tie set matrix and loop current, number of possible tree of a graph, analysis of network equilibrium equation.	**11%**	**5**

i. Text Book and Reference Book:

1. Engineering Circuit Analysis by W H Hayt, S M Durbin, Tata McGraw-Hill Education
2. Fundamentals of Electric Circuits by C. K. Alexander and M. N. O. Sadiku, McGraw Hill Education, 5th edition, Pub. Year 2013
3. Network Analysis by M. E. Van Valkenburg , PHI
4. Circuit Theory: Analysis and Synthesis by Abhijit Chakrabarti, Dhanpat Rai & co.
5. Networks and Systems by D. Roy Choudhury, New Age Science, 2nd Edition

a. **Course Name:** Electrical Circuit Analysis Lab

b. **Course Code:** 303106206

c. **Prerequisite:** Knowledge of basics of electrical engineering and mathematics.

d. **Rationale:** The course will impart the knowledge of various network theorems, analysis of transient analysis of series-parallel R-L, RC, R-L-C , two-port network and network topology.

e. **Course Learning Objective:**

CLOBJ 1	To recall and describe various theorems used in electrical circuit analysis to justify their application in problem-solving.
CLOBJ 2	Demonstrate their understanding of time constants by evaluating them for different connections of R-L, R-C, and R-L-C circuits, and relate this understanding to circuit behaviour.
CLOBJ 3	Apply their knowledge to estimate two-port parameters, demonstrating the ability to use theoretical concepts to analyse and model complex electrical networks.
CLOBJ 4	Analyse and verify the responses of second-order systems, using their analytical skills to understand the dynamic behaviour of these systems.

f. **Course Learning Outcomes:**

CLO 1	Justify various theorems.
CLO 2	Evaluate time constant for various connections of R-L, R-C & R-L-C circuit.
CLO 3	Estimate two-port parameters.
CLO 4	Verify responses of second order systems.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Text Book and Reference Book:**

1. Engineering Circuit Analysis, by W H Hayt, S M Durbin, Tata McGraw-Hill Education

2. Fundamentals of Electric Circuits, by C. K. Alexander and M. N. O. Sadiku, McGraw Hill Education, 5th edition, Pub. Year 2013
3. Network Analysis, by M. E. Van Valkenburg , PHI
4. Circuit Theory: Analysis and Synthesis, by Abhijit Chakrabarti, Dhanpat Rai & co.

i. List of Experiment:

Sr. No.	Experiment List
1	Verification of Maximum power transfer theorems in dc circuits
2	Verification of Norton's theorems in dc circuits
3	Verification of Reciprocity Theorem dc circuits.
4	Verification of Tellegen's theorem dc circuits
5	Verification of open circuit impedance parameter of two port networks.
6	Verification of short circuit admittance parameter of two port networks.
7	Verification of hybrid parameters of two port networks.
8	Verification of ABCD parameters of two port networks.
9	Verification of transient RL circuit and obtain time constant
10	Verification of transient RC circuit and obtain time constant
11	Verification of transient response of second order system for step input
12	Verification of transient response of second order system for ramp input

j. Laboratory Equipment: Training kit, Multimeters, CRO, DSO, capacitor, transformer, and resistor.

a. **Course Name:** Analog Electronics Circuits

b. **Course Code:** 303106209

c. **Prerequisite:** Knowledge of Physics, Basic Electrical Engineering, Basic Electronics.

d. **Rationale:** The course provides Analog circuits, such as amplifiers, are crucial for signal amplification, ensuring faithful reproduction and enhancement of signals across diverse applications. Analog electronics circuits form the foundation of electronic systems, enabling the processing and manipulation of continuous signals essential for various applications.

e. **Course Learning Objective:**

CLOBJ 1	Understand the principles of differential amplifiers, analyze common-mode rejection, and design circuits for specific gain requirements.
CLOBJ 2	Understand the foundational principles of operational amplifiers, covering their characteristics, modes of operation, and ideal behavior.
CLOBJ 3	Investigate the nonlinear applications of operational amplifiers, delving into circuits involving diodes, transistors, and nonlinear elements to design precision rectifiers, logarithmic amplifiers, oscillators, and other nonlinear functions.
CLOBJ 4	Design and analyze cascaded amplifier stages, considering gain, input/output impedance, and frequency response for effective signal amplification.
CLOBJ 5	Explore the internal structure of op-amps, analyze ideal op-amp behavior, and address non-idealities in circuit design for precision and stability.

f. **Course Learning Outcomes:**

CLO 1	Understand the functioning and analyze design of op-amp based circuit and use linear and non-linear applications of op-amp.
CLO 2	Apply circuit analysis techniques, including Ohm's law and Kirchhoff's laws, to analyse and solve simple and complex analog electronic circuits.
CLO 3	Analyze and design circuits involving operational amplifiers, including inverting and non-inverting amplifiers, integrators, differentiators, and voltage followers.
CLO 4	Analyze cascaded amplifier stages, considering gain, input/output impedance, and frequency response for effective signal amplification.

g. **Teaching & Examination Scheme:**

Teaching Scheme	**Evaluation Scheme**

L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Differential, multi-stage and operational amplifiers** Differential amplifier; power amplifier; direct coupled multistage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)	13%	8
2	**Linear applications of op-amp** Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, Timer (555 ICs), oscillators (Wein bridge and phase shift). Analog to Digital Conversion.	17%	6
3	**Nonlinear applications of op-amp** Hysteretic Comparator, Zero Crossing Detector, Square wave and triangular-wave generators. Precision rectifier, peak detector.	10%	9

i. Text Book and Reference Book:

1. Op-Amps & Linear ICs, by Ramakant A. Gayakwad, PHI
2. Introduction to Operational Amplifier theory and applications, by J. V. Wait, L. P. Huelsman and G. A. Korn, McGraw Hill U. S, Pub. Year 1992
3. Microelectronics, by J. Millman and A. Grabel, McGraw Hill Education, Pub. Year 1988.

4. Analysis and Design of Analog Integrated Circuits, by P.R. Gray, R.G. Meyer and S. Lewis, John Wiley & Sons, Pub. Year 2001
5. Electronic Devices and Circuits, by S. Salivahanan, N. Suresh Kumar, A. Vallavaraj, Tata McGraw-Hill.
6. Electronic Circuit Analysis, K. Lal Kishore, Pearson Education

a. **Course Name:** Analog Electronics Circuits Lab

b. **Course Code:** 303106208

c. **Prerequisite:** Knowledge of Physics, Basic Electrical Engineering, Basic Electronics.

d. **Rationale:** : This subject focuses on the study of analog and digital electronics and digital logic along with the basics of Digital Circuits. It also briefs the students about different types of amplifiers and digital circuits. It informs the students about use of digital and analog electronics in Microprocessors and Microcontrollers and Its application in various electrical related fields Power system Protection, instrumentation, power electronics, Electrical Drives and control of Electrical Equipments.

e. **Course Learning Objective:**

CLOBJ 1	Foster a foundational understanding of analog electronic principles and signal processing.
CLOBJ 2	Cultivate practical skills through hands-on exercises in circuit design, construction, and analysis.
CLOBJ 3	Provide a comprehensive understanding of digital electronics principles, covering logic gates, sequential circuits, and microcontroller interfacing.
CLOBJ 4	Provide a comprehensive understanding of digital electronics principles, covering logic gates, sequential circuits, and microcontroller interfacing.
CLOBJ 5	Develop expertise in designing amplifiers and filters for applications in audio, communications, and instrumentation. Enhance troubleshooting abilities to identify and resolve issues in analog circuits.
CLOBJ 6	Enable practical application of theoretical knowledge through hands-on experiments and digital system design. Cultivate proficiency in using logic analyzers for digital signal analysis and refining skills in debugging digital circuits.

f. **Course Learning Outcomes:**

CLO 1	Acquire a robust foundational understanding of the course subject, encompassing key theories, principles, and fundamental concepts.
CLO 2	Develop critical analytical skills to solve complex problems within the scope of the course, applying theoretical knowledge to practical scenarios.
CLO 3	Demonstrate the ability to apply learned concepts through hands-on projects, experiments, or real-world simulations, fostering practical competence.
CLO 4	Cultivate effective communication skills, both written and verbal, to articulate ideas, findings, and solutions related to the course content.

CLO 5	Embrace ethical and professional standards, showcasing integrity, responsibility, and respect in all aspects of academic and practical endeavours related to the course.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. Op-Amps & Linear ICs, (TextBook) by Ramakant A. Gayakwad, PHI
2. Digital Logic and Computer Design, (TextBook) by Morris Mano, PHI
3. Digital Fundamentals, by Thomas L Floyd, Pearson
4. Modern Digital Electronics, by R. P. Jain, Tata McGraw-Hill Education

i. List of Experiment:

Sr. No.	Experiment Title
1	Measure input & output offset voltage of OP-AMP, Configure it in voltage follower mode and measure its slew rate.
2	Verify the Operation of OP-AMP as inverting amplifier & non-inverting amplifier and Measure its Gain & Bandwidth.
3	Verify the Operation of OP-AMP as Summation & Averaging amplifier
4	Verify the Operation of OP-AMP as Differential & Integration amplifier.
5	To design Schmitt trigger circuit using op-amp and take measurements
6	To design Monostable multi-vibrators using 555 timer IC and verify their operations using 555 timer IC.
7	To design Bistable multi-vibrators using 555 timer IC and verify their operations using 555 timer IC
8	To design Astable multi-vibrators using 555 timer IC and verify their operations using 555 timer IC.

9	To design Butterworth low-pass filter (Sallen-key circuit), construct the same circuit on breadboard and take necessary measurements.
10	To Realize several logic gates using universal gates (NAND and NOR logic gates).
11	To design and realize a combinational circuit to convert binary to gray/gray to binary code.
12	To design and realize half-adder, full-adder, half-subtractor and full Substractor combinational circuit.
13	To design and implement Encoder, Decoder, Multiplexer and DeMultiplexer.
14	To design & implementation of SR, JK, D & T flip flops.
15	To design and implement a 4-bit ripple counter.
16	To design and implement Shift Register using D Flip Flop.

j. Laboratory Equipment: Power Supplies, Oscilloscopes, Resistors, Capacitors, and Inductors, Filter Kits, Voltage and Current Probes, Digital Multimeters, Digital Trainer Kits , Digital Multimeters, Microcontroller Boards, etc

a. **Course Name:** Mathematics-III

b. **Course Code:** 303191203

c. **Prerequisite:** Knowledge of Mathematics up to 12th science level

d. **Rationale**: The Mathematics I, Mathematics-II syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and vector calculus, preparing students for engineering challenges with optimized problem-solving skills.

e. **Course Learning Objective:**

CLOBJ 1	Understand the principles of Z-transform, including linearity, elementary functions transformation, shifting theorems, and the application of Z-transforms in solving difference equations.
CLOBJ 2	Develop the ability to solve and analyze first-order partial differential equations using methods such as Charpit's method, separation of variables, and apply these techniques to model and solve heat, wave, and Laplace equations.
CLOBJ 3	Acquire proficiency in solving systems of linear equations using iterative methods like Gauss-Jacobi and Gauss Seidel, and mastering techniques for finding roots of algebraic and transcendental equations through methods such as Bisection, Newton-Raphson, and Regula-Falsi.
CLOBJ 4	Develop a strong understanding of finite differences, interpolation, and related formulas, with a focus on applying Newton's forward and backward difference formula, and Lagrange's interpolation to solve practical problems.
CLOBJ 5	Master numerical integration techniques, including the application of the Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, and gain proficiency in solving ordinary differential equations using methods such as Taylor's series, Euler's method, Modified Euler's method, and the Runge-Kutta method.
CLOBJ 6	Develop the ability to analyze statistical relationships between variables using correlation and regression techniques. Gain proficiency in curve fitting through the method of least squares, including fitting straight lines, second-degree parabolas, and more general curves.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate the ability to translate physical or engineering problems into mathematical equations and solve them.
CLO 2	Develop analytical and critical thinking skills through the process of solving complex mathematical problems.
CLO 3	Understand and interpret mathematical solutions in the context of the given problems.

CLO 4	Communicate mathematical concepts and solutions clearly and effectively, both in written and verbal forms.
CLO 5	Present mathematical arguments and solutions in a logical and organized manner.
CLO 6	Lay a solid foundation for more advanced courses in mathematics and related disciplines.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
4	**0**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	UNIT 1 Z- Transform: Linearity, Z- transform of elementary functions, Shifting theorem, initial and final value theorem, Convolution theorem, inversion of Z- transform, solution of difference equations by Z- Transforms	8%	5
2	UNIT 2 Partial Differential Equations: First order partial differential equations, solutions of first order linear and nonlinear PDEs, Charpit's Method Solution to homogeneous and nonhomogeneous linear partial differential equations second and higher order by	15%	9

Sr. No.	Content	Weightage	Teaching Hours
	complementary function and particular integral method. Separation of variables method to simple problems in Cartesian coordinates, second-order linear equations and their classification, Initial and boundary conditions, Modeling and solution of the Heat, Wave and Laplace equations.		
3	UNIT 3 Solution of a System of Linear Equations, Roots of Algebraic and Transcendental Equations: Gauss-Jacobi and Gauss Seidel Methods, Solution of Polynomial and Transcendental Equations – Bisection Method, Newton-Raphson Method and Regula-Flasi Method	25%	15
4	UNIT 4 Finite Differences and Interpolation: Finite Differences, Relation between Operators, Interpolation using Newton's Forward and Backward Difference Formula. Newton's Divided and Lagrange's Formula for Unequal Intervals	17%	10
5	UNIT 5 Numerical Integration: Trapezoidal rule, Simpson's 1/3rd and 3/8th Rules. Numerical solution of Ordinary Differential Equations: Taylor's Series, Euler and Modified Euler's Methods, Runge Kutta Method of Fourth Order for Solving First Order Equations	10%	6
6	UNIT 6 Correlation, Regression and Curve Fitting : Correlation and Regression – Rank correlation Curve Fitting by The Method of Least Squares- Fitting of Straight Lines, Second Degree Parabolas and More General Curves	25%	15

i. Text Book and Reference Book:

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India Edition.
2. L. Debnath, D. Bhatta, Integral Transforms and their applications, Chapman and Hall, CRC.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2010
4. R. Haberman, Elementary Applied Partial Differential equations with Fourier Series and Boundary Value Problem, 4th Ed, Prentice Hall, 1998.
5. L.S. Andrews, Bhimsen K. Shivamoggi, Integral Transforms for Engineers

a. **Course Name:** Professional Communication Skills

b. **Course Code:** 303193203

c. **Prerequisite:** Knowledge of English language in practical life

d. **Rationale:** Knowledge and application of English, Aptitude and Management Skills are crucial for better employability as well as professionalism

e. **Course Learning Objective:**

CLOBJ 1	Students will be able to demonstrate the ability to communicate clearly and persuasively in oral presentations.
CLOBJ 2	Students will practice active listening techniques to enhance understanding in professional interactions.
CLOBJ 3	Students will write professional emails, memos, and reports with clarity and conciseness.
CLOBJ 4	Students will understand and practice time management strategies effectively.
CLOBJ 5	Students will be able to demonstrate skills in resolving conflicts and negotiating effectively.
CLOBJ 6	Students will use digital communication tools and platforms effectively.

f. **Course Learning Outcomes:**

CLO 1	To develop advanced communication skills
CLO 2	To become more proficient in formal writing
CLO 3	To apply interpersonal communication skills to be more productive at the workplace
CLO 4	To identity set and achieve the goals with the help of time management
CLO 5	To use with range of vocabulary to communicate effectively

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**2**	**0**	**2**	**-**	**100**	**-**	**-**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Technical Writing: Email etiquette & Email writing Letter Writing (Types of Letters & Layout)**: • Trains students on detailed email and letter writing etiquette. • Students will be able to write formal letters following certain stipulated formats. • They will learn different types of letters for different official purposes.	10%	4
2	**Interpersonal Communication at Workplace: Dynamics of communication**: • To develop the confidence to handle a wide range of demanding situation more effectively at the workplace • To enable the students to analyse their own interpersonal communication style.	10%	2
3	**Debate: The three minute debate planner**: • To enable the students to generate effective critical thinking into primary issues in the given topic. • Students will be able to resolve controversies and recognize strengths and weaknesses of arguments.	10%	4
4	**Goal setting & Tracking**: • To enable the students to define strategies or implementation steps to attain the identified goals and make progress every day.	10%	2
5	**Time Management & Task Planning (Case –study)**: • To enable the students to identify their own time wasters and adopt strategies to reduce them. • To enable students to clarify and priorities their objective and goals by creating more planning time	5%	2

Sr. No.	Content	Weightage	Teaching Hours
6	**Reading Comprehension: Intermediate level**: • To enable the students develop the knowledge, skills, and strategies they must possess to become proficient and independent readers	5%	2
7	**Listening Skills: Small everyday conversation & comprehension**: • Provides practice on understanding accents and day to day conversations. • Listening to English conversations in different contexts.	10%	2
8	**Information design and writing for print and online media: Blog Writing**: • To enable students to design information that is targeted to specific audiences in specific situations to meet defined objectives. • To create blogs and share their own knowledge and experience to the world.	5%	2
9	**Advanced vocabulary Building:**: • The students will expand their vocabulary so as to enhance their proficiency in reading and listening to academic texts, writing, and speaking. • The students will attain vocabulary to comprehend academic and social reading and listening texts. • The students will develop adequate speaking skills to communicate effectively.	10%	4
10	**Picture Perception**: • To prepare the students for a test for basic intelligence and IQ, generally done on the first day of SSB (Sashastra Seema Bal is one of India's Central Armed Police Forces)	5%	1
11	**Appreciation, Apology and Acknowledgement letters**: • To enable the students to maintain productive business relationships through different types of letters. • To enable the students to express their feelings without speaking out loud.	10%	2

Sr. No.	Content	Weightage	Teaching Hours
12	**The Art of Negotiation**: • To enable the students to reach an agreement for mutual benefits through negotiation. • To enable the students to learn a process by which compromise or agreement is reached while avoiding argument and dispute.	5%	2
13	**Activity Session (Game of Truth)**: • To make the students think of the significance of certain things in their life. • To make them share their thoughts and perception of matters in life, with others.	0%	1

i. Reference Books:

1. Business Correspondence and Report Writing Sharma, R. And Mohan, K.
2. Communication Skills, Kumar S And Lata P; New Delhi Oxford University Press
3. Practical English Usage, by MICHAEL SWAN
4. A Remedial English Grammar for Foreign Student, by F.T. Wood
5. On Writing Well, William Zinsser; Harper Paperbacks,2006; 30th anniversary edition
6. Oxford Practice Grammar, John Eastwood; Oxford University Press
7. Quantitative Aptitude for Competitive Examinations, by Dr. R.S. Aggarwal

a. **Course Name:** Product Realisation

b. **Course Code:** 303106213

c. **Prerequisite:** Knowledge of the Design process of Electrical Engineering.

d. **Rationale:** This course is meant for beginners. The course is designed to imbibe Design Thinking understanding and mindset for the 3rd-semester students. The course aims to expose students to the primary process and framework of Design Thinking and relevant tools & techniques for Creativity & Innovation.

e. **Course Learning Objective:**

CLOBJ 1	Define and explain the stages of the Design Thinking process.
CLOBJ 2	Develop user personas and empathy maps to guide the design process.
CLOBJ 3	Apply Design Thinking principles and methods to real-world challenges across various domains
CLOBJ 4	Use mind mapping as a tool for brainstorming and idea generation.
CLOBJ 5	Effectively communicate design concepts, solutions, and the rationale behind them to both technical and non-technical audiences.
CLOBJ 6	Analyze user feedback to refine and improve design solutions through multiple iterations.

f. **Course Learning Outcomes:**

CLO 1	Develop group working, including task sub-division and integration of individual contributions from the team.
CLO 2	Importance and understanding of Design Thinking for innovation, entrepreneurship, societal solutions with various learning tools.
CLO 3	Perform various tasks like market survey, industrial visits, creative and innovative techniques, etc to identify project
CLO 4	Develop sense of Environmental responsibility

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Introduction of Design Thinking:** Overview, objective and goal of this course, What is Design Thinking? - Its importance, socio-economical relevance, Systematic problem identification & problem-solving approaches. Observation: Through AEIOU.	21%	6
2	**Ideation Phase** Preparation of Ideation canvas. Brainstorming (What, Why, How, When, For Whom). Situation/Context/Location, Props/non-living, things/tools /equipment	21%	6
3	**Mind map:** Begin with the main concept. Determine the main purpose of your mind map & add branches that will outline the most basic subtopics. Explore topics by adding more branches.	21%	6
4	**Empathy Map:** Define scope and goals. Gather materials. Your purpose should dictate the medium you use to create an empathy map. Converge to cluster and synthesize. Polish and plan.	15%	4
5	**Product Development Phase:** Discussion on Product Development Canvas (PDC) :Preparation of Product Development Canvas (PDC)	15%	4
6	**Feedback & Final Report:** Upload duly signed, Continuous Assessment Card.	7%	2

i. Text Book and Reference Book:

1. Integrated Product and Process Design and Development, by Edward B Magrab, Satyandra K Gupta, F Patrick McCluskey
2. Product Realization: Going from One to Million, by Anna C Thornton
3. Product Realization: Comprehensive Approach, by Mileta Tomovic, Shaoping Wang.
4. Empathy Maps: Step by Step guide, by Robert Curedale
5. Empathy Maps: Step by Step guide, by Natasha Hampshire, Glaudia Califano & David Spinks

Semester 4

a. **Course Name:** Control System Engineering Lab

b. **Course Code: 3**03106252

c. **Prerequisite:** Knowledge of Basic Electrical Engineering, Linear differential equations, Differential equations and its solution, Laplace transform and signals & systems.

d. **Rationale:** The course provides fundamentals of Fourier Transform, systems and control, Understanding and predicting system behaviour to the students of electrical engineering

e. **Course Learning Objective:**

CLOBJ 1	Understand basic concepts of Fourier Transform and control theory
CLOBJ 2	Assess the stability criterion of closed loop systems with the help of root locus on system performance
CLOBJ 3	Analyze behaviour of system in time and frequency domain
CLOBJ 4	Understand concepts of state space concepts of control system
CLOBJ 5	Design controller to meet desired specifications
CLOBJ 6	Use and apply PID Control.

f. **Course Learning Outcomes:**

CLO 1	Develop the mathematical model of the physical systems
CLO 2	Analyse the response of the closed and open loop systems
CLO 3	Analyse the stability of the closed and open loop systems
CLO 4	Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions.
CLO 5	Formulate different types of analysis in frequency domain to explain the nature of stability of the system
CLO 6	Develop and analyse state space models.

g. **Teaching & EExamination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	

3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**30**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Introduction to Control systems:** Introduction, History of Automatic Control, Open loop control and close loop control; Illustrative examples of control systems.	**6%**	**3**
2	**Mathematical Models of Systems:** Linear and non-linear systems; equations and transfer functions for linear mechanical translational systems and linear electrical network; Force-Voltage and Force-Current analogy; Block diagram representation of control systems; Block diagram reduction; Signal flow graph and Mason's gain formula.	**24%**	**12**
3	**Time domain analysis:** Typical test signals; Response of first-order systems; Transient response of a second order system due to impulse and step input; Time domain specifications of a second order system; Steady-state errors and Static error coefficients.	**17%**	**8**
4	**Stability:** Concept of Stability: absolute, relative and marginal, nature of system response for the various locations of roots in S-plane of characteristic equation, stability analysis using Hurwitz's criterion, Routh's criterion. Basic properties of Root Loci, construction of Root loci. Angle and magnitude condition for stable systems.	**17%**	**8**
5	**Frequency Domain Analysis:** Steady state response of a system due to sinusoidal input; Relation between time & frequency response for second order systems. Frequency response specifications. Stability Analysis with bode plots, polar plot and Nyquist stability criterion.	**15%**	**7**
6	**State Variable Analysis :**	**15%**	**7**

Sr. No.	Content	Weightage	Teaching Hours
	Introduction to state space analysis, advantages, important definitions state, state variables, State vector, state space, state equation, output equation etc. State space representation for Electrical Network, nth order differential equation, Transfer function.		
7	**Basic Concept of compensator and Controller:** Introduction to phase lag, phase lead and phase lag-lead networks and their applications. P, PI, PID Controllers.	**6%**	**3**

i. Text Book and Reference Book:

1. CONTROL SYSTEMS ENGINEERING (TextBook), by I J Nagrath, M Gopal, New Age International Publishers Ltd.
2. Modern Control Engineering, by Katsuhiko Ogata, Prentice Hall of India
3. Feedback and Control Systems, by Joseph J Distefano,Tata McGraw - Hill Education
4. Automatic Control Systems, by Benjamin C.Kuo, John Wiley & Sons.
5. Control Systems, by N.C.Jaynn, B.S. Publications, 2nd Edition

a. **Course Name:** Control System Engineering Lab

b. **Course Code:** 303106251

c. **Prerequisite:** Knowledge of Basic Electrical Engineering, Linear differential equations, Differential equations and its solution, Laplace transform and signals & systems.

d. **Rationale:** The course provides fundamentals of Fourier Transform, systems and control, Understanding and predicting system behaviour to the students of electrical engineering

e. **Course Learning Objective:**

CLOBJ 1	Understand basic concepts of Fourier Transform and control theory
CLOBJ 2	Assess the stability criterion of closed loop systems with the help of root locus on system performance
CLOBJ 3	Analyze behaviour of system in time and frequency domain
CLOBJ 4	Understand concepts of state space concepts of control system
CLOBJ 5	Design controller to meet desired specifications
CLOBJ 6	Use and apply PID Control.

f. **Course Learning Outcomes:**

CLO 1	Analyze first and second order systems using time domain analysis.
CLO 2	Analyze first and second order systems using frequency domain analysis.
CLO 3	Design PID controller.
CLO 4	Design and Implement PID controller for any applications
CLO 5	To get acquainted with MATLAB programming, MATLAB-SIMULINK in order to simulate, analyze and design control system design for different plants under consideration.

g. **Teaching & EExamination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**0**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. CONTROL SYSTEMS ENGINEERING (TextBook), by I J Nagrath, M Gopal, New Age International Publishers Ltd.
2. Modern Control Engineering, by Katsuhiko Ogata, Prentice Hall of India
3. Feedback and Control Systems, by Joseph J Distefano, Tata McGraw - Hill Education
4. Automatic Control Systems, by Benjamin C.Kuo, John Wiley & Sons.
5. Control Systems, by N.C.Jaynn, B.S. Publications, 2nd Edition

i. List of Experiment:

Sr. No.	Experiment Title
1	Introduction to MATLAB.
2	Introduction to Simulink and various block sets.
3	Analysis Different Input Signals To Control System.
4	Analyse Linear Time-invariant Systems and Representation
5	Write a MATLAB program for reduction of Block diagram.
6	Plotting response of first order circuit and second order circuits with the help of MatLab programming.
7	Simulation of armature control DC motor.
8	Obtain the root locus plot for the system using MATLAB.
9	Obtain the Bode plot for the system using MatLab.
10	Obtain the Nyquist plot for the system using MatLab.
11	Basic concept of state space and its conversion.
12	Simulation of control system represented in state space form.
13	Analysis Effect of P, PD, PI, PID Controller on systems.

j. Laboratory Equipment: MATLAB software.

a. Course Name: Electrical Machines- II

b. Course Code: 303106253

c. Prerequisite: Fundamental of Network Analysis and Electrical Machine- I

d. Rationale: The course will provide a strong foundation on A. C. Machines which will be useful for understanding the foundation of operation, working, analysis testing and applications of single and three phase motors. The students will learn proper applications of motors for their efficient use in industry. Students will also explore the industrial applications of such motors

e. Course Learning Objective:

CLOBJ 1	Demonstration of construction on AC Machines.
CLOBJ 2	Construction, principle of operation and performance of induction machines.
CLOBJ 3	Starting and speed control of three-phase induction motors.
CLOBJ 4	Construction, principle of operation and performance of single phase induction motors and special machines.
CLOBJ 5	Principle of operation and performance of synchronous motor.
CLOBJ 6	Construction and performance of salient and non – salient type synchronous generators.

f. Course Learning Outcomes:

CLO 1	Explain the fundamental principles of AC machine windings, including their physical arrangement, magnetic field distribution, and performance characteristics.
CLO 2	Describe the behavior of pulsating and revolving magnetic fields in AC machines.
CLO 3	Analyze the construction, operation, and performance characteristics of induction motors.
CLO 4	Evaluate the construction, operation, and performance characteristics of synchronous machines, including cylindrical and salient pole types, and their parallel operation.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**		
L	**T**	**P**	**C**	**Internal Evaluation**	**ESE**	**Total**

				MSE	CE	P	Theory	P	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Fundamentals of AC machine** Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, Air-gap MMF distribution with fixed current through winding-concentrated and distributed, Sinusoidally distributed winding, winding distribution factor.	**17%**	**8**
2	**Pulsating and revolving magnetic fields:** Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.	**17%**	**8**
3	**Induction Machines** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). No load and Blocked rotor test on induction motor Circle Diagram of Induction motor Methods of starting, braking and speed control for induction motors. Induction motor as a Generator.	**27%**	**12**
4	**Single-phase induction motors** Constructional features double revolving field theory, equivalent circuit, and determination of parameters. Splitphase starting methods and applications.	**12%**	**5**
5	**Synchronous machines**	**27%**	**12**

Sr. No.	Content	Weightage	Teaching Hours
	Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division		

i. Text Book and Reference Book:

1. Electrical Machinery, by Dr P.S. Bhimbra, Khanna Publishers
2. Electric Machines, (TextBook) by I. J. Nagrath and D. P. Kothari, McGraw Hill Education, Pub. Year 2010
3. A course in electrical machine Design, (TextBook) by A. K. Sawhney, Dhanpat Rai and Sons
4. Electrical Machinery, (TextBook) by A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, Mcgraw Hill

a. **Course Name:** Electrical Machines-II lab

b. **Course Code:** 303106254

c. **Prerequisite:** Fundamental of Network Analysis and Electrical Machine-I

d. **Rationale:** The course will impart the knowledge of magnetic circuits, various fundamentals of A.C. machines.

e. **Course Learning Objective:**

CLOBJ 1	Validate the theory and working of 3 phase and 1 phase Induction machines through laboratory experimental work.
CLOBJ 2	Perform circuit diagram connections for experiments and measure and analyze the observed data to come to a conclusion.
CLOBJ 3	Prepare the report based on results received.
CLOBJ 4	Determine the different parameters of a three-phase alternator and its regulation

f. **Course Learning Outcomes:**

CLO 1	Interpret various characteristics of the Induction Machine.
CLO 2	Estimate various parameters after conducting different tests on a Synchronous machine.
CLO 3	Assess the performance of Single Phase Induction Motor.
CLO 4	Perform synchronization of the alternator with grid.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**0**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Text Book and Reference Book:**

1. Electrical Machinery, by Dr P.S. Bhimbra, Khanna Publishers
2. Electric Machines, (TextBook) by I. J. Nagrath and D. P. Kothari, McGraw Hill Education, Pub. Year 2010

3. A course in electrical machine Design, (TextBook) by A. K. Sawhney, Dhanpat Rai and Sons
4. Electrical Machinery, (TextBook) by A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, Mcgraw Hill

i. List of Experiment:

Sr. No.	Experiment Title
1	Perform no load and blocked rotor test on a three phase induction motor to find out its performance parameters with the help of Equivalent Circuit Diagram
2	Perform no load and blocked rotor test on a three phase induction motor to find out its performance parameters with the help of Circle Diagram.
3	Perform direct load test on a three phase induction motor to find out its performance parameters at different load conditions.
4	To perform no load and blocked rotor test on single phase induction motor to obtain its equivalent circuit.
5	Perform speed control of induction motor using Cascade connection.
6	Perform open circuit, short circuit and resistance measurement test on synchronous generator
7	Find out voltage regulation of synchronous machines by Synchronous impedance method.
8	Find out voltage regulation of synchronous machine by MMF method
9	Perform the synchronization of three phase alternator with grid using two bright one dark lamp methods.
10	Find out voltage regulation of synchronous machines by ZPF method.

j. Equipment: 3-phase induction motor, single phase induction motor, synchronous motor, generator

a. **Course Name:** Power Electronics - I

b. **Course Code:** 303106255

c. **Prerequisite:** Knowledge of Physics, Mathematics and Basic Electronics.

d. **Rationale:** This course provides an introduction to power electronics and its applications. The broad objective of the course is to teach students energy conversion, processing using power electronic converters, application of power electronics for drives. At the end of this course students will be able to explain working of various power devices and power converters, derive converters mathematical relations,. Laboratory exercises are basically guided design problems

e. **Course Learning Objective:**

CLOBJ 1	Understanding power electronics principles, applications, converter classification, and ideal switching device criteria for efficient power control and conversion.
CLOBJ 2	Comprehensive understanding of power semiconductor devices, including their characteristics, firing circuits, commutation, gate drive circuits, symbolic study, protection methods, effects of dv/dt and di/dt, snubber circuit design, series and parallel operation of SCR, and the functioning of gate turn off thyristors (GTO).
CLOBJ 3	Mastery of thyristor-based rectifiers (single-phase half-wave, full-wave, full-bridge), understanding their operation with resistive and highly inductive loads, analysis of input current waveform, power factor considerations, exploration of single-phase and three-phase semi-converters, dual converters, and assessing the impact of source and load inductances.
CLOBJ 4	Mastering DC-DC buck converters: grasping the basics of choppers, understanding duty ratio and average voltage concepts, analyzing power circuits, steady-state waveforms, and regulating output voltage via duty ratio control.
CLOBJ 5	Comprehensive understanding of DC-DC boost converters: exploring power circuitry, analyzing steady-state waveforms, establishing the connection between duty ratio and average output voltage. Additionally, comprehension of various thyristor-based DC-DC converter circuits including voltage-commutated, current-commutated, and load-commutated circuits.
CLOBJ 6	Mastering how to create steady power sources, designing efficient chargers, controlling motors, and using power electronics in solar systems and high-voltage

f. **Course Learning Outcomes:**

CLO 1	Explain the construction and characteristics of the Power semiconductor devices family.
CLO 2	Understand the differences between signal level and power level devices.

CLO 3	Analyse controlled rectifier circuits.
CLO 4	Analyse the operation of DC-DC converters.
CLO 5	Demonstrate the knowledge of power electronic converters for different DC applications.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Introduction** to power electronics Introduction, Scope and applications, Classification of power electronic converters, Requirements of ideal switching device.	04%	02
2	**Power switching devices** Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT. Symbolic study of all power semiconductor switching devices, Protection of Power switching devices, Effect of dv/dt and di/dt, Snubber circuit design, Series and parallel operation of SCR, Gate turn off thyristors (GTO)	22%	10
3	**Thyristor** Rectifiers Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R load and	22%	10

Sr. No.	Content	Weightage	Teaching Hours
	highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor. Single phase and three phase semi converters with R load and highly inductive load, Single phase and three phase dual converters, Effect of source and load inductances.		
4	**DC-DC buck converter** Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.	**16%**	**07**
5	**DC-DC boost converter** Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage. Thyristor DC-DC converter circuits: Voltage commutated, Current Commutated and Load Commutated.	**18%**	**08**
6	**Applications** Regulated power supply, SMPS, Battery charger, DC motor control, DC Circuit Breakers, Overview of HVDC systems, Overview on Application of Power electronics in solar system.	**18%**	**08**

i. Text Book and Reference Book:

1. Power Electronics by Dr P.S. Bhimbra, Khanna and Khanna Publishers, New Dehli .
2. Power Electronics - Circuits, Devices and Applications (TextBook) by Muhammad H. Rashid, Prentice Hall of India
3. Power Electronics – Converters, Applications and Design (TextBook) by Ned Mohan, Undeland and Robbins, John Willey & sons, Inc.
4. Fundamentals of Power Electronics (TextBook) by R. W. Erickson and D. Maksimovic, Springer Science & Business Media, Pub. Year 2007
5. Power Electronics : Essentials & Applications (TextBook) by L. Umanand, Wiley India Pvt Ltd

a. Course Name: Power Electronics - I Lab

b. Course Code: 303106256

c. Prerequisite: Knowledge of Physics, Mathematics and Basic Electronics.

d. Rationale: This course provides an introduction to power electronics and its applications. The broad objective of the course is to teach students energy conversion, processing using power electronic converters, application of power electronics for drives. At the end of this course students will be able to explain working of various power devices and power converters, derive converters mathematical relations, Laboratory exercises are basically guided design problems

e. Course Learning Objective:

CLOBJ 1	Understanding power electronics principles, applications, converter classification, and ideal switching device criteria for efficient power control and conversion.
CLOBJ 2	Comprehensive understanding of power semiconductor devices, including their characteristics, firing circuits, commutation, gate drive circuits, symbolic study, protection methods, effects of dv/dt and di/dt, snubber circuit design, series and parallel operation of SCR, and the functioning of gate turn off thyristors (GTO).
CLOBJ 3	Mastery of thyristor-based rectifiers (single-phase half-wave, full-wave, full-bridge), understanding their operation with resistive and highly inductive loads, analysis of input current waveform, power factor considerations, exploration of single-phase and three-phase semi-converters, dual converters, and assessing the impact of source and load inductances.
CLOBJ 4	Mastering DC-DC buck converters: grasping the basics of choppers, understanding duty ratio and average voltage concepts, analyzing power circuits, steady-state waveforms, and regulating output voltage via duty ratio control.
CLOBJ 5	Mastering how to create steady power sources, designing efficient chargers, controlling motors, and using power electronics in solar systems and high-voltage

f. Course Learning Outcomes:

CLO 1	Discriminate different data sheets of power electronics devices.
CLO 2	Assess the performance of different power electronics devices characteristics and operation.
CLO 3	Construct the simulation of power electronics DC output converters and conclude its output.
CLO 4	Assess the performance of power electronics DC output converters

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. Electrical Machinery, by Dr. P.S. Bhimbra, Khanna Publishers
2. Electric Machines (TextBook), by I. J. Nagrath and D. P. Kothari, McGraw Hill Education, Pub. Year 2010
3. A course in electrical machine Design (TextBook), by A. K. Sawhney, Dhanpat Rai and Sons
4. Electrical Machinery (TextBook) by A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, Mcgraw Hill

i. List of Experiment:

Sr. No.	Experiment Title
1	Survey of power electronics devices and study of its data sheet
2	Obtain Static VI characteristic of Thyristor.
3	Perform operation of the firing circuit for thyristor using UJT as a relaxation oscillator.
4	Perform the operation of a single-phase half wave controlled rectifier using RC phase shift triggering.
5	Perform single phase Dual Converter.
6	Perform step Down chopper (Buck Converter)
7	Perform step Up chopper (Boost Converter).
8	Simulate and verify a 1- Ø Full controlled rectifier bridge with different kinds of load and effect of Freewheeling Diode.
9	Simulate and verify a 3- Ø full controlled rectifier bridge with different kinds of load and effect of Freewheeling Diode.
10	Simulate operation of 1 - Ø full wave controlled rectifier with considering effects of source impedance.

j. Equipment: DSO, connecting wire, diode, thyristors , multimeters,UJT

a. Course Name: Electromagnetic

b. Course Code: 303106257

c. Prerequisite: Knowledge of Physics and Mathematics up to 12th science level.

d. Rationale: The course will impart the knowledge of electric field, magnetic field, Energy, Potential, conductors, dielectric capacitance and various mathematical

Equations like Poisson's and Laplace's equations and Maxwell's equations.

e. Course Learning Objective:

CLOBJ 1	Upon completion of this course, students will comprehend the fundamental concepts of Scalars and Vectors, Vector Algebra, and coordinate systems. They will adeptly manipulate vector components, explore vector fields, and apply mathematical operations such as dot and cross products. Proficiency in Circular Cylindrical and Spherical coordinates, vector operators (del), gradient, divergence, curl, and their practical applications will be achieved through comprehensive examples.
CLOBJ 2	By the end of this course, students will grasp the experimental law of Coulomb, comprehend Electric Field Intensity, and analyze fields generated by continuous volume, line, and sheet charge distributions.
CLOBJ 3	Students will grasp Electric Flux Density, Gauss's Law, and the relationship between Divergence Electric Flux Density. Through practical examples and applications, they will develop a thorough understanding of Gauss's law and its significance in electrostatics.
CLOBJ 4	Students will comprehend energy expenditure in moving a point charge within an electric field. They will master the concepts of line integrals, potential, potential difference, and analyze potential fields of point charges, systems of charges, and electric dipoles through practical examples.
CLOBJ 5	Students will acquire a comprehensive understanding of current, current density, and the continuity of current in metallic conductors. They will delve into the properties of dielectric materials, explore capacitance principles, and apply capacitance concepts through practical examples.
CLOBJ 6	Students will acquire the Biot-Savart law and Ampere's circuital law, gaining proficiency in curl, magnetic flux, and magnetic flux density. They will understand scalar and vector magnetic potentials, applying these principles in practical scenarios.

f. Course Learning Outcomes:

CLO 1	Apply vector calculus to understand the behavior of static electric fields and static magnetic fields in standard configurations

CLO 2	Identify the physical explanation and application of divergence, curl and gradient operator.
CLO 3	Analyze the electromagnetic waves using divergence, stoke's theorem, Maxwell's, Poisson's and Laplace equations
CLO 4	Calculate the electrostatic and magneto static fields.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Vector Analysis** Scalars and Vectors, Vector Algebra, The rectangular coordinate system, Vector components and unit vectors, The vector field, The dot product, The cross product, Circular cylindrical coordinates, Spherical coordinate system, vector operator del, gradient, divergence, curl and Examples	18%	8
2	**Coulomb's law and Electric Field Intensity** The experimental law of Coulomb, Electric field intensity, Field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge.	16%	7
3	**Electric Flux Density, Gauss law and Divergence**	16%	7

	Electric flux density, Gauss's law, Examples and Application of Gauss law.		
4	**Energy and Potential** Energy expended in moving a point charge in an electric field, The line integral, Definition of potential and potential difference, The potential field of a point charge, The potential field of a system of charges, An Electric Dipole, Examples.	18%	8
5	**Current and Conductors** Current and current density, Continuity of current, Metallic conductors, The nature of dielectric materials, Capacitance, Capacitance examples.	16%	8
6	**The Steady Magnetic Field** Biot-Savart law, Ampere's circuital law, Curl, Magnetic flux and magnetic flux density, The scalar and vector magnetic potentials.	16%	7

i. Text Book and Reference Book:

1. Engineering Electromagnetics, by William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, Seventh Edition (TextBook)
2. CBS Problems & Solutions Series: Problems & Solutions of Engineering Electromagnetics, by Experienced Teachers, CBS Publisher
3. Engineering Electromagnetics, by Nathan Ida, Springer India Pvt Ltd
4. Elements of Electromagnetic, by Matthew N. O. Sadiku, Oxford University Press

a. **Course Name:** Electromagnetic Lab

b. **Course Code:** 303106257

c. **Prerequisite**: Knowledge of Physics and Mathematics up to 12th science level.

d. **Rationale:** The course will impart the knowledge of electric field, magnetic field, Energy, Potential, conductors, dielectric capacitance and various mathematical

equations like Poisson's and Laplace's equations and Maxwell's equations.

e. **Course Learning Objective:**

CLOBJ 1	**Coordinate Systems:** Apply Cartesian, cylindrical, and spherical coordinate systems to solve problems. Convert between coordinate systems and solve real-world examples.
CLOBJ 2	**Vector Operations:** Master dot and cross products, applying them in vector algebra. Solve advanced problems involving the product of three vectors.
CLOBJ 3	**Electrostatics:** Apply Coulomb's law to solve problems with point charges. Analyze interactions between multiple charges.
CLOBJ 4	**Electric Fields and Charge Distributions:** Calculate electric field intensity for various charge distributions. Analyze and solve problems for electric fields created by volume, line, and sheet charges.
CLOBJ 5	**Gauss's Law and Electric Potential:** Apply Gauss's law for electric flux density and understand its applications. Analyze and solve problems involving electric potential fields, considering point, line, surface, and volume charges.

f. **Course Learning Outcomes:**

CLO 1	Calculate the electrostatic and magneto static fields.
CLO 2	Apply mathematical knowledge of vector algebra to determine charge behaviour in magnetic fields and its applications.
CLO 3	Describe the magnetic behaviour of various materials in different electric conditions and its applications.
CLO 4	Apply vector calculus to understand the behavior of static electric fields and static magnetic fields in standard configurations.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. Engineering Electromagnetics, by William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, Seventh Edition (TextBook)
2. CBS Problems & Solutions Series: Problems & Solutions of Engineering Electromagnetics, by Experienced Teachers, CBS Publisher
3. Elements of Electromagnetic, by Matthew N. O. Sadiku, Oxford University Press
4. Engineering Electromagnetics, by Nathan Ida, Springer India Pvt Ltd

i. List of Experiment:

Sr. No.	Experiment Title
1	Solve the examples of the coordinate systems. (Cartesian, cylinder and spherical coordinate system).
2	Solve the examples of dot & cross product and product of three vector.
3	Solve the examples based on Coulomb's law.
4	Solve the examples based on Electrical field intensity and Field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge.
5	Solve the examples based on the Electric field due to a continuous volume charge distribution, Field of a line charge, Field. of a sheet charge
6	Solve the examples based on Electric flux density and Application of Gauss's law.
7	Solve the examples based on the Potential field of a point charge, line charge, surface charge, and volume charge.
8	Solve the examples based on Current density and Conductors.
9	Solve the examples based on the application of Dielectrics and Capacitances.

10	Solve the examples based on the Finite Element Method using software.

j. Laboratory Equipment: Softwares like FEMM, VLab.

a. **Course Name:** Power Plant Engineering

b. **Course Code:** 303106259

c. **Prerequisite:** The course will provide understanding of power generation technology using conventional and non-conventional energy sources which will be useful for understanding the operation and working of power plants. Students will learn the basics of Tariff structure for energy production. Students will understand the Operation, maintenance and working of substations

d. **Rationale:** This course provides complete knowledge of various Power plants. The course is designed to give fundamental knowledge of construction & working of various power plants. It provides basic knowledge of the technologies available at power plants and would also acquaint with the latest technological advances taking place in this sector.

e. **Course Learning Objective:**

CLOBJ 1	Describe the working of thermal power station (TPS) and hydro energy conversion process using a single line diagram and state the functions of the major equipment and auxiliaries.
CLOBJ 2	Clarify the working of Nuclear power station, Diesel power station and Gas turbine power plant
CLOBJ 3	Prepare economic analysis for Commercial/ Industrial/ Residential PV energy conservation systems and Identify various components of Wind Energy Conversion systems.
CLOBJ 4	Compare various economic aspects of different types of Tariffs
CLOBJ 5	To Cognize Different Equipment used in Substation
CLOBJ 6	Evaluation between various Power Plants which is economically beneficial.

f. **Course Learning Outcomes:**

CLO 1	Recall the sources of energy generation
CLO 2	Explain working of Thermal, Hydro, Nuclear, and Gas Turbine power plants with their auxiliaries, environmental aspects of site selection and shall be able to distinguish between different types of power plants.
CLO 3	Describe solar power generation and wind power generation.
CLO 4	Understand power generation through different types of fuel cells
CLO 5	Understand different types of equipment used in substations and learn the economic factors of power generation.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction : Generation of electric power from Conventional and non-conventional sources of energy. Calculation of gross calorific and Net calorific value of fuel, Bomb calorimeter application, Power crisis in India.	7%	3
2	Thermal Power Plants: Schematic arrangement, advantages and disadvantages, choice of site, efficiency of steam power station, Types of prime movers, Types of Boiler, Dust collection, feed water system, steam power plant auxiliaries, Super critical thermal power plant.	13%	6
3	HydroElectric Power Plant: Schematic arrangement, advantages and disadvantages, choice of site constituents of hydro power plant, Types of Dam, Types of Hydro turbine. Environmental aspects for selecting the sites and locations of hydro power stations.	12%	5
4	Nuclear Power Plant: Schematic arrangement, advantages and disadvantages, selection of site, Nuclear Reaction, Nuclear fission and chain reaction classification of reactors, Nuclear reactor main parts and their function, pollution from nuclear power plants.	13%	6
5	Gas Turbine Power Plant:	9%	4

Sr. No.	Content	Weightage	Teaching Hours
	Schematic arrangement, advantages and disadvantages of Gas turbine power plant. Open cycle and Closed cycle gas turbine power plant, Combined cycle power plant.		
6	Solar Power Plant: Solar radiation spectrum, Radiation measurement, Applications of solar thermal systems, schematic arrangement of solar power plant, Solar Photovoltaic (SPV) systems Operating principle, Photovoltaic cell concepts, Types of solar cells, fabrication of SPV cells, Cell, module, array (Series and parallel connections), SPV system components and their characteristics.	13%	6
7	Wind Power Generation: Basic principles of wind energy conversion , forces on the blade, power in the wind maximum power, Basic components of wind energy conversion systems, classifications of WECS-HAWT, VAWT, Schemes of electric generation, Squirrel Cage Induction Generators (SCIG), wound rotor (WRIG), doubly-fed (DFIG), wound rotor synchronous generator (WRSG), Permanent magnet synchronous generator (PMSG)., Site selection considerations.	11%	5
8	Fuel cell based power plant: Introduction, concept, types, Electrochemical Reactions, Hydrogen, Oxygen Fuel cells, Phosphoric Acid Fuel cells, Molten Carbonate Fuel cells, Methanol fuel cells, Medium temperature, fuel cell, Fuels, Commercial plants in the world.	9%	4
9	Substation and Economics of Power Generation: Classification of Substations, substation equipment, Specification and selection of equipment, Site selection of substation Load curves, Load duration curves, Connected load, Maximum load, Peak load, Base load and peak load power plants, Load factor, Plant capacity factor, Plant use factor, Demand factor, Diversity factor, Cost of power plant, Performance and operating characteristics of power plant, Tariff for electric energy	13%	6

i. Text Book and Reference Book:

1. Renewable Energy Sources for Sustainable Development, N. S. Rathore; New India Publishing Agency.
2. A Textbook of Power System Engineering, A. Chakrabarti , M.L. Soni , U.S. Bhatnagar, P.V. Gupta; Dhanpat Rai & Co
3. Wind power in Power Systems, Thomas Ackermann; John Willy and sons, 2005.
4. Power Plant Engineering, Manish Dwivedi , Amit Prakash Srivastava , A. K. Raja; New Age International
5. Electric Power Generation: Transmission and Distribution, Singh S.N; PHI
6. Electrical Power, S Rao , S L Uppal; Khanna Publishers
7. Non-Conventional Energy Sources, G. D. Rai; khanna publishers; fifth, 2012

a. **Course Name:** PROFESSIONAL GROOMING & PERSONALITY DEVELOPMENT

b. **Course Code:** 303193252

c. **Prerequisite:** Knowledge of English language in practical life

d. **Rationale:** Knowledge and application of English, Aptitude and Management Skills are crucial for better employability as well as professionalism

e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLOBJ 2	Solve problems related to Alternating current, alternating voltage, etc, Demonstrate a clear understanding of Pure R, L C circuit and combination of RLC, Series and Parallel combination of R, L and C, etc
CLOBJ 3	Acquire knowledge of the resistor, capacitor, and inductor and their performance characteristics for series and parallel connections.
CLOBJ 4	Understand different single phase and three phase circuits.
CLOBJ 5	Demonstrate a clear understanding of the basic concepts, working principles and applications of transformer, DC machines and AC machines.
CLOBJ 6	Study the use of LT SwitchGear, Fuse, MCB, ELCB etc

f. **Course Learning Outcomes:**

CLO 1	Identity and develop soft skills required for personal and professional growth.
CLO 2	Develop professional etiquette & desired behaviour at the workplace
CLO 3	Speak and participate effectively in oral organizational communication
CLO 4	Improve comprehension skills for reading.
CLO 5	Know how to be assertive in professional environment

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**1**	**0**	**1**	**-**	**100**	**-**	**-**	**-**	**100**

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Topic	Weightage	Teaching Hrs.
1	Self-Development and Assessment: Various self-assessments for personal and professional development skills that are relevant to career development: • Change, Grow, Persist, Prioritize, Read, Learn, Listen, Record, Remember, Guess, Think, Communicate, Relate, and Dream	25%	4
2	Corporate Etiquette: Tips and guides to develop personality and gain various etiquettes, manners, case studies and activities. Telephone etiquette • Etiquette for foreign business trips • Etiquette for small talks • Respecting privacy • Learning to say 'No'	25%	4
3	Public Speaking: It's process of communicating information to an audience and is helpful in career advancement. Effective Public speaking skills includes:Choosing appropriate pattern • Selecting appropriate method • Art of persuasion • Making speeches effective • Delivering different types of speeches	20%	4
4	Reading Skills Activity & Reading Comprehension: Aims to improve students' Comprehension Skills in English Language by getting them involved in reading activity and providing practice for reading comprehension.	15%	2
5	Listening Skills- Inquiry Based Listening Questions: Aims to improve students' listening skills in English Language providing them practice of various types of inquiry based	15%	1

Sr. No.	Topic	Weightage	Teaching Hrs.
	listening tracks. Students will listen and will be able to find out details from the conversations.		

i. Reference Books:

1. Business Correspondence and Report Writing Sharma, R. And Mohan, K
2. Communication Skills, Kumar S and Lata P; New Delhi Oxford University Press
3. Practical English Usage Michael Swan
4. A Remedial English Grammar for Foreign Student, by F.T. Wood
5. On Writing Well, William Zinsser; Harper Paperbacks,2006; 30th anniversary edition
6. Oxford Practice Grammar, John Eastwood; Oxford University Press

Semester-5

a. Course Name: Microcontroller and its Application

b. Course Code: 303106301

c. Prerequisite: Basic Knowledge of programming in Assembly and C language, Knowledge of basic things of Computer and their working.

d. Rationale: The course provides understanding of microcontrollers and enables students to use microcontroller for hardware implementation of various electrical engineering concepts.

Course Learning Objective:

CLOBJ 1	Explain the internal architecture of microcontrollers, including the CPU, memory, I/O ports, and peripherals.
CLOBJ 2	Demonstrate proficiency in programming microcontrollers using a high-level language (C) and assembly language.
CLOBJ 3	Design electrical circuitry for microcontroller I/O ports.
CLOBJ 4	Analyze program performance and optimize code where necessary.

e. Course Learning Outcomes:

CLO 1	Assess and solve basic operations using the different instructions of microprocessors/microcontroller and explain the different Microcontroller's internal architecture and its operation.
CLO 2	Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microcontroller.
CLO 3	Design and develop electrical circuitry for the Microcontroller I/O ports in order to interface the controller to external devices.
CLO 4	Evaluate and Analyse C language and assembly language programs, select appropriate assembler and download the machine code that will provide solutions for the real-world control problems

f. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		Bloom's Level
CLO 1	Assess and solve basic operations using the different instructions of microprocessors/microcontroller and explain the different Microcontroller's internal architecture and its operation.	4
CLO 2	Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microcontroller.	3
CLO 3	Design and develop electrical circuitry for the Microcontroller I/O ports in order to interface the controller to external devices.	6
CLO 4	Evaluate and Analyse C language and assembly language programs, select appropriate assembler and download the machine code that will provide solutions for the real-world control problems	4,5

g. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	PLOs												PSLO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00
CLO 2	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00
CLO 3	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 4	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Weighted Average	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50

h. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

i. **Course Content:**

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Fundamentals Of Microprocessors:** Introduction of embedded system, basic architecture of the Embedded System, Role of microcontrollers in embedded systems, Fundamentals of Microprocessor Architecture, 8-bit Microprocessor and Microcontroller architecture, Comparison of 8-bit, 16-bit and 32-bit microcontrollers, Criteria in choosing micro-controllers.	**5**	**2**
2	**The 8051 Architecture:** Architecture of 8051, Pin diagram of 8051, Functional Block diagram of 8051, Internal memory organization (RAM and ROM). PORT structure of 8051.	**9**	**4**
3	**Instruction Set And Programming:** Concepts of assembler, editor, linker, loader, debugger, simulator, emulator and assembly directives. Difference between programming in embedded C and programming in assembly language. Assembly instructions set: addressing modes, Immediate addressing, Register addressing, Direct Addressing, Indirect addressing, Relative addressing, indexed addressing,	**13**	**15**

	Classification of Instruction sets: Data transfer, Logical, Branching, Arithmetic and bit wise operation instruction set. Basic C language programming for microcontroller Embedded C Programming Concepts. Assembly& C language programs for Arithmetic & logical operations and I/O port.		
4	**Timer/Counter And Interrupt Programming:** Generation of Delay using loop in Assembly & C language. Internal Hardware architecture of Timer, Modes of Timer, Functional explanation & SFRs, Timer module as Counter, Assembly & C language programs for Timer/Counter. 8051 Interrupts, Interrupt Vector table, Interrupt Execution, External and Internal Interrupts, SFRs (IE, IP), Interrupts Priority, programming of Timers using interrupts. Programming for external interrupts.	**22**	**10**
5	**Serial Communication Programming:** Basics of communication (Protocol, Synchronous & Asynchronous Communications). Advantages & Disadvantages of Serial communication. Applications, Serial communication Protocol Explanation (Bit pattern, Baud Rate, Bit Frame), Various SFRs related to serial communication. RS232 Standard, interfacing with RS232, Program to communicate simple character data & string. Programming of Serial Communication using Interrupts.	**11**	**5**
6	**Microcontroller Design And Interfacing:** External Memory Interfacing (RAM and ROM), Keyboard Interfacing (Key Debouncing Concept, Simple Key interfacing, Matrix key board), Displays Interfacing (7-Segmentdisplay and LCD display), Analog to Digital Convertor as well as Digital to Analog Converter, interfacing of relay, opto-isolator and DC Motor, Sensor interfacing	**20**	**9**

j. Text Book and Reference Book:

1. "The 8051 Microcontroller and Embedded Systems Using Assembly And C language" by M A Mazidi, Janice Mazidi, Rolin Kinlay
2. "8051 microcontroller & Embedded system using assembly & C language by K J Ayala
3. "Microprocessor and Interfacing-Programming and Hardware" by D. V. Hall

a. Course Name: Microcontroller and its Application Lab

b. Course Code: 303106302

c. Prerequisite: Basic Knowledge of programming in Assembly and C language, Knowledge of basic things of Computer and their working.

d. Rationale: The course provides understanding of microcontrollers and enables students to use microcontroller for hardware implementation of various electrical engineering concepts.

Course Learning Objective:

CLOBJ 1	Implement real-world applications that require arithmetic calculations, precise timing, and event counting.
CLOBJ 2	Understand the electrical and communication requirements for effective peripheral interfacing.
CLOBJ 3	Understand the selection criteria for choosing the appropriate microcontroller based on project requirements.
CLOBJ 4	Create programs that utilize a variety of addressing modes for data manipulation and transfer.

e. Course Learning Outcomes:

CLO 1	Develop the programming skill to perform different arithmetic operation, timer operation, counter operation etc
CLO 2	Design and analyze interfacing of peripherals like I/O, A/D, D/A etc.
CLO 3	Develop embedded systems using different microcontrollers.
CLO 4	Develop programming skills to work with different addressing modes provided by microcontroller architectures.

f. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		Bloom's Level
CLO 1	Develop the programming skill to perform different arithmetic operation, timer operation, counter operation etc	3
CLO 2	Design and analyze interfacing of peripherals like I/O, A/D, D/A etc.	4
CLO 3	Develop embedded systems using different microcontrollers.	6
CLO 4	Develop programming skills to work with different addressing modes provided by microcontroller architectures.	3

g. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	PLOs												PSLO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 2	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 3	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 4	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Weighted Average	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

h. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**0**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

i. Text Book and Reference Book:

1. “The 8051 Microcontroller and Embedded Systems Using Assembly And C language” by M A Mazidi, Janice Mazidi, Rolin Kinlay
2. “8051 microcontroller & Embedded system using assembly & C language by K J Ayala
3. “Microprocessor and Interfacing-Programming and Hardware” by D. V. Hall

j. List of Experiment:

1. Introduction to 8051 Simulation tool (KEIL).
2. Introduction to IDE and Assembler Directives.
3. Write and execute Assembly language programs to demonstrate addressing modes of 8051.
4. Write and execute Assembly language programs based on Arithmetic and Logical Instructions.
5. Write and execute Assembly language programs based on Block Data Transfer.
6. Write and execute Assembly and C language program for Reading and Writing on a parallel port.
7. Write and execute Assembly and C language program to demonstrate timers in different modes.
8. Write and execute C language program using Timer and Counter for Time Delay and frequency measurement using Interrupt.
9. Write and execute C language program for serial communication implementation.
10. Write and execute C language program to interface LCD Display with 8051 microcontroller.

Laboratory Equipment: Keil software

a. **Course Name:** Electrical Measurements & Instrumentation

b. **Course Code:** 203106303

c. **Prerequisite**: Basics of Fundamentals of Electrical Engineering.

d. **Rationale:** The course provides the details knowledge different measuring apparatus. The field of electrical measurement continues to grow, with new techniques developed each year. It is also becoming an increasingly digital endeavour. The subject introduces the fundamentals-including main terms and definitions, methods of estimating accuracy and uncertainty, and standards of electrical quantities-and the classical methods of measurement.

e. **Course Learning Objective:**

CLOBJ 1	To equip with an in-depth understanding of measurement philosophy, including measurement methods, systems, classification, instrument characteristics, error analysis, and the significance of standards in accurate measurement.
CLOBJ 2	Proficiently employ analog techniques to measure electrical quantities, including current, voltage, and power. They will also diagnose errors and apply remedies in watt-meters and energy-meters.
CLOBJ 3	Adeptly employ various methods to measure resistances across a wide range, determine inductance and capacitance using AC Bridges, and utilize Q-Meters for precise parameter measurement.
CLOBJ 4	Understand the principles of digital measurement, analyze block diagrams of digital voltmeters, frequency meters, power analyzers, and harmonics analyzers, enabling them to perform accurate electrical measurements.
CLOBJ 5	Comprehend instrument transformers, including their construction and operation. They will determine ratio and phase angle errors, understand burden and power factor effects, and apply proper precautions and testing methods according to relevant standards.
CLOBJ 6	Define transducers, evaluate selection criteria, comprehend various transducer types, analyze thermocouples, RTDs, and Hall Effect transducers, and understand data transmission, telemetry, and digital methods for frequency, phase, time, and period measurements.

f. **Course Learning Outcomes:**

CLO 1	Understands the role of errors in measurement system.
CLO 2	Learn different techniques to mitigate errors.
CLO 3	Understands the techniques to measure electrical and non-electrical quantities.
CLO 4	Understands the operation of digital and analog measuring apparatus.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understands the role of errors in measurement system.	2
CLO 2	Learn different techniques to mitigate errors.	4
CLO 3	Understands the techniques to measure electrical and non-electrical quantities.	4
CLO 4	Understands the operation of digital and analog measuring apparatus.	3

h. Mapping of Course Learning Outcomes and Program Learning Outcomes and Program Specific Learning Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	3.00	3.00	2.00		1.00	2.00	2.00		1.00			2.00	1.00	
CLO 2	3.00	2.00	2.00		1.00	1.00	1.00		2.00			2.00	1.00	
CLO 3	3.00	2.00	2.00		1.00	2.00	2.00		1.00			1.00	1.00	
CLO 4	3.00	1.00	2.00		1.00	2.00	1.00		2.00			2.00	2.00	

CLO 5														
CLO 6														
Weighted Average	**3.00**	**2.00**	**2.00**	**0.00**	**1.00**	**1.75**	**1.50**	**0.00**	**1.50**	**0.00**	**0.00**	**1.75**	**1.25**	**0.00**

i. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	-	-	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**PHILOSOPHY OF MEASUREMENT:** Methods of Measurement, Measurement System, Classification of instrument system, Characteristics of instruments & measurement system, Errors in measurement & its analysis, Standards.	**10%**	**4**
2	**ANALOG MEASUREMENT OF ELECTRICAL QUANTITIES:** Electro dynamic, Thermocouple, Electrostatic & Rectifier type Ammeters & Voltmeters, Electro dynamic Wattmeter, Three Phase Wattmeter, Power in three phase system, errors & remedies in wattmeter and energymeter.	**20%**	**9**
3	**MEASUREMENT OF PARAMETERS:** Different methods of measuring low, medium & high resistances,	**20%**	**9**

	measurement of inductance & capacitance with the help of AC Bridges, QMeter		
4	**DIGITAL MEASUREMENT OF ELECTRICAL QUANTITIES:** Concept of digital measurement, block diagram Study of digital voltmeter, frequency meter Power Analyzer and Harmonics Analyzer.	**20%**	**9**
5	**INSTRUMENT TRANSFORMERS:** Construction of current transformers. Determination of ratio & phase angle errors. Effect of change in burden & power factor on the ratio & phase angle of CTs. Precautions while using a CT. CT testing requirements &equipment as per IS. Construction of Potential Transformers. Determination of ratio & phase angle errors of PTs. Effect of change in burden & burden power factor on the ratio & phase angle of PTs.	**20%**	**9**
6	**TRANSDUCERS :** Definition - different types of transducers ′criteria for selection ′general characteristics, Thermocouple and RTD method, Hall Effect transducer and applications Data transmission and telemetry ′methods of data transmission, General telemetry systems ′Digital methods of frequency, phase, time and period measurements.	**20%**	**5**

k. Text Book and Reference Book:

1. **Electrical and Electronics Measurement and Instrumentation (TextBook)**

   By A. K. Shawney | Dhanpatrai & sons publications

2. **Electrical Measurement and Measuring Instruments**

   By R.K.Rajput | S. Chand Publication

3. **Electrical Measurement and Measuring Instruments**

   By J.B.Gupta | S.K. Kataria& Sons

4. **Elements of Electronic Instrumentation and Measurement**

   By Joseph J. Carr | Pearson Education | 3rd ed

5. **Modern Electronic instrumentation & Measuring instruments**

   By A.D. Heltric& W.C. Copper | Wheeler Publication

a. Course Name: Electrical Measurements & Instrumentation Lab

b. Course Code: 203106304

c. Prerequisite: Basic Principles of Electrical Engineering, Basic Digital and Analog Electronics.

d. Rationale: The course provides the details knowledge different measuring apparatus. It also provides different methods for measurement of electric parameters with standard quantity of electrical quantities along-with the classical methods of measurement.

e. Course Learning Objective:

CLOBJ 1	Understand the principles of Electrical Measuring Instruments and their applications in electrical measurements.
CLOBJ 2	Demonstrate the ability to measure the value of unknown resistance accurately using the Wheatstone Bridge method.
CLOBJ 3	Proficiently employ Kelvin's Double Bridge technique to measure low resistances with precision and efficiency.
CLOBJ 4	Master the skills required to determine the unknown value of inductance using Maxwell's, Hay's, and Anderson bridges, including practical applications.
CLOBJ 5	Gain expertise in measuring the unknown value of capacitance utilizing Owen's, De Sauty's, Schering's, and Wien's bridges, and recognize their specific advantages and limitations.

f. Course Learning Outcomes:

CLO 1	Perform different methods of bridges for measurement of electrical parameters.
CLO 2	Observe different techniques to mitigate errors.
CLO 3	Perform the operation of digital and analog measuring apparatus.

CLO 4	Understand the concept of DSO, Function Generator, Data acquisition system.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Perform different methods of bridges for measurement of electrical parameters.	4,6
CLO 2	Observe different techniques to mitigate errors.	4
CLO 3	Perform the operation of digital and analog measuring apparatus.	4
CLO 4	Understand the concept of DSO, Function Generator, Data acquisition system.	5

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	3.00	2.00	2.00	1.00	2.00	1.00		2.00		2.00	2.00	2.00	
CLO 2	2.00	2.00	2.00	1.00	2.00	1.00			1.00		1.00	1.00		
CLO 3	2.00	1.00	2.00	2.00	2.00	2.00	1.00		2.00		1.00	2.00	1.00	
CLO 4	2.00	2.00	1.00	2.00	2.00	2.00	2.00		2.00		2.00	2.00	1.00	
Weighted Average	**2.00**	**2.00**	**1.75**	**1.75**	**1.75**	**1.75**	**1.33**	**0.00**	**1.75**	**0.00**	**1.50**	**1.75**	**1.33**	**0.00**

i. Teaching & Examination Scheme:

Teaching Scheme	**Evaluation Scheme**

L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

1.	**Electrical and Electronics Measurement and Instrumentation** By A. K. Shawney **|** Dhanpatrai & sons publications
2.	**Electrical Measurement and Measuring Instruments** By R. K. Rajput | S. Chand Publication
3.	**Electrical Measurement and Measuring Instruments** By J. B. Gupta | S.K. Kataria& Sons
4.	**Elements of Electronic Instrumentation and Measurement** By Joseph J. Carr **|** Pearson Education **|** 3rd ed
5.	**Modern Electronic instrumentation & Measuring instruments** By A. D. Heltric & W. C. Copper **|** Wheeler Publication

k. List of Experiment:

Sr. No.	Experiment Title
1	To study about Electrical Measuring Instruments.
2	To measure value of unknown resistance using Wheatstone Bridge
3	To measure low resistance using Kelviṅs Double bridge.

4	To measure unknown value of inductance by Maxwell̓s bridge.
5	To measure unknown value of inductance by Haẏs bridge.
6	To measure unknown value of inductance by Anderson bridge.
7	To measure unknown value of capacitance by Oweṅs bridge.
8	To measure unknown value of capacitance by De Sauty bridge.
9	To measure unknown value of capacitance by Schering bridge.
10	To measure unknown value of capacitance by Wieṅs bridge.

l. Laboratory Equipment: Connecting wires, Testing Kits, CRO, DSO, Galvanometer, Multimeter, Rheostate, Dual Power Supply, Potentiometer

a. **Course Name:** Power System - I

b. **Course Code:** 203106309

c. **Prerequisite: Basic knowledge of Power System and Components**

d. **Rationale: The course provides basic knowledge to the students related to the power system components, electrical and mechanical design of transmission line.**

e. **Course Learning Objective:**

CLOBJ 1	Develop a comprehensive understanding of power system.
CLOBJ 2	Grasping of knowledge of how to represent power system components.
CLOBJ 3	Analyse different parameters that affects electrical and mechanical design of transmission line.
CLOBJ 4	Learn analysis of distribution network.

f. **Course Learning Outcomes:**

CLO 1	Understand working of power system.
CLO 2	Explain about power system components and their representation
CLO 3	Understand electrical and mechanical design of transmission line.
CLO 4	Do analysis of distribution network

g. **Mapping of Course Learning Outcomes and Bloom's Taxonomy:**

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand working of power system.	1
CLO 2	Explain about power system components and their representation	1,2
CLO 3	Understand electrical and mechanical design of transmission line.	3
CLO 4	Do analysis of distribution network	4

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	PLOs												PSLO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CLO 1	3.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
CLO 2	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
CLO 3	3.00	3.00	2.00	3.00	3.00	3.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
CLO 4	3.00	3.00	3.00	3.00	3.00	2.00	2.00	3.00	2.00	2.00	3.00	3.00	3.00	3.00
Weighted Average	3.00	2.75	2.50	2.75	3.00	2.75	2.50	3.00	2.75	2.75	3.00	3.00	3.00	3.00

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Introduction:** Development in power system and present scenario, structure of power grid and micro grid, overview of renewable and non-renewable energy sources, energy storage, and power transmission and distribution system: line diagrams, voltage levels and topologies, review and analysis of three phase power system, system interconnection: synchronous and asynchronous,	12	5

	effect of reactive power in system.		
2	**Electrical and Mechanical design of transmission line**: Main components of transmission line, Bundled conductors, Resistance, Skin effect and Ferranti effect, power transfer, reactive power, surge impedance loading, concept of series and shunt compensation of transmission lines, insulators, potential distribution over insulator string, string efficiency, methods of improving string efficiency, corona, sag calculation in overhead lines.	22	10
3	**R, L, C of transmission line:** Inductance of single phase and three phase overhead line, capacitance of single phase and three phase overhead line.	22	10
4	**DC and AC distribution :** Distribution system, classification of Distribution systems, AC distribution, DC distribution, AC distribution calculations, Methods of solving AC distribution problems, 3-phase unbalanced loads 4 wire, Star connected unbalanced loads, Ground detectors.	22	10
5	**Power System Components and their representation**: Introduction, Single phase Representation of balanced three phase networks, The one line diagram and impedance or reactance diagram, Per unit system, Advantages of PU system, Per unit representation of A transformer, Per unit impedance diagram of a power system, Complex power, The steady state model of synchronous Machine, Power factor and power control, Salient pole synchronous generator, Loading capability diagram.	22	10

k. Text Book and Reference Book:

1. Power System Analysis, J. J. Grainger, W.D. Stevenson; Mc-Graw Hill series publication.
2. Modern Power System Analysis, D P Kothari and I J Nagrath; Tata McGrawHill
3. Principles of Power System V. K. Mehta Rohit Mehta; S. Chand
4. Power System Analysis and Design B. R. Gupta,, S. Chand; 2008.
5. Power System Analysis and Stability S. S. Vadhera,; KHANNA
6. HVDC Transmission S. Kamakshaiah and V. Kamaraju; MC Graw hill; 2013

a. **Course Name:** High Voltage Engineering

b. **Course Code:** 303106331

c. **Prerequisite:** Basic of Physics, Basic of chemistry, Basic Electrical Engineering

d. **Rationale:** This subject deals with detail analysis of breakdown occur in gaseous, liquid and solid dielectrics. It also gives detail technical incites about generation and measurement of high alternating as well as direct voltage and current. In addition, high voltage testing methods required for testing high voltage electrical apparatus are also discussed.

e. **Course Learning Objective:**

CLOBJ 1	Develop a comprehensive understanding of performing high voltage testing of electrical apparatus used in power system.
CLOBJ 2	Grasping of knowledge of how breakdown is created in different insulators used electrical apparatus.
CLOBJ 3	Apply practical knowledge in analysis of factors affecting output of generators used to generate high AC, DC and Impulse voltage as well as current.
CLOBJ 4	Learning of different measurement methods used to measure high AC, DC and Impulse voltage as well as current
CLOBJ 5	Understand reason of occurring overvoltage in power system.
CLOBJ 6	Analyse different parameters that affects breakdown strength of solid, liquid and gaseous dielectric.

f. **Course Learning Outcomes:**

CLO 1	Understand physics behind various types of breakdown in solid, liquid and gaseous insulating materials used in electrical apparatus.
CLO 2	Demonstrate generation and measurement techniques for D.C., A.C., & Impulse voltages as well as currents.
CLO 3	Decide testing required and understand factors affecting testing for various high voltage electrical apparatus.

CLO 4	Explain phenomenon behind occurrence of overvoltage in power system and protection required against it.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand physics behind various types of breakdown in solid, liquid and gaseous insulating materials used in electrical apparatus.	2
CLO 2	Demonstrate generation and measurement techniques for D.C., A.C., & Impulse voltages as well as currents.	3, 5 , 6
CLO 3	Decide testing required and understand factors affecting testing for various high voltage electrical apparatus.	3
CLO 4	Explain phenomenon behind occurrence of overvoltage in power system and protection required against it.	2

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	1.00			1.00	2.00	1.00	2.00	1.00	
CLO 2	2.00	1.00	1.00	2.00	2.00				1.00	2.00	1.00	2.00	1.00	2.00
CLO 3	3.00	2.00	2.00	3.00	3.00	1.00	2.00		3.00	3.00	3.00	3.00	3.00	3.00
CLO 4	2.00	2.00		1.00					1.00	2.00	1.00	2.00		
Weighted Average	2.25	1.75	1.67	2.00	2.33	1.00	2.00		1.50	2.25	1.50	2.25	1.67	2.50

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**Breakdown in Gases:** Gas / Vacuum as insulating media, collision process, ionization process and de-ionization process, types of discharge, Paschen's law, Townsend's theory, breakdown in uniform gap and non-uniform gap, Streamer mechanism, Corona discharge.	18%	8
2	**Breakdown in liquid and solid Insulating materials:** Liquid Dielectrics, Solids and Composites, breakdown in pure and commercial liquids, intrinsic breakdown, electromechanical breakdown and thermal breakdown, breakdown in solid dielectrics and composite dielectrics, Partial discharge, Applications of insulating materials.	15%	7
3	**Generation of High Voltages and Currents:** Generation of high D.C. and A.C. voltages and currents, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.	18%	8
4	**Measurement of High Voltages and Currents:** High AC voltage & current, impulse voltage & current and high DC voltage & current measurement techniques, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.	18%	8
5	**Lightning and Switching Over-voltages:** Charge formation in clouds, Stepped leader, Dart leader,	15%	7

	Lightning Surges, Switching over-voltages, Protection against over-voltages, Surge diverters, Surge modifiers, Principles of Insulation Coordination in High Voltage and Extra High Voltage power systems.		
6	**High Voltage Testing of Electrical Apparatus:** Various standards for High Voltage testing of electrical apparatus, IS, IEC standards, testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and surge arresters, Radio Interference measurement, testing facility requirements for HV and EHV laboratories.	**16%**	**7**

k. Text Book and Reference Book:

1. "High Voltage Engineering" by M. S. Naidu and V. Kamaraju.
2. “High Voltage Engineering” by C. L. Wadhwa.
3. “High Voltage Engineering Fundamentals” by D. V. Razevig (Translated by Dr. M. P. Chourasia).
4. “High Voltage Engineering: Fundamentals” by E. Kuffel, W. S. Zaengl and J. Kuffel.

a. Course Name: High Voltage Engineering Lab

b. Course Code: 303106332

c. Prerequisite: Basic of Physics, Basic of chemistry, Basic Electrical Engineering.

d. Rationale: This subject deals with detail analysis of breakdown occur in gaseous, liquid and solid dielectrics. It also gives detail technical incites about generation and measurement of high alternating as well as direct voltage and current. In addition, high voltage testing methods required for testing high voltage electrical apparatus are also discussed.

e. Course Learning Objective:

CLOBJ 1	Analyse parameters affecting output of impulse voltage and current generator.
CLOBJ 2	Learning MATLAB programming for calculation of different parameters related to circuits used to generate high ac, dc and impulse voltage and current.
CLOBJ 3	Analyse parameters affecting breakdown strength of liquid and gaseous dielectric.
CLOBJ 4	Demonstrate stress analysis for different electrode configuration through FEMM.
CLOBJ 5	Understand methodologies to generate high ac, dc and impulse voltage.

f. Course Learning Outcomes:

CLO 1	Explain generation and measurement of High DC and AC voltage through sphere gaps and parameters affecting the output.
CLO 2	Analyse parameters affecting dielectric strength of transformer oil.
CLO 3	Do stress analysis of cable with insulating material using FEMM.
CLO 4	Demonstrate Marx generator for generation of high impulse voltage and do analysis of parameters which can be varied to change output as per requirement.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		Bloom's Level
CLO 1	Explain generation and measurement of High DC and AC voltage through sphere gaps and parameters affecting the output.	2
CLO 2	Analyse parameters affecting dielectric strength of transformer oil.	4
CLO 3	Do stress analysis of cable with insulating material using FEMM.	4
CLO 4	Demonstrate Marx generator for generation of high impulse voltage and do analysis of parameters which can be varied to change output as per requirement.	2

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	PLOs												PSLO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	1.00	1.00	2.00	2.00				1.00	2.00	1.00	2.00	1.00	2.00
CLO 2	2.00	2.00		2.00	1.00	1.00			1.00	2.00		2.00	2.00	2.00
CLO 3	2.00	2.00		2.00	3.00				2.00	2.00	1.00	2.00	2.00	2.00
CLO 4	2.00	1.00	2.00	2.00	2.00				1.00	2.00	1.00	2.00	2.00	2.00
Weighted Average	2.00	1.50	1.50	2.00	2.00	1.00			1.25	2.00	1.00	2.00	1.75	2.00

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**0**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

1. "High Voltage Engineering" by M. S. Naidu and V. Kamaraju.
2. “High Voltage Engineering” by C. L. Wadhwa.
3. “High Voltage Engineering Fundamentals” by D. V. Razevig (Translated by Dr. M. P. Chourasia).
4. “High Voltage Engineering: Fundamentals” by E. Kuffel, W. S. Zaengl and J. Kuffel.

k. List of Experiment:

Sr. No.	Experiment Title
1	Learning of High Voltage Laboratory Design and Safety measure.
2	Testing of Transformer Oil according to IS:6792.
3	Generation of high D.C. voltages and Measurement through sphere gaps.
4	Generation of high A.C. voltages and Measurement through sphere gaps.
5	Testing of Solid Insulation with Tape Electrodes.
6	To generate High AC voltages through cascaded Transformer.
7	Impulse Voltage Generation through Marx generator.
8	Impulse Voltage Generation through Simulation.
9	Stress Analysis of single core single layer insulation cable using FEMM.
10	Stress Analysis of different types of Electrode Arrangements using FEMM.
11	Part-1 (Cockroft-Walton Voltage Multiplier using Virtual Lab) Part-2 (Impulse Voltage Generator using Virtual Lab) Part-3 (Impulse Current Generator using Virtual Lab)
12	High Voltage Engineering Parameter Calculation using MATLAB.

Laboratory Equipment: MATLAB software, FEMM Software, Impulse Voltage Generator, AC DC Voltage Generator, Transformer Oil Testing Kit, Horn Gap Arrester.**Ele**

a. Course Name: Industrial Electrical Systems

b. Course Code: 303106333

c. Prerequisite: Basic Principles of Electrical Engineering, Power system**.**

d. **Rationale:** The Course will provide basic knowledge about various Protecting devices, Residential and commercial wiring and Illumination system. The objective of the course is to introduce the students with the detail knowledge of Industrial power system and automation system.

e. Course Learning Objective:

CLOBJ 1	To practice safe working methods on electrical systems
CLOBJ 2	To understand the relevant regulative requirements and demonstrate an understanding of electrical principles and units.
CLOBJ 3	To understand the principles of earthing / protection and associated protective devices and demonstrate an understanding of electrical systems, switchgear and circuit types
CLOBJ 4	To diagnose basic faults and recognise their associated symptoms and work with a range of cable types and carry out correct terminations and connections
CLOBJ 5	Recognise the most common industrial motor types and understand their operation, connections and maintenance requirements and use electrical test equipment effectively and carry out testing of a range of motors, solenoids, cables, etc. (using insulation, continuity, tong testers, etc.)
CLOBJ 6	To use circuit diagrams as an aid to maintenance and access electrical enclosures and replace fuses, reset overloads etc. and perform electrical isolation, testing for dead, etc on a wide range of devices and circuits safely.

f. Course Learning Outcomes:

CLO 1	Understand the problem of power system stability and its impact on the system

CLO 2	Analyse linear dynamical systems and use of numerical integration methods
CLO 3	Model different power system components for the study of stability.
CLO 4	Understand the methods to improve stability.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand the problem of power system stability and its impact on the system	2
CLO 2	Analyse linear dynamical systems and use of numerical integration methods	4,5
CLO 3	Model different power system components for the study of stability.	2,5
CLO 4	Understand the methods to improve stability.	2

h. Mapping of Course Learning Outcomes and Program Learning Outcomes and Program Specific Learning Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	3	1	2			2	3	3		2	3	2	3	
CLO 2	3	2	2		3	2	3	3	1	2	3	2	3	2
CLO 3	3	1	2	2	2	2	3	2	1	2	3	1	3	
CLO 4	3	2	2	3	2	2	3	1		2	3	2	3	2
CLO 5														
CLO 6														

Weighted Average	3	1.5	2	2.5	2.33	2	3	2.25	1	2	3	1.75	3	2

i. Teaching & ExEExamination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Electrical System Components** LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.	**18**	**8**
2	**Residential and Commercial Electrical Systems** Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of	**18**	**8**

	lamps, earthing of commercial installation, selection and sizing of components.		
3	**Illumination Systems** Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.	**18**	**8**
4	**Industrial Electrical Systems I** HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction ′kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components	**18**	**8**
5	**Industrial Electrical Systems II** DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks	**14**	**6**
6	**Industrial Electrical System Automation** Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.	**14**	**6**

k. Text Book and Reference Book:

1. Electrical Design, estimating & Costing By Raina, K. B. and Bhattacharya, S.K. | New Age International (p) Limited, New Delhi.

2. Electrical Wiring, Estimating & Costing By S.L. Uppal and G.C. Garg | Khanna publishers, Pub. Year 2008

3. Electrical estimating and costing By S. Singh and R. D. Singh | Dhanpat Rai and Co, Pub. Year 1997

4. Residential Commercial and Industrial Systems By H. Joshi | McGraw Hill Education, Pub. Year 2007

a. **Course Name: Industrial Electrical Systems Lab**

b. **Course Code: 303106334**

c. **Prerequisite: Basic Principles of Electrical Engineering, Power system.**

d. **Rationale:** The Course will provide basic knowledge about various Protecting devices, Residential and commercial wiring and Illumination system. The objective of the course is to introduce the students with the detail knowledge of Industrial power system and automation system.

e. **Course Learning Objective:**

CLOBJ 1	To develop electrical wiring skills in students through systematic training that would enable the students to construct and test various electrical circuits using appropriate electrician tools, wires, protective devices and wiring accessories as per IS standards.
CLOBJ 2	To understand the stages of product (hardware/ software) design and development.
CLOBJ 3	To learn the different considerations of circuit design.
CLOBJ 4	To be acquainted with methods of PCC design & different tools used for PCC design
CLOBJ 5	To understand the importance of testing in product design cycle.
CLOBJ 6	To understand the processes and importance of documentation.

f. **Course Learning Outcomes:**

CLO 1	Understand the different types of protective equipments (Fuse, MCB, ELCB etc).
CLO 2	Develop wiring of tube light and bulb, staircase, godown wiring, classroom and commercial complexes.
CLO 3	Solving Load Calculation of commercial building.
CLO 4	Experimenting measurement of Earth resistance.

CLO 5	Validating PCC and MCC panels in industry and various LT circuit breakers.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand the different types of protective equipments (Fuse, MCB, ELCB etc).	5
CLO 2	Develop wiring of tube light and bulb, staircase, godown wiring, classroom and commercial complexes.	1
CLO 3	Solving Load Calculation of commercial building.	4
CLO 4	Experimenting measurement of Earth resistance.	3
CLO 5	Validating PCC and MCC panels in industry and various LT circuit breakers.	4

h. Mapping of Course Learning Outcomes and Program Learning Outcomes and Program Specific Learning Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2	3	3	2	3	2	2	2	2	2	2	3	3	3
CLO 2	2	3	2	2	2	2	2		2	2	2	3	2	3
CLO 3	2	3	2	2	2	2	2		3	2	3	3	2	3
CLO 4	2	3	2	2	2	2	2		2	2	3	3	2	3
CLO 5	2	3	2	3	2.	2	3		2	3	3	3	2	3
CLO 6														
Weighted Average	2	3	2	2.20	2.20	2	2.20	2	2.20	2.20	2.60	3	2.20	3

i. Teaching & ExaExmination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. List of Experiments:

1. Demonstration and study of different types of protective equipment's (Fuse, MCB, ELCB etc).
2. Wiring of tube light and bulb.
3. Wiring of staircase wiring
4. Wiring of godown wiring.
5. Preparation of Electrical Wiring diagram for any of the following- Class-room.
6. Preparing Bill of Material with specifications, for the above-mentioned Wiring Diagram.
7. Load Calculation of commercial building.
8. To perform measurement of Earth resistance.
9. Study about PCC and MCC panels in industry.
10. Study about various LT circuit breakers

Semester-6

a. **Course Name:** Power System Protection

b. **Course Code:** 303106385

c. **Prerequisite:** Basic knowledge of Power System, Operation and Components

d. Rationale: Increasing power demand and generation day by day, development of transmission and distribution network and connection of generating sources to the distribution level makes overall system very complex. Objective of the course is to introduce to the students with detail knowledge of different types of protective relaying and their function in the power system. The course also covers wide range of protection aspects including basic operating principle of relays, electromagnetic relays, static relays and numerical relays along with basic algorithms used in numerical relaying for protection of system as well as equipments.

e. Course Learning Objective:

CLOBJ 1	Explanation of fundamentals for different equipment as well as system protection.
CLOBJ 2	Grasping of knowledge of how different system as well as equipment protection works.
CLOBJ 3	Apply practical knowledge in selection and calculation of parameters related to different equipment protection.
CLOBJ 4	Learning importance and requirement of current transformer and voltage transformer for relaying.
CLOBJ 5	Understanding structure and algorithms used in different digital/numerical relay based protection.
CLOBJ 6	Evaluation of relay setting for the protection of various equipments.

f. Course Learning Outcomes:

CLO 1	Explain requirement, importance and rating selection of current transformer and voltage transformer.

CLO 2	Do selection of protection required for equipment as well as system for their safety and explain fundamentals of protection for equipment as well as system.
CLO 3	Decide the relay setting for the protection of various equipments in Power System.
CLO 4	Understand structure, application and importance of digital/numerical relay.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Explain requirement, importance and rating selection of current transformer and voltage transformer.	2, 5
CLO 2	Do selection of protection required for equipment as well as system for their safety and explain fundamentals of protection for equipment as well as system.	2, 5
CLO 3	Decide the relay setting for the protection of various equipments in Power System.	3, 4, 5
CLO 4	Understand structure, application and importance of digital/numerical relay.	2

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	3.00	3.00	3.00	2.00	2.00				2.00	2.00	2.00	3.00	3.00	2.00
CLO 2	3.00	2.00	3.00	3.00	3.00	1.00			3.00	3.00	2.00	3.00	3.00	3.00

CLO 3	3.00	3.00	3.00	3.00	3.00	1.00			3.00	3.00	3.00	3.00	3.00	3.00
CLO 4	1.00	1.00	1.00	1.00	1.00				1.00	1.00		2.00		
Weighted Average	2.50	2.25	2.50	2.25	2.25	1.00			2.25	2.25	2.33	2.75	3.00	2.67

i. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Switchgear and Protection Fundamentals:** Principles of Power System Protection, Zone of protection, Primary and Back-up Protection, Classification of Protection Relays and their advantages and disadvantages, Basic of Relay Testing, Current Transformer and Voltage Transformer: Operating principle and construction, characteristic, performance and specification, CT / VT modelling and standards, Circuit Breakers types. Principles of Power System Protection, Zone of protection, Primary and Backup Protection, Classification of Protection Relays and their advantages and disadvantages, Basic of Relay Testing, Current Transformer and Voltage Transformer: Operating principle and construction, characteristic, performance and specification, CT / VT modelling and standards, Circuit Breakers types.	**10**	**6**
2	**Overcurrent Protection:** Protection by fuse, fuse characteristic, types of fuse, limitation of fuse,	**22**	**10**

	Operating principle of induction relay, Types of over current relay, Operating characteristics of Overcurrent Relays, Plug setting and Time setting for over current relays, Requirement of directional relaying, operating principle of directional over current relay or Reverse Power relay, Over current schemes: time-graded and current-graded, Static over current relay, Examples.		
3	**Equipment Protection:** Transformer Protection: Differential protection, Percentage biased differential protection, harmonic restraint relay, Restricted earth fault protection, miscellaneous protections for transformer, Protection of Generator: Generator differential protection, stator inter-turn and earth fault protection, Rotor earth fault protection, Protection against loss of prime mover and loss of excitation, Induction Motor Protection: Protection against overloading, stalling, single phasing, miscellaneous protection for induction motor, Bus bar Protection: Types of Busbar scheme, Differential protection of bus bar, selection of CT ratio for bus bar protection, Examples.	**30**	**12**
4	**System Protection:** Protection of radial feeder, two over current and one earth fault scheme for radial feeder, three over current and one earth fault scheme for transformer feeder, Protection of parallel feeders and ring main feeder, Distance protection of transmission line, Impedance relay, reactance relay, Mho relay, Carrier aided protection and its components, Effect of Power Swings on Distance Relaying, Under Frequency, Under Voltage and df/dt relays, Out of step protection, Synchrophasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS), Application of WAMS for improving protection systems.	**28**	**12**
5	**Numerical Protection:** Advantages of numerical relaying, Numerical relay structure, facilities available in numerical relaying, sample and hold circuit, sampling theorem, Anti aliasing filter, sampling rate criteria, Fourier analysis and estimation of Phasors from DFT, Full cycle Fourier	**10**	**5**

	algorithm, half cycle Fourier algorithm, least square estimation, digital signal processing, data acquisition system, recent technologies.		

k. Text Book and Reference Book:

1. "Power System Protection and Switchgear" by B. Ram and D. N. Vishwakarma.
2. "Power System Protection and Switchgear" by B. A. Oza, N. C. Nair, R. P. Mehta and V. H. Makwana.
3. "Fundamentals of Power System Protection" by Y. G. Paithankar and S. R. Bhide.
4. "Protection and Switchgear" by B. Bhalja, R. P. Maheshwari, N. G. Chothani.
5. "Computer Relaying for Power Systems" by A. G. Phadke and J. S. Thorp.
6. "Digital protection of power systems" by A. T. Johns and S. K. Salman.

a. Course Name: Power System Protection Lab

b. Course Code: 303106386

c. Prerequisite: Basic knowledge of Power System, Operation and Components.

d. Rationale: Increasing power demand and generation day by day, development of transmission and distribution network and connection of generating sources to the distribution level makes overall system very complex. Objective of the course is to introduce to the students with detail knowledge of different types of protective relaying and their function in the power system. The course also covers wide range of protection aspects including basic operating principle of relays, electromagnetic relays, static relays and numerical relays along with basic algorithms used in numerical relaying for protection of system as well as equipments.

e. Course Learning Objective:

CLOBJ 1	Analyse different factors affecting protections in power system.
CLOBJ 2	Demonstrate working principle of buchholz relay used for protection of power transformers.
CLOBJ 3	Understand selection of appropriate protection required for equipments in power system.
CLOBJ 4	Learning MATLAB programming for calculation of parameters related to different equipment protection.
CLOBJ 5	Understand fundamentals of power system protection.

f. Course Learning Outcomes:

CLO 1	Select protections required for equipment as well as system for their safety.
CLO 2	Practically explain fundamentals of protection for equipment as well as system considering standards.
CLO 3	Decide the relay setting for the protection of various equipments in Power System.

CLO 4	Explain working principle and operation of Buchholz relay used for the protection of Power Transformer.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Select protections required for equipment as well as system for their safety.	5
CLO 2	Practically explain fundamentals of protection for equipment as well as system considering standards.	2
CLO 3	Decide the relay setting for the protection of various equipments in Power System.	3, 5
CLO 4	Explain working principle and operation of Buchholz relay used for the protection of Power Transformer.	2

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	3.00	2.00	3.00	3.00	3.00	1.00			3.00	3.00	2.00	3.00	3.00	3.00
CLO 2	1.00	1.00	1.00	1.00					1.00	1.00		2.00		
CLO 3	3.00	3.00	3.00	3.00	3.00	1.00			3.00	3.00	3.00	3.00	3.00	3.00
CLO 4	1.00	1.00	1.00	1.00					1.00	1.00		2.00		
Weighted Average	2.00	1.75	2.00	2.00	3.00	1.00			2.00	2.00	2.50	2.50	3.00	3.00

i. Teaching & Examination Scheme:

Teaching Scheme	**Evaluation Scheme**

L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

1. "Power System Protection and Switchgear" by B. Ram and D. N. Vishwakarma.
2. "Power System Protection and Switchgear" by B. A. Oza, N. C. Nair, R. P. Mehta and V. H. Makwana.
3. "Fundamentals of Power System Protection" by Y. G. Paithankar and S. R. Bhide.
4. "Protection and Switchgear" by B. Bhalja, R. P. Maheshwari, N. G. Chothani.
5. "Computer Relaying for Power Systems" by A. G. Phadke and J. S. Thorp.
6. "Digital protection of power systems" by A. T. Johns and S. K. Salman.

k. List of Experiment:

Sr. No.	Experiment Title
1	To study of fundamentals of power system protection.
2	To perform over current electromagnetic induction relay.
3	To perform radial feeder protection.
4	To study the Buchholz Relay.
5	To perform induction motor protection.
6	To perform overcurrent and earth fault protection.
7	To perform generator protection.
8	To perform reverse power protection.
9	To perform differential protection of transformer.

10	To perform transmission line protection.

Laboratory Equipment: MATLAB software, Radial Feeder Protection Setup (Electromechanical Relay), Generator Protection Setup (Numerical Relay), Induction Motor Protection Setup (Numerical Relay), Transmission Line Protection Setup (Numerical Relay), O/C and E/F Protection Setup (Numerical Relay).

a. **Course Name:** Electrical Machine Design
b. **Course Code:** 303106389
c. **Prerequisite:** Basic knowledge of Electrical Machines.
d. **Rationale:** To give good understanding and some experience in the physical design of electrical machines.
e. **Course Learning Objective:**

CLOBJ 1	To explain the design concepts of transformer with mathematical calculations.
CLOBJ 2	To explain the design aspects of salient pole and turbo alternators with calculations.
CLOBJ 3	To make understand designing of three phase induction motor in detail.

f. **Course Learning Outcomes:**

CLO 1	Understand design concepts of transformers and rotating machines.
CLO 2	Do Design calculations for transformers.
CLO 3	Do Design calculations for Synchronous machines
CLO 4	Do Design calculations for Induction motors.

g. **Mapping of Course Learning Outcomes and Bloom's Taxonomy:**

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand design concepts of transformers and rotating machines.	1, 2
CLO 2	Do Design calculations for transformers.	3, 4
CLO 3	Do Design calculations for Synchronous machines	3, 4
CLO 4	Do Design calculations for Induction motors.	3, 4

h. **Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:**

CLOs	PLOs												PSLO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CLO 1	3.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	2.00	2.00	1.00	0.00
CLO 2	3.00	1.00	2.00	0.00	1.00	0.00	1.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00
CLO 3	3.00	1.00	2.00	0.00	1.00	0.00	1.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00
CLO 4	3.00	1.00	2.00	0.00	1.00	0.00	1.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00
Weighted Average	3.00	1.00	1.75	0.00	1.00	0.00	1.00	1.75	2.00	1.00	2.00	2.00	1.75	1.00

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**DESIGN OF THREE PHASE TRANSFORMER**: Classification of transformers; Core and Winding arrangement of single and three phase transformer; Position of winding relative to core; Core & Yoke cross section; Different types of transformer windings; Tapings and its importance; Window space factor & factors affecting window space factor; Relation between emf per turn and transformer rating; Stacking factor. Design of window dimensions, yoke dimensions and overall core dimensions; Numerical examples. <u>Winding Design</u> HV & LV Winding design: Turns per phase, cross-sectional area of conductor, selection of type of winding, axial length & depth of winding; Resistance and Leakage reactance calculation; Calculation of no load current, Losses and Temperature rise of transformer; Design of	40	18

	tank with tubes; Calculation of tank dimensions; Numerical examples		
2	**SYNCHRONOUS MACHINE DESIGN**: Introduction Output equation, Choice of specific electrical and magnetic loading. Design of Salient Pole Machine Main Dimensions, SCR, effect of SCR on machine performance, Influence of length of air gap and shape of pole face. Armature design Armature winding, Slots dimension, Elimination of harmonics, Armature parameters, Estimation of Air-gap length, Design of rotor Magnetic circuit, Design of Damper winding, Determination of full load field MMF, Design of field winding, Determination of direct and quadrature axis synchronous reactance. Design of Turbo Alternator Main dimensions, Length of air gap, Stator & Rotor design.	**29**	**13**
3	**INDUCTION MOTOR DESIGN**: Introduction Output equation, Choice of specific magnetic loading and specific electrical loading, separation of D &L. Stator Design Stator winding design, Number of stator slots, Area of stator slots, stator winding resistance, stator teeth design, depth of the stator core, Examples. Rotor design Length of the air gap, Design of Squirrel cage rotor - number of rotor slots, Harmonic induction torques; Harmonic synchronous torques; rules for selecting of rotor slots, skewing, design of rotor bars and slots; Design of End rings; Design of wound rotor ; Examples Performance characteristics No load current, Short circuit current calculation - stator and rotor resistance, leakage reactance; Examples.	**31**	**14**

k. Text Book and Reference Book:

1. A course in electrical machine Design (Text Book) A. K. Sawhney; DhanpatRai and Sons.
2. Electrical Machine Design (Text Book) R. K. Agrawal; S.K. Kataria & Sons.
3. Design of Electrical Machine (Text Book) V. N Mittle ; Standard Publishers Distributors.
4. Design Data Handbook A. Shanmugasundarm, G Gangadharan, R. Palani; Wiley Eastern Ltd

a. **Course Name:** Electrical Machine Design Lab
b. **Course Code:** 303106390
c. **Prerequisite:** Knowledge of Electrical Machines.
d. **Rationale:** The course will give idea about practical design aspects about AC Electrical Machines.
e. **Course Learning Objective:**

CLOBJ 1	To understand the working and functioning of various parts of Transformer.
CLOBJ 2	To learn design calculations of core, windings, performance calculation etc.
CLOBJ 3	To understand the working and functioning of various parts of Induction Motor.
CLOBJ 4	To make learn design calculation of stator, rotor and performance calculations.
CLOBJ 5	TO give overview of FEM.

f. **Course Learning Outcomes:**

CLO 1	Do the detail design calculations of transformer
CLO 2	Evaluate performance for Induction Motor.
CLO 3	Do the design calculations of Induction Motor
CLO 4	Understand the basics related to FEM

g. **Mapping of Course Learning Outcomes and Bloom's Taxonomy:**

Course Learning Outcomes		**Bloom's Level**
CLO 1	Do the detail design calculations of transformer.	3,4
CLO 2	Evaluate performance for Induction Motor.	3,4
CLO 3	Do the design calculations of Induction Motor	3,4
CLO 4	Understand the basics related to FEM	2

h. **Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:**

CLOs	PLOs												PSLO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CLO 1	3.00	2.00	2.00	0.00	1.00	0.00	0.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00
CLO 2	3.00	2.00	2.00	0.00	1.00	0.00	0.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00
CLO 3	3.00	2.00	2.00	0.00	1.00	0.00	0.00	2.00	2.00	1.00	2.00	2.00	1.00	1.00
CLO 4	2.00	1.00	1.00	1.00	2.00	0.00	0.00	1.00	1.00	0.00	1.00	2.00	0.00	2.00
Weighted Average	2.75	1.75	1.75	1.00	1.25	0.00	0.00	1.75	1.75	1.00	1.75	2.00	1.67	1.25

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

1. A course in electrical machine Design (Text Book) A. K. Sawhney; DhanpatRai and Sons.
2. Electrical Machine Design (Text Book) R. K. Agrawal; S.K. Kataria & Sons.
3. Design of Electrical Machine (Text Book) V. N Mittle; Standard Publishers Distributors.
4. Design Data Handbook A. Shanmugasundarm, G Gangadharan, R. Palani; Wiley Eastern Ltd.

k. List of Experiment:

Sr. No.	Experiment Title
1	Drawing sheet of parts of Transformer
2	Design problem of Three phase Transformer
3	Drawing sheet of parts of Induction Motor.
4	Design problem of Induction Motor
5	Introduction to FEM.

a. **Course Name:** HVDC Transmission System
b. **Course Code:** 303106387
c. **Prerequisite:** Basic knowledge of power system, power electronics and control engineering.
d. **Rationale:** The course will provide strong foundation on power systems transmission which will be useful for creating foundation of modelling and analysis of system performance. The students will learn concepts of HVDC transmission system in real system model.
e. **Course Learning Objective:**

CLOBJ 1	Demonstrate the implementation benefits of HVDC transmission over EHVAC transmission with respect to economics, performance and technological developments from LCC to VSC based systems.
CLOBJ 2	Illustrate the detailed performance analysis of LCC and VSC converter-valve operation with the study of relevant PWM techniques used in VSCs
CLOBJ 3	Derive and analyze the HVDC link control techniques for managing power flow, reactive power control and voltage regulation in LCC and VSC based HVDC systems.
CLOBJ 4	Analyze the applicability and performance of filters, reactors, insulators & circuit breakers with the converter control strategies during faults in HVDC LCC and VSC systems.
CLOBJ 5	Demonstrate the performance analysis for stability enhancement and power modulation of synchronous and asynchronous HVDC links along with MTDC system controls.

f. **Course Learning Outcomes:**

CLO 1	Understand the advantages of dc transmission over ac transmission.
CLO 2	Understand the operation of Line Commutated Converters and Voltage Source Converters
CLO 3	Understand the control strategies used in HVDC transmission system.
CLO 4	Understand the improvement of power system stability using an HVDC system.

g. **Mapping of Course Learning Outcomes and Bloom's Taxonomy:**

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand the advantages of dc transmission over ac transmission.	5, 1

CLO 2	Understand the operation of Line Commutated Converters and Voltage Source Converters	5, 4
CLO 3	Understand the control strategies used in HVDC transmission system.	5, 3
CLO 4	Understand the improvement of power system stability using an HVDC system.	5, 1

h. Mapping of Course Learning Outcomes and Program Learning Outcomes and Program Specific Learning Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	3	3	2	2		2	3					3	3	3
CLO 2	3	3	2	2		2	3					3	3	3
CLO 3	3	3	2	2		2	3					3	3	3
CLO 4	3	3	2	2		2	3					3	3	3
CLO 5														
CLO 6														
Weighted Average	3	3	2	2		2	3					3	3	3

i. Teaching & ExEExamination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**DC Transmission Technology** Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVDC Systems. Components	**13**	**6**

	of a HVDC system. Line Commutated Converter and Voltage Source Converter based systems		
2	**Analysis of Line Commutated and Voltage Source Converters** Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.	**23**	**10**
3	**Control of HVDC Converters** Principles of Link Control in a LCC HVDC system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVDC system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation.	**23**	**10**
4	**Components of HVDC systems** Smoothing Reactors, Reactive Power Sources and Filters in LCC HVDC systems DC line: Corona Effects. Insulators, Transient Over-voltages. dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.	**15**	**7**
5	**Stability Enhancement using HVDC Control** Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/DC systems.	**13**	**6**
6	**MTDC Links** Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTDC systems using LCCs. MTDC systems using	**13**	**6**

	VSCs. Modern Trends in HVDC Technology. Introduction to Modular Multi-level Converters.		

k. Text Book and Reference Book:

1. HVDC Power Transmission Systems (Text Book) By K. R. Padiyar | New Age International Publishers | 2nd edition.
2. High Voltage Direct Current Transmission By J. Arrillaga | Peter Peregrinus Ltd
3. Direct Current Transmission By E. W. Kimbark

l. **Course Name: HVDC Transmission System Lab**

m. **Course Code: 303106388**

n. **Prerequisite: Basic knowledge of power system, power electronics and control engineering.**

o. **Rationale:** The course will provide strong foundation on power systems transmission which will be useful for creating foundation of modelling and analysis of system performance. The students will learn concepts of HVDC transmission system in real system model.

p. **Course Learning Objective:**

CLOBJ 1	To introduce the concepts of breakdown in gases, solids, generation and measurement of high voltage and their tests.
CLOBJ 2	Demonstrate the implementation benefits of HVDC transmission over EHVAC transmission with respect to economics, performance and technological developments from LCC to VSC based systems.
CLOBJ 3	Illustrate the detailed performance analysis of LCC and VSC converter-valve operation with the study of relevant PWM techniques used in VSCs
CLOBJ 4	Derive and analyze the HVDC link control techniques for managing power flow, reactive power control and voltage regulation in LCC and VSC based HVDC systems.
CLOBJ 5	Analyze the applicability and performance of filters, reactors, insulators & circuit breakers with the converter control strategies during faults in HVDC LCC and VSC systems.
CLOBJ 6	Demonstrate the performance analysis for stability enhancement and power modulation of synchronous and asynchronous HVDC links along with MTDC system controls.

q. **Course Learning Outcomes:**

CLO 1	Understand the advantages of dc transmission over ac transmission.
CLO 2	Understand the operation of Line Commutated Converters and Voltage Source Converters.
CLO 3	Understand the control strategies used in HVDC transmission system.
CLO 4	Understand the improvement of power system stability using an HVDC system.

r. **Mapping of Course Learning Outcomes and Bloom's Taxonomy:**

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand the advantages of dc transmission over ac transmission.	5,1

CLO 2	Understand the operation of Line Commutated Converters and Voltage Source Converters.	5,4
CLO 3	Understand the control strategies used in HVDC transmission system.	5,3
CLO 4	Understand the improvement of power system stability using an HVDC system.	5,1

s. Mapping of Course Learning Outcomes and Program Learning Outcomes and Program Specific Learning Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	3	3	3	2	3	2	3		3	2	3	3	2	3
CLO 2	3	3	2	2	3	2	3		3	2	3	3	2	3
CLO 3	3	3	2	2	3	2	3		3	2	3	3	2	3
CLO 4	3	3	2	2	3	2	3		3	2	3	3	2	3
CLO 5														
CLO 6														
Weighted Average	3	3	2	2	3	2	3		3	2	3	3	2	3

t. Teaching & ExaExmination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**0**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

u. List of Experiments:

1. To do simulation of simple six pulse Converter.
2. To do simulation of simple six pulse Inverter.
3. To do simulation of Monopolar HVDC transmission.
4. To do simulation of Bipolar HVDC transmission.
5. To do simulation of Homopolar HVDC transmission.
6. To do simulation of simple six pulse HVDC system.
7. To do simulation of 12 pulse converter.

8. To do simulation of 12 pulse inverter.
9. To do simulation of Voltage controlling of HVDC link.
10. To do simulation of faults on HVDC system.

Semester 7

a. Course Name: Project I

b. Course Code: 203106402

c. Prerequisite: Basic knowledge of Power System, Power Electronics, Machines, Controllers and softwares used for design and analysis in Electrical Engineering.

d. Rationale: With increasing upgradation and technological requirement in engineering, new methods or products need to be developed. Objective of this course is to make students gain technical and practical knowledge in area of their interest and develop project to solve problems in existing technologies which are already developed. Student will also be able to make themselves sound in software analysis with the software they are using like MATLAB, ETAB, MULTISIM, MIPOWER, PSCAD, ARDUINO etc. as well as hardware preparation for the project they are developing.

e. Course Learning Objective:

CLOBJ 1	Project Understanding: Students should be able to demonstrate a clear understanding of the project scope, objectives, and requirements. This includes the ability to define the problem or challenge to be addressed.
CLOBJ 2	Problem Analysis: Analyzing the problem statement critically and identifying key parameters and constraints. This may involve mathematical modeling and analysis techniques.
CLOBJ 3	Problem-solving: Developing problem-solving skills to address technical challenges that may arise during the project.
CLOBJ 4	Prototype Development (if applicable): Depending on the project, students may be expected to develop a prototype or proof of concept during this phase.
CLOBJ 5	Technical Documentation: Proficiency in documenting project requirements, specifications, and initial design concepts. This includes creating schematics, diagrams, and technical reports.

f. Course Learning Outcomes:

CLO 1	Use and apply information from technical literature, identify and set clearly the aims and objectives of research project.
CLO 2	Develop a research proposal and plan for a research project in an appropriate area relevant to the Programme of study.
CLO 3	Source and critically review literature relevant to a chosen project topic.
CLO 4	Evaluate a range of data analysis methods, experimental methods, alternative approaches in relation to specific project objectives.
CLO 5	Do detail software analysis with the software they are using for project work.
CLO 6	Understand and develop hardware for different types of products.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Use and apply information from technical literature, identify and set clearly the aims and objectives of research project.	3
CLO 2	Develop a research proposal and plan for a research project in an appropriate area relevant to the Programme of study.	6
CLO 3	Source and critically review literature relevant to a chosen project topic.	5
CLO 4	Evaluate a range of data analysis methods, experimental methods, alternative approaches in relation to specific project objectives.	3
CLO5	Do detail software analysis with the software they are using for project work.	2
CLO6	Understand and develop hardware for different types of products.	1

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	PLOs												PSLO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CLO 1	3.00	3.00	3.00	3.00	2.00	2.00	2.00	0	3.00	3.00	3.00	3.00	1.00	1.00
CLO 2	3.00	2.00	2.00	3.00	2.00	2.00	2.00	0	3.00	3.00	3.00	3.00	2.00	2.00
CLO 3	2.00	3.00	2.00	2.00	2.00	2.00	2.00	0	3.00	3.00	1.00	3.00	2.00	1.00
CLO 4	3.00	3.00	3.00	3.00	3.00	2.00	2.00	0	3.00	3.00	3.00	3.00	3.00	3.00
CLO 5	3.00	2.00	3.00	3.00	3.00	2.00	2.00	0	3.00	3.00	3.00	3.00	3.00	3.00
CLO 6	3.00	2.00	3.00	3.00	3.00	1.00	2.00	0	3.00	3.00	3.00	3.00	3.00	3.00
Weighted Average	2.83	2.5	2.67	2.83	2.5	1.83	2.00	0	3.00	3.00	2.67	3.00	2.33	2.17

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	Lab Hr/week	C	Internal Evaluation			External		Total
				T	CE	P	T	P	
0	0	10	5	-	-	100	-	100	200

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content: NA**

k. Text Book and Reference Book: NA

a. Course Name: Industrial Automation

b. Course Code: 303106448

c. Prerequisite: Knowledge of Basic Electronics, Microcontroller, Industrial Instrumentation and Power Electronics.

d. Rationale: present global scenario of manufacturing, industries are moving towards more and more automation. Small scale and medium scale industries require PLC, HMI and SCADA technology, but large scale and very large scale industries require PLC, HMI and SCADA. So, it is very necessary for Electrical engineers to have knowledge of PLC, HMI and SCADA. So this course attempts to provide basic configurationally knowledge of these technologies to develop operational competency. Hence this course is very important for Electrical engineers who want to specialize in industrial automation.

e. Course Learning Objective:

CLOBJ 1	Demonstrate their comprehension of the fundamental architecture and components of PLC.
CLOBJ 2	Apply their knowledge to identify and program various functions and features offered by different PLC models.
CLOBJ 3	Acquired knowledge and skills to configure and program industrial control systems effectively using the available PLC
CLOBJ 4	Demonstrate comprehension of the basics of SCADA and HMI systems, including their principles and applications within industrial control contexts.

f. Course Learning Outcomes:

CLO 1	To Understand the architecture of PLC.
CLO 2	Identify and programme the different functions of available PLC.
CLO 3	Configure and programme the Industrial control systems using available PLC.
CLO 4	Design the hardware and control the different systems using available PLC.
CLO 5	To understand the basics of SCADA/HMI.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		Bloom's Level
CLO 1	To Understand the architecture of PLC.	2
CLO 2	Identify and programme the different functions of available PLC.	2
CLO 3	Configure and programme the Industrial control systems using available PLC.	4
CLO 4	Design the hardware and control the different systems using available PLC.	6
CLO 5	To understand the basics of SCADA/HMI.	2

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	PLOs												PSLO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00
CLO 2	2.00	2.00	2.00	1.00	2.00	2.00	1.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00
CLO 3	3.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 4	3.00	2.00	2.00	3.00	2.00	2.00	1.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00
CLO 5	2.00	3.00	2.00	2.00	3.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00
Weighted Average	1.40	2.20	2.00	2.20	2.20	2.00	2.00	1.80	1.40	2.20	2.00	2.20	2.20	2.00

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
2	**-**	**2**	**3**	**20**	**20**	**20**	**60**	**30**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**Programmable Logic Controller:** An overview of PLC, History of PLC, Advantages and Disadvantages of PLC, Internal Architecture, PLC Components, PLC System. **Input-Output Processing:** Input and Output module interfacing, PLC selection criteria, Detailed design process, Different mode of PLC operation, Basic function of PLC, Scan cycle, Scan time, Scan rate. **Ladder Programming:** General Programming Procedure, Ladder Diagram, Block Functions, Instruction list, Sequential Function Chart, Structured Text, Rules of ladder diagram, Construction of ladder diagram, Programming, Memory structure for ladder diagram, Variables and data types in PLC, PLC memory mapping and I/O addressing, ON/OFF inputs to produce ON/OFF outputs, Logic Functions and Relation of digital gate logic to contact / coil logic, Creating ladder diagrams from process control descriptions. **PLC Functions:** Timer function, Counter function, Arithmetic function, Number comparison functions, Numbering systems and number conversion function, Skip and Master control relay functions, Jump functions, PLC data move systems, Digital bit functions and applications, Sequencer function, Analog PLC operations. **Applications of PLCs:** Stepper motor control, Speed control of D.C. motor & Induction motor, Lift/Elevator control, Water level control, Traffic control, Temperature control.	87%	26
2	**Introduction to HMI:** Definition of HMI, History of HMI, Application of HMI, Difference between HMI and SCADA.	6%	2
3	**Introduction to SCADA:** Definition of SCADA, History of SCADA, Application area of SCADA, Advantages and disadvantages of SCADA.	7%	2

k. Text Book and Reference Book:

1. "Programmable Logic Controller" by John w. Webb and Ronald A. Reis; PHI.
2. "Programmable Logic Controllers" by John R. Hackworth, Frederick D. Hackworth; Pearson Education Inc.
3. "Programmable Logic Controllers " by W. Bolton; Newness (an imprint of Elsevier).
4. "Practical SCADA for Industry " by David Bailey, Edwin Wright, Newnes; Elsevier, 2003.
5. “SCADA-Supervisory Control and Data Acquisition”, by Stuart A. Boyer; Instrument Society of America Publications,USA; 4, 2004

a. Course Name: Industrial Automation Lab

b. Course Code: 303106449

c. Prerequisite: Knowledge of Basic Electronics, Microcontroller, Industrial Instrumentation and Power Electronics.

d. Rationale: present global scenario of manufacturing, industries are moving towards more and more automation. Small scale and medium scale industries require PLC, HMI and SCADA technology, but large scale and very large scale industries require PLC, HMI and SCADA. So, it is very necessary for Electrical engineers to have knowledge of PLC, HMI and SCADA. So this course attempts to provide basic configurationally knowledge of these technologies to develop operational competency. Hence this course is very important for Electrical engineers who want to specialize in industrial automation.

e. Course Learning Objective:

CLOBJ 1	Describe the key components and architecture of a Programmable Logic Controller (PLC) system, including input/output modules, CPU, memory, and communication interfaces.
CLOBJ 2	Develop PLC programs that integrate ladder logic diagrams with input/output configurations to control real-world industrial processes effectively.
CLOBJ 3	Apply timer functions within PLC programming to design and implement control systems for industrial processes that require precise timing and synchronization.
CLOBJ 4	Apply counter functions in PLC programming to develop systems that count and sequence components or events within industrial processes

f. Course Learning Outcomes:

CLO 1	Demonstrate comprehension by describing the key components and architecture of a Programmable Logic Controller (PLC) system, including input/output modules, CPU, memory, and communication interfaces.
CLO 2	Formulate PLC programs that integrate ladder logic diagrams with input/output configurations, enabling them to control real-world industrial processes effectively.

CLO 3	Implement timer functions within PLC programming to design and implement control systems for industrial processes that require precise timing and synchronization.
CLO 4	Analyze and apply counter functions in PLC programming to develop systems capable of accurately counting and sequencing components

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Recognise key components and architecture of a PLC system, including input/output modules, CPU, memory, and communication interfaces.	2
CLO 2	Formulate PLC programs that integrate ladder logic diagrams with input/output configurations, enabling them to control real-world industrial processes effectively.	6
CLO 3	Implement timer functions within PLC programming to design and implement control systems for industrial processes that require precise timing and synchronization.	3
CLO 4	Analyze counter functions in PLC programming to develop systems capable of accurately counting and sequencing components	4

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	3.00	3.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	3.00	1.00	3.00	1.00	1.00
CLO 2	3.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	3.00	3.00	1.00	3.00	1.00	2.00
CLO 3	3.00	3.00	2.00	1.00	1.00	3.00	2.00	2.00	1.00	2.00	2.00	3.00	2.00	3.00
CLO 4	3.00	2.00	2.00	2.00	1.00	2.00	1.00	2.00	2.00	3.00	3.00	3.00	2.00	3.00
Weighted Average	3.00	2.50	2.00	1.50	1.25	2.00	1.75	1.50	1.75	2.75	1.75	3.00	1.50	2.25

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	-	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

1. "Programmable Logic Controller" by John w. Webb and Ronald A. Reis; PHI.
2. "Programmable Logic Controllers" by John R. Hackworth, Frederick D. Hackworth; Pearson Education Inc.
3. "Programmable Logic Controllers " by W. Bolton; Newness (an imprint of Elsevier).
4. "Practical SCADA for Industry " by David Bailey, Edwin Wright, Newnes; Elsevier, 2003.
5. "SCADA-Supervisory Control and Data Acquisition", by Stuart A. Boyer; Instrument Society of America Publications,USA; 4, 2004

k. List of Experiment:

1. Program based on ON/OFF input and ON/OFF output.
2. Program based on Timer functions.
3. Program based on Counter functions.
4. Program based on arithmetic and compare functions.
5. Program based on analog PLC Operation.
6. Simulate Traffic Light Control in PLC system.
7. Simulate bottle filling system using available PLC system.
8. Simulate mixing process in the tank using available PLC system.
9. Develop SCADA mimic diagram for tank level control.
10. Simulate Temperature control system using available SCADA system.

l. Laboratory Equipment: Siemens Simatic Manager Software

a. **Course Name:** Electrical Energy Conservation & Audit

b. **Course Code:** 303106431

c. **Prerequisite:** Power Plant Engineering, Power System

d. **Rationale:** The course provides basic understanding of energy audit and management Essential Theoretical and practical knowledge about the concept of energy conservation, energy management, Different approaches of energy conservation in industries, economic aspects of energy conservation Project and energy audit.

e. **Course Learning Objective:**

CLOBJ 1	Define and explain fundamental energy concepts, including forms of energy, energy conversion, and energy efficiency.
CLOBJ 2	Comprehend the principles and importance of energy conservation in reducing environmental impact and operational costs.
CLOBJ 3	Demonstrate the ability to measure and analyse energy consumption data to identify areas of energy waste and potential savings.
CLOBJ 4	Evaluate various energy-efficient technologies and practices, including HVAC systems, lighting, insulation, and renewable energy systems.
CLOBJ 5	Apply energy conservation principles and audit techniques to real-world scenarios and case studies.
CLOBJ 6	Collaborate with peers to work on energy conservation projects and audits, fostering teamwork and problem-solving skills.

f. **Course Learning Outcomes:**

CLO 1	Understand the basic knowledge of Different terms & principles of energy audit and management
CLO 2	Calculate return on investment (ROI) and perform financial analysis to determine the economic feasibility of energy conservation projects.

CLO 3	Understand about heat utilization, saving and recovery in different thermal system
CLO 4	Learn the preparation of energy audit report & Different cases related to industries.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand the basic knowledge of Different terms & principles of energy audit and management	2
CLO 2	Calculate return on investment (ROI) and perform financial analysis to determine the economic feasibility of energy conservation projects.	3
CLO 3	Understand about heat utilization, saving and recovery in different thermal system	2
CLO 4	Learn the preparation of energy audit report & Different cases related to industries.	3

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 2	2.00	2.00	3.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00	2.00	2.00	2.00	2.00
CLO 3	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	1.00	2.00	1.00	2.00	2.00	3.00
CLO 4	2.00	2.00	2.00	1.00	3.00	3.00	2.00	2.00	3.00	2.00	1.00	2.00	3.00	2.00

Weighted Average	2.00	2.00	2.25	2.00	2.25	2.25	2.00	2.25	1.75	1.75	1.50	2.00	2.25	2.25

i. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
2	**-**	**0**	**2**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	Energy Scenario: Commercial and Non-Commercial Energy, Primary Energy Resources, Commercial Energy Production, Final Energy Consumption, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment: Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features.	**8%**	**4**
2	Energy Management and Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments	**13%**	**6**
3	Electrical Distribution and Utilization: Supply Side Management: Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management	**17%**	**7**

	(DSM): Load Management, Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for lighting, LED Lighting, Trends and Approaches.		
4	Energy Efficiency in Electrical Utilities: Electric motors: Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient Motors., Assessment of cooling towers Diesel Generating system: Factors affecting selection, Energy performance assessment of diesel conservation avenues Fans and blowers: Types, Performance evaluation, Efficient system operation, Flow control strategies and Energy conservation opportunities.	**20%**	**9**
5	Energy Efficiency in Thermal Utilities: Boilers: Types, Combustion in boilers, Performances evaluation, Analysis of losses, Feed water treatment, Blow down, Energy conservation opportunities. FBC boilers: Introduction, Mechanism of fluidized bed combustion, Advantages, Types of FBC boilers, Waste Heat Recovery: Classification, Advantages and applications.	**20%**	**9**
6	Energy action planning: Energy policy purpose, perspective, Contents, Formulation, Ratification, Organizing location of energy management, Top management support, Managerial function, Roles and responsibilities of energy manager, Accountability. Motivating-motivation of employees information system-designing barriers, Strategies; Marketing and communicating-training and planning. and their characteristics.	**13%**	**6**
7	Energy Performance Assessment of Lighting Systems: Introduction Purpose of the Performance Test Color Rendering Index (CRI) Procedure for Assessment of Lighting Systems ILER Assessment Areas for Improvement.	**9%**	**5**

k. Text Book and Reference Book:

1. "Energy Management" W.R.Murphy, G.Mckay
2. "Guide Books of National Certificate Examination for Energy Managers and Energy Auditors" bureau of energy efficiency

a. Course Name: Electrical Energy Conservation & Audit Lab

b. Course Code: 303106432

c. Prerequisite: Knowledge of Power Plant Engineering, Power System

d. Rationale: The "Electrical Energy Conservation & Audit Lab" provides basic understanding of energy audit and management Essential theoretical and practical knowledge about the concept of energy conservation, energy management, different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit.

e. Course Learning Objective:

CLOBJ 1	Learn how to conduct energy audits in different types of facilities, such as industrial, commercial, and residential settings, using appropriate tools and methodologies.
CLOBJ 2	Develop the ability to analyse energy consumption patterns and identify areas where energy is being wasted or inefficiently used.
CLOBJ 3	Familiarize oneself with energy management systems and tools used for monitoring, control, and optimization of energy usage.
CLOBJ 4	Develop the ability to prepare comprehensive energy audit reports that include findings, recommendations, and cost estimates for energy-saving measures.
CLOBJ 5	Gain knowledge of project management principles and practices related to the implementation of energy conservation projects.

f. Course Learning Outcomes:

CLO 1	Grasp the fundamental principles of energy conservation, including the laws of thermodynamics and the concept of energy efficiency.
CLO 2	Learn various methods and techniques used in conducting energy audits, including data collection, measurement, and analysis.
CLO 3	Explore and understand various technologies and strategies for conserving energy, such as energy-efficient lighting, HVAC systems, insulation, and renewable energy sources.

CLO 4	Explore ethical considerations related to energy conservation and auditing, including issues of transparency, conflicts of interest, and confidentiality.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Grasp the fundamental principles of energy conservation, including the laws of thermodynamics and the concept of energy efficiency.	2
CLO 2	Learn various methods and techniques used in conducting energy audits, including data collection, measurement, and analysis.	3
CLO 3	Explore and understand various technologies and strategies for conserving energy, such as energy-efficient lighting, HVAC systems, insulation, and renewable energy sources.	3
CLO 4	Explore ethical considerations related to energy conservation and auditing, including issues of transparency, conflicts of interest, and confidentiality.	3

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	1.00	1.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 2	3.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00	3.00	3.00	1.00	3.00	1.00	2.00
CLO 3	2.00	3.00	2.00	2.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 4	3.00	2.00	2.00	2.00	1.00	2.00	1.00	2.00	2.00	2.00	3.00	3.00	2.00	3.00

Weighted Average	2.50	2.25	2.00	1.75	1.25	1.50	1.75	1.75	2.25	2.25	2.00	2.75	1.75	2.25

i. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

1. "Guide Books of National Certificate Examination for Energy Managers" and Energy Auditors bureau of energy efficiency
2. "Energy Management" W.R.Murphy, G.Mckay

k. List of Experiment:

1. To Study about Energy Management System Energy Conservation and Audit
2. To Study about Various measuring instruments used for energy Audit
3. To Study about Energy Action planning and Energy Policy
4. To Study about Electrical Distribution and Utilization
5. To Study about Financial Management
6. Find out the payback period for a given energy conservation equipment
7. Solve Examples on ROI,NPV method
8. To Study about Sample Format Of Audit
9. To Study technical report on energy conservation act 2003
10. To Study about Energy Performance Assessment of Lighting Systems and Motors and Variable Speed Drives
11. To Carried out Energy Audit of PIET A Block with Technical Repot

l. **Laboratory Equipment:** Power Analyser and Measuring Instruments

a. **Course Name:** Electrical Drives

b. **Course Code:** 303106437

c. **Prerequisite:** Power Electronics, Electrical Machines and Control Systems

d. Rationale: This course provides an introduction to electrical drives. The broad objective of the course is to teach students energy conversion, processing using electrical drives, application of static drives. At the end of this course, students will be able to explain working of various electrical drives and selection of electrical drives for industrial load.

e. Course Learning Objective:

CLOBJ 1	Explain the basic principles of electrical drives, including the role of electric motors and their importance in various applications.
CLOBJ 2	Differentiate between various types of electric motors (e.g., induction motors, synchronous motors, and stepper motors) and their characteristics.
CLOBJ 3	Evaluate different chopper topologies (e.g., buck, boost, buck-boost) and their applications in motor control.
CLOBJ 4	Analyze various control strategies, including proportional-integral-derivative (PID) control, for DC drives.
CLOBJ 5	Define scalar control (constant V/f control) and its role in regulating the speed and torque of induction motors.
CLOBJ 6	Analyze the impact of varying rotor resistance on motor performance, including speed regulation and torque control.

f. Course Learning Outcomes:

CLO 1	Understand the characteristics of dc motors and induction motors.
CLO 2	Comprehend principles of speed-control of dc motors and induction motors
CLO 3	Analyze the power electronic converters used for dc motor and induction motor speed control.

CLO 4	Examine energy conservation concept using electrical drives

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Understand the characteristics of dc motors and induction motors.	2
CLO 2	Comprehend principles of speed-control of dc motors and induction motors	2
CLO 3	Analyze the power electronic converters used for dc motor and induction motor speed control.	4
CLO 4	Examine energy conservation concept using electrical drives	3

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	1.00	1.00				1.00						1.00		
CLO 2	2.00	1.00	1.00			1.00	1.00					1.00		
CLO 3	2.00	3.00	2.00			1.00	2.00					3.00	1.00	
CLO 4	3.00	3.00	2.00	2.00		1.00	2.00		1.00	1.00		3.00	1.00	
Weighted Average	2.00	2.00	1.67	2.00	0.00	1.00	1.67	0.00	1.00	1.00	0.00	2.00	1.00	0.00

i. Teaching & Examination Scheme:

Teaching Scheme	**Evaluation Scheme**

L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	00	60	00	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**DC motor characteristics** Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, armature voltage control for varying motor speed, flux weakening for high speed operation.	16%	7
2	**Chopper fed DC drive** Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting. Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers, regenerative braking	22%	10
3	**Closed-loop control of DC Drive** Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor ′dynamic equations and transfer functions, modeling of chopper as gain with switching delay, current controller specification and design, speed controller specification and design.	16%	7
4	**Induction motor** characteristics Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque speed	16%	7

	curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, constant flux operation, flux weakening operation.		
5	**Scalar control or constant V/f control of induction motor** Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, constant V/f control of induction motor, speed drop with loading, slip regulation.	**17%**	**8**
6	**Control of slip ring induction motor** Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.	**13%**	**6**

k. Text Book and Reference Book:

1. "Control of Electric Drives" By W. Leonhard Springer Science & Business Media
2. "Electric motor drives: modelling, analysis and control" By R. Krishnan
3. "Fundamentals of Electrical Drives" By Gopal K. Dubey
4. Power semiconductor controlled drives By G.K. Dubey

a. **Course Name:** Electrical Drives Lab

b. **Course Code:** 303106438

c. **Prerequisite:** Power Electronics, Electrical Machines and Control Systems

d. Rationale: This course provides a practical exposure to electrical drives. The broad objective of the course is give hands on / simulations practice to students of energy conversion, processing using electrical drives, application of static drives. At the end of this course students will be able to take practical exposure of electric drives for industry and do selection of electrical drives for industrial load. Laboratory exercises are basically guided design problems.

e. Course Learning Objective:

CLOBJ 1	Describe the operation and characteristics of power electronic converters used in electrical drives, including inverters and rectifiers.
CLOBJ 2	Explain how chopper-fed DC drives achieve precise and continuous speed regulation.
CLOBJ 3	Explain control strategies for speed, torque, and position control in electrical drives.
CLOBJ 4	Analyze the dynamic response of chopper-fed DC drives under different load conditions.
CLOBJ 5	Analyze methods for controlling motor speed through variations in voltage and frequency.
CLOBJ 6	Create mathematical models of electrical drive systems using simulation tools (e.g., MATLAB/Simulink)

f. Course Learning Outcomes:

CLO 1	Create the characteristics of dc motors and induction motors in simulator.

CLO 2	Generate the speed-control of dc motors and induction motors.
CLO 3	Justify the power electronic converters used for dc motor and induction motor speed control.
CLO 4	Speculate the energy conservation concept using electrical drives performance.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Create the characteristics of dc motors and induction motors in simulator.	6
CLO 2	Generate the speed-control of dc motors and induction motors.	5
CLO 3	Justify the power electronic converters used for dc motor and induction motor speed control.	3
CLO 4	Speculate the energy conservation concept using electrical drives performance.	4

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	1.00	2.00	1.00	1.00	2.00	2.00			3.00	2.00	2.00	2.00	3.00	3.00
CLO 2	2.00	3.00	1.00	1.00	2.00	2.00			3.00	2.00	2.00	2.00	3.00	3.00
CLO 3	1.00	2.00	1.00	2.00	3.00	2.00			3.00	2.00	2.00	2.00	3.00	3.00
CLO 4	1.00	2.00	2.00	2.00	3.00	2.00			3.00	2.00	2.00	2.00	3.00	3.00
Weighted Average	1.25	2.25	1.25	1.50	2.50	2.00			3.00	2.00	2.00	2.00	3.00	3.00

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
				Internal Evaluation			ESE		Total
L	T	P	C	MSE	CE	P	Theory	P	
0	0	2	1	0	0	20	00	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

1. "Control of Electric Drives" By W. Leonhard Springer Science & Business Media
2. "Electric motor drives: modelling, analysis and control" By R. Krishnan
3. "Fundamentals of Electrical Drives" By Gopal K. Dubey
4. "Power semiconductor controlled drives" By G.K. Dubey

k. List of Experiment

1. To simulate single phase fully controlled converter for a DC separately Excited Motor using MATLAB
2. simulate single phase semi control of a separately Excited DC Motor using MATLAB
3. To simulate type A chopper control of D.C. Motor
4. To simulate four quadrants control of DC drive using chopper
5. To simulate Closed loop speed control of DC motor
6. To develop a MATLAB program, to plot torque-speed characteristics of poly phase induction motor
7. To develop a MATLAB program, to plot torque-speed characteristics of stator voltage controlled induction machine
8. To simulate AC voltage controller based speed control of AC motor
9. To simulate Inverter based speed control of Induction motor

10. To perform the v/f control of Induction motor with PWM inverter

Semester-8

a. Course Name: Electrical Installation, Maintenance & Testing

b. Course Code: 303106451

c. Prerequisite: Knowledge of AC & DC Machines and Substations

d. Rationale: The course provides detail study of testing methods of various electrical machines & Equipment's and also useful for evaluating different electrical parameters.

e. Course Learning Objective:

CLOBJ 1	Understanding of transformer testing principles, methods, and applications, enabling them to proficiently assess transformer performance and troubleshoot issues within the broader context of electrical systems.
CLOBJ 2	Acquire a comprehensive knowledge of induction motor testing techniques, procedures, and analysis, equipping them with the skills to assess motor performance, troubleshoot, and optimize the operation of induction motors within various industrial applications.
CLOBJ 3	Understanding of synchronous machine testing methods, principles, and applications, enabling them to effectively evaluate the performance, troubleshoot, and ensure the reliability of synchronous generators and motors.
CLOBJ 4	Acquire knowledge in testing various substation equipment components including transformers, circuit breakers, relays, and switchgear.
CLOBJ 5	Understanding of the testing techniques, procedures, and analysis related to power transmission and distribution lines, as well as underground and overhead cables.

f. Course Learning Outcomes:

CLO 1	Distinguish between routine, type and commissioning tests for various electrical machines and equipment.
CLO 2	Learn different testing methods for electrical machines and technical details of electrical equipment.
CLO 3	Sum-up about the maintenance of static & rotating electrical machines.

CLO 4	Know ´how of different equipment used in sub-stations
CLO 5	Learn testing procedures for switch gear equipment.
CLO 6	Fault finding of underground cables.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Distinguish between routine, type and commissioning tests for various electrical machines and equipment.	4
CLO 2	Learn different testing methods for electrical machines and technical details of electrical equipment.	4
CLO 3	Sum-up about the maintenance of static & rotating electrical machines.	3
CLO 4	Know ´how of different equipment used in sub-stations	2
CLO 5	Learn testing procedures for switch gear equipment.	4
CLO 6	Fault finding of underground cables.	4

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1								1.00				2.00		
CLO 2	1.00				1.00	1.00	1.00		1.00		1.00	3.00		1.00
CLO 3			1.00			1.00						1.00		
CLO 4					1.00			1.00		1.00	1.00	1.00		

CLO 5			1.00		1.00		1.00	1.00	1.00		1.00	2.00		1.00
CLO 6	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	1.00	2.00	1.00	1.00
Weighted Average	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.33	1.50	1.00	1.83	1.00	1.00

i. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Transformer Testing** Classification of different types of tests for power and instrument transformers, DC & AC resistance measurement, Polarity test of transformers including CT & PT, Ratio test, Determination of losses form no load and short circuit tests, Evaluation of short circuit impedance, Load test and Temperature rise test of power transformer, Insulation resistance test, Determination of Polarization Index, Separate voltage source testing, Induced voltage testing, Impulse & Surge testing, Power frequency voltage withstand test, Partial discharge test, Tan- delta testing, H.V testing, Sudden short circuit withstand test, Noise & vibration level testing, Determination of connection group for three phase transformers, Condition monitoring of bushing and its testing, On load tap changer, Properties of transformer oil, Transformer oil testing, Purification & Filtration process of transformer oil, Drying procedure for transformer, Commissioning	**25%**	**11**

	steps for transformer, Troubleshooting & Maintenance of transformer.		
2	**Induction Motor Testing** Insulation resistance measurement, Polarization Index, H.V testing, Tan-delta testing, No load & Blocked rotor test, Load & Heat run test, Temperature rise test, Slip & Slip measurement, Vibration & Noise testing, Degree of protection (I.P grade), Methods of cooling (IC designations), Selections of induction motors, Drying out methods, Installation and commissioning of Induction motors, Maintenance & Troubleshooting of Induction motors	**16%**	**7**
3	**Synchronous Machine Testing** Measurement of DC & AC resistance of armature and field windings, OC & SC test characteristics, Phase sequence test, Temperature rise test, Dielectric test on armature and field windings, H.V testing, Over speed test, Noise & Vibration measurement, Rotor balancing, Bearings & their maintenance, Induced shaft currents, Voltage recovery test, Low slip test, Static & Brushless excitation systems, Drying out procedure, Installation and commissioning of synchronous machines, Maintenance & Trouble shooting of synchronous machines	**22%**	**10**
4	**Condition Monitoring of Electrical Machines** Concept of condition monitoring, benefit of condition monitoring, Fault detection & diagnosis techniques for Transformer and Induction motor, Recent trends in condition monitoring.	**8%**	**4**
5	**Substation Equipments** Busbar: Temperature rise test, Rated short time current test, HV test, Power frequency voltage withstand test, Impulse / surge testing, Vibration test. Earthing: Earthing resistance measurement, Substation grid Earthing, Soil resistivity measurement. Testing of circuit breakers: Classification, Description of a simple testing station, Equipments used in the station, Testing procedure, Direct testing, Indirect testing, Test Report. Mechanical endurance test, Temperature rise test, Impulse & surge testing, Short time testing, Short circuit making & breaking testing,	**22%**	**10**

	Trouble shooting and maintenance of circuit breakers. LT switchgears: Electrical & Mechanical endurance tests for LT switch gear like MCB / MCCB / ELCB. Lightning Arrestors: Testing & Commissioning of Lightning arrestors.		
6	**Lines & Cables** Derating of cable, HV test, AC & DC resistance check, Insulation resistance, Location of finding technique for fault in underground cables (Murray loop test & Varley loop test), Testing of open circuit faults in cables, Line charging, loading & Dropping.	**7%**	**3**

k. Text Book and Reference Book:

1. **Testing Commissioning Operation & Maintenance of Electrical Equipments (TextBook)** By S. Rao | Khanna Publication | 6th edition edition (2010)
2. **The Commissioning of Electrical Plant (TextBook)** By RCH Richardson, Chapman | Hall Publications

Electrical Equipment Handbook: Troubleshooting and Maintenance (TextBook) By Philip Kiameh | McGraw-Hill

a. Course Name: Project II

b. Course Code: 303106453

c. Prerequisite: Basic knowledge of Power System, Power Electronics, Machines, Controllers and softwares used for design and analysis in Electrical Engineering.

d. Rationale: With increasing upgradation and technological requirement in engineering, new methods or products need to be developed. Objective of this course is to make students gain technical and practical knowledge in area of their interest and develop project to solve problems in existing technologies which are already developed. Student will also be able to make themselves sound in software analysis with the software they are using like MATLAB, ETAB, MULTISIM, MIPOWER, PSCAD, ARDUINO etc. as well as hardware preparation for the project they are developing.

e. Course Learning Objective:

CLOBJ 1	Project Understanding: Students should be able to demonstrate a clear understanding of the project scope, objectives, and requirements. This includes the ability to define the problem or challenge to be addressed.
CLOBJ 2	Problem Analysis: Analyzing the problem statement critically and identifying key parameters and constraints. This may involve mathematical modeling and analysis techniques.
CLOBJ 3	Problem-solving: Developing problem-solving skills to address technical challenges that may arise during the project.
CLOBJ 4	Prototype Development (if applicable): Depending on the project, students may be expected to develop a prototype or proof of concept during this phase.
CLOBJ 5	Technical Documentation: Proficiency in documenting project requirements, specifications, and initial design concepts. This includes creating schematics, diagrams, and technical reports.

f. Course Learning Outcomes:

CLO 1	Use and apply information from technical literature, identify and set clearly the aims and objectives of research project.
CLO 2	Develop a research proposal and plan for a research project in an appropriate area relevant to the Programme of study.
CLO 3	Source and critically review literature relevant to a chosen project topic.
CLO 4	Evaluate a range of data analysis methods, experimental methods, alternative approaches in relation to specific project objectives.
CLO 5	Do detail software analysis with the software they are using for project work.
CLO 6	Understand and develop hardware for different types of products.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Use and apply information from technical literature, identify and set clearly the aims and objectives of research project.	3
CLO 2	Develop a research proposal and plan for a research project in an appropriate area relevant to the Programme of study.	6
CLO 3	Source and critically review literature relevant to a chosen project topic.	5
CLO 4	Evaluate a range of data analysis methods, experimental methods, alternative approaches in relation to specific project objectives.	3
CLO5	Do detail software analysis with the software they are using for project work.	2
CLO6	Understand and develop hardware for different types of products.	1

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	PLOs												PSLO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CLO 1	3.00	3.00	3.00	3.00	2.00	2.00	2.00	0	3.00	3.00	3.00	3.00	1.00	1.00
CLO 2	3.00	2.00	2.00	3.00	2.00	2.00	2.00	0	3.00	3.00	3.00	3.00	2.00	2.00
CLO 3	2.00	3.00	2.00	2.00	2.00	2.00	2.00	0	3.00	3.00	1.00	3.00	2.00	1.00
CLO 4	3.00	3.00	3.00	3.00	3.00	2.00	2.00	0	3.00	3.00	3.00	3.00	3.00	3.00
CLO 5	3.00	2.00	3.00	3.00	3.00	2.00	2.00	0	3.00	3.00	3.00	3.00	3.00	3.00
CLO 6	3.00	2.00	3.00	3.00	3.00	1.00	2.00	0	3.00	3.00	3.00	3.00	3.00	3.00
Weighted Average	2.83	2.5	2.67	2.83	2.5	1.83	2.00	0	3.00	3.00	2.67	3.00	2.33	2.17

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	Lab Hr/week	C	Internal Evaluation			External		Total
				T	CE	P	T	P	
0	0	10	5	-	-	100	-	100	200

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content: NA**

k. Text Book and Reference Book: NA

a. Course Name: Power Quality & FACTs

b. Course Code: 303106496

c. Prerequisite: Power Electronics, Power System and Control Systems

d. Rationale: This course provides an introduction and practical exposure to Power Quality & FACTs. The broad objective of the course is teach and give hands on / simulations practice to students of energy conversion, processing using FACTs, application of FACTs for Power Quality improvements. At the end of this course students will be able to explain working of various and take practical exposure of various FACTs devices and concept of power quality, derive converters mathematical relations. Laboratory exercises are basically guided design problems

e. Course Learning Objective:

CLOBJ 1	Explain the impact of poor power quality on electrical equipment and systems.
CLOBJ 2	Understand the causes and effects of electrical transients on equipment and systems.
CLOBJ 3	Evaluate the impact of harmonics on power quality, including voltage distortion and flicker.
CLOBJ 4	Define shunt compensation (reactive power injection) and series compensation (reactance addition) and their roles in AC transmission.
CLOBJ 5	Describe various types of thyristor-based FACTS controllers, including Thyristor-Controlled Series Compensators (TCSC) and Static Voltage Controller
CLOBJ 6	Define Flexible AC Transmission Systems (FACTS) and their significance in power system control.

f. Course Learning Outcomes:

CLO 1	Recognize importance of Power Quality

CLO 2	Recognize different Power Quality standards
CLO 3	Analyze the characteristics of ac transmission and the effect of shunt and series reactive compensation
CLO 4	Understand the working principles of FACTs devices and their operating characteristics

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Recognize importance of Power Quality	1
CLO 2	Recognize different Power Quality standards	1
CLO 3	Analyze the characteristics of ac transmission and the effect of shunt and series reactive compensation	4
CLO 4	Understand the working principles of FACTs devices and their operating characteristics	1

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	1.00	1.00		1.00		2.00	2.00					3.00		
CLO 2	1.00	1.00		1.00		2.00	2.00					3.00		
CLO 3	3.00	3.00	1.00	1.00	1.00	2.00	2.00			1.00		3.00	2.00	2.00
CLO 4	3.00	3.00	1.00	1.00	1.00	2.00	2.00			1.00		3.00	2.00	2.00
Weighted Average	2.00	2.00	1.00	1.00	1.00	2.00	2.00			1.00		3.00	2.00	2.00

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	2	4	20	20	20	60	30	150

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**Introduction to Power Quality and Events:** Definition of power Quality, power quality terminology, power quality issues, Susceptibility Criteria, Responsibility of supplier and users ofelectrical power, Power Quality Standards, Common power frequency disturbances, voltage sags, cures of low frequency disturbances, voltage tolerance, CBEMA curve	15%	7
2	**Electrical Transients & Power factor mitigation:** Transient System Model, Examples of Transient Models and Their Response, Application of DC Voltage to a Capacitor, Application of DC Voltage to an Inductor, Power System Transient Model, Examples of Transient Waveforms Power Factor: Active and Reactive Power, Displacement and True Power Factor, Power Factor Improvement, Power Factor Correction, Other Advantages of Power Factor Correction, Voltage Rise Due to Capacitance.	15%	7
3	**Harmonics:** Definition of Harmonics, Harmonic Number, Odd and Even Order Harmonics, Harmonic Phase Rotation and Phase Angle Relationship, Causes of Voltage and Current Harmonics, Individual and Total Harmonic Distortion, Harmonic Signatures, Effect of	20%	10

	Harmonics on Power System Devices, Guidelines for Harmonic Voltage and Current Limitation, Harmonic Current Mitigation		
4	**Transmission Lines and Series/Shunt Reactive Power Compensation Basics of AC Transmission.** Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.	**15%**	**6**
5	**Thyristor-based Flexible AC Transmission Controllers (FACTS)** Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC). Configurations/Modes of Operation, Harmonics and control of SVC and TCSC	**15%**	**6**
6	**Voltage Source Converter based (FACTS) controllers STATCOM:** Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC)	**12%**	**4**
7	**Power Quality Measurement** Power quality measurement devices, power quality measurements, Number of test locations, Test duration, Instrument set-up, Instrument set up guidelines.	**8%**	**5**

k. Text Book and Reference Book:

1. "Electric power quality" By G.T. Heydt,
2. "Understanding FACTS" By N. G. Hingorani and L. Gyugyi
3. "FACTS Controllers in Power Transmission & Distribution" By K R Padiyar
4. "Reactive Power Control in Electric Systems" By T J E Miller
5. "Power quality" By C. Sankaran
6. "Electrical Power Systems Quality" By Roger C. Dugan

l. List of Experiment

1. To Study and calculation of THD and IHD of various types of non-linear loads
2. To Simulate voltage and current harmonics of nonlinear load (uncontrolled rectifier).
3. To Simulate voltage and current harmonics of nonlinear load (controlled rectifier)
4. To Simulate voltage and current harmonics of nonlinear load (Three Phase Inverter).
5. Simulate Voltage Sag
6. To Simulate Voltage Swell
7. To Simulate Electrical Transient
8. To simulate the series compensated Transmission line.
9. To simulate the Shunt compensated Transmission line
10. To simulate the Thyristor Controlled Reactor TCR for power compensation
11. To simulate the Thyristor Switched Capacitor TSC for power compensation.
12. To simulate voltage and current harmonics analysis of nonlinear load using pulse control
13. To simulate voltage and current harmonics analysis of nonlinear load using SPWM.
14. To simulate Harmonics and Unbalance mitigation in distribution systems using Shunt Active Filters.

a. Course Name: Wind and Solar Energy Systems

b. Course Code: 303106481

c. Prerequisite: Control Systems Engineering, Electrical Machines-I, Electrical Machines-II, Power Electronics

d. Rationale: This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles. A hybrid vehicle is a vehicle with multiple distinct energy sources which could be separately or simultaneously operated to propel the vehicle. Many hybridization configurations such as fuel cell, gas turbine, solar, hydraulic, pneumatic, ethanol, electric and many more are proposed over the years. Among these, the hybrid electric vehicles, integrating two technically and commercially proven and well established technologies of electric motors and I.C. engine, allowing drawing upon their individual benefits have been widely accepted by the technologies and users.

e. Course Learning Objective:

CLOBJ 1	Explanation on the importance of power generation through wind and solar energy systems.
CLOBJ 2	Grasping knowledge of how wind and solar energy generation systems work.
CLOBJ 3	Apply practical knowledge in implementation of solar and wind energy system considering international standards.
CLOBJ 4	Learning different power electronics interfaces used in connecting wind and solar energy system with power system.
CLOBJ 5	Develop solar and wind power generation systems for smaller installations.
CLOBJ 6	Evaluation of effects from implementation of wind and solar energy generation in power systems.

f. Course Learning Outcomes:

CLO 1	Analyze the models hybrid vehicles and their performance.
CLO 2	Determine the component sizing of Electric Vehicles.
CLO 3	Develop hybrid possible ways of energy storage and energy management for Hybrid Electric Vehicle.

CLO 4	Program the energy management for Hybrid Electric Vehicles.
CLO 5	Design the propulsion unit for the Hybrid Electric Vehicles.
CLO 6	Implement the Electrical Drive for Hybrid Electric Vehicles.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Analyze the models hybrid vehicles and their performance.	4
CLO 2	Determine the component sizing of Electric Vehicles.	4
CLO 3	Develop hybrid possible ways of energy storage and energy management for Hybrid Electric Vehicle.	6
CLO 4	Program the energy management for Hybrid Electric Vehicles.	4
CLO 5	Design the propulsion unit for the Hybrid Electric Vehicles.	6
CLO 6	Implement the Electrical Drive for Hybrid Electric Vehicles.	3

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00
CLO 2	2.00	2.00	2.00	1.00	2.00	2.00	1.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00
CLO 3	3.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 4	3.00	2.00	2.00	3.00	2.00	2.00	1.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00
CLO 5	2.00	3.00	2.00	2.00	3.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00
CLO 6	3.00	2.00	2.00	3.00	2.00	3.00	3.00	2.00	1.00	2.00	2.00	3.00	2.00	3.00
Weighted Average	2.50	2.16	2.00	2.16	2.33	1.66	2.16	1.83	2.16	2.16	2.16	2.16	2.00	2.00

i. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**INTRODUCTION** Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	22%	10
2	**ELECTRIC TRAINS** Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies and hybrid drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	29%	13
3	**ENERGY STORAGE**	29%	13

	Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.		
4	**ENERGY MANAGEMENT STRATEGIES** Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	**20%**	**9**

k. Text Book and Reference Book:

1. "Hybrid Electric Vehicles Principles And Applications With Practical Perspectives" by Chris Mi, M. Abul Masrur & David Wenzhong Gao | Wiley Publication
2. "Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain | CRC Press
3. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design " by M. Ehsani, Y. Gao, S. Gay and Ali Emadi | CRC Press

a. Course Name: Wind and Solar Energy Systems Lab

b. Course Code: 303106482

c. Prerequisite: Control Systems Engineering, Electrical Machines-I, Electrical Machines-II, Power Electronics

d. Rationale: This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles. A hybrid vehicle is a vehicle with multiple distinct energy sources which could be separately or simultaneously operated to propel the vehicle. Many hybridization configurations such as fuel cell, gas turbine, solar, hydraulic, pneumatic, ethanol, electric and many more are proposed over the years. Among these, the hybrid electric vehicles, integrating two technically and commercially proven and well established technologies of electric motors and I.C. engine, allowing drawing upon their individual benefits have been widely accepted by the technologies and users.

e. Course Learning Objective:

CLOBJ 1	Analyze different factors affecting V-I and P-V Characteristics of solar PV system.
CLOBJ 2	Demonstrate working of solar and wind energy systems.
CLOBJ 3	Design wind and solar systems for smaller installations.
CLOBJ 4	Learning MATLAB programming for calculation of parameters related to different parameters of wind and solar energy systems.
CLOBJ 5	Understand usage and effect of wind-solar hybrid system in power system.

f. Course Learning Outcomes:

CLO 1	Determine the component sizing for hybrid electric vehicles based on vehicle dynamics.
CLO 2	Model and simulate the series, parallel and series-parallel Hybrid Electric Vehicles.

CLO 3	Simulate the torque control of Hybrid Electric Vehicles.
CLO 4	Analyze the performance of Hybrid Electric Vehicles.

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Determine the component sizing for hybrid electric vehicles based on vehicle dynamics.	4
CLO 2	Model and simulate the series, parallel and series-parallel Hybrid Electric Vehicles.	5
CLO 3	Simulate the torque control of Hybrid Electric Vehicles.	3
CLO 4	Analyze the performance of Hybrid Electric Vehicles.	4

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00
CLO 2	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00
CLO 3	3.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 4	3.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00
Weighted Average	2.50	2.00	2.00	2.00	2.00	2.25	2.0	2.25	2.00	2.25	2.25	2.00	1.75	1.75

i. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

1. "Hybrid Electric Vehicles Principles And Applications With Practical Perspectives" by Chris Mi, M. Abul Masrur & David Wenzhong Gao | Wiley Publication
2. "Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain | CRC Press
3. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design " by M. Ehsani, Y. Gao, S. Gay and Ali Emadi | CRC Press

k. List of Experiment:

1. Determine the component sizing of Hybrid Electric Vehicles.
2. Modeling the acceleration of Electric Vehicle.
3. Range simulation of Electric Vehicle.
4. To plot motor efficiency plot.
5. Super capacitors and Battery power management for Hybrid Electric Vehicles.
6. Modeling and simulation of Series Hybrid Electric Vehicles.
7. Modeling and simulation of Parallel Hybrid Electric Vehicles.
8. Simulation of Torque Control in a Series-Parallel HEV.
9. Demonstration of working of automotive hybrid car.

l. Laboratory Equipment: MATLAB Software

a. Course Name: Electrical Hybrid Vehicles

b. Course Code: 303106483

c. Prerequisite: Control Systems Engineering, Electrical Machines-I, Electrical Machines-II, Power Electronics

d. Rationale: This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles. A hybrid vehicle is a vehicle with multiple distinct energy sources which could be separately or simultaneously operated to propel the vehicle. Many hybridization configurations such as fuel cell, gas turbine, solar, hydraulic, pneumatic, ethanol, electric and many more are proposed over the years. Among these, the hybrid electric vehicles, integrating two technically and commercially proven and well established technologies of electric motors and I.C. engine, allowing drawing upon their individual benefits have been widely accepted by the technologies and users.

e. Course Learning Objective:

CLOBJ 1	Analyze various hybrid vehicle models, including their components and technologies, to assess their performance characteristics and advantages in terms of efficiency and emissions reduction.
CLOBJ 2	Determine the appropriate sizing of components for Electric Vehicles (EVs), including batteries, motors, and power electronics, to optimize vehicle performance and range.
CLOBJ 3	Develop innovative strategies for energy storage and management in Hybrid Electric Vehicles (HEVs), considering different hybrid architectures and energy sources.
CLOBJ 4	Programming and configuring the energy management system for HEVs, ensuring optimal utilization of power sources and efficient operation under various driving conditions.

g. Course Learning Outcomes:

CLO 1	Analyze the models hybrid vehicles and their performance.
CLO 2	Determine the component sizing of Electric Vehicles.
CLO 3	Develop hybrid possible ways of energy storage and energy management for Hybrid Electric Vehicle.

CLO 4	Program the energy management for Hybrid Electric Vehicles.
CLO 5	Design the propulsion unit for the Hybrid Electric Vehicles.
CLO 6	Implement the Electrical Drive for Hybrid Electric Vehicles.

h. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Analyze the models hybrid vehicles and their performance.	4
CLO 2	Determine the component sizing of Electric Vehicles.	4
CLO 3	Develop hybrid possible ways of energy storage and energy management for Hybrid Electric Vehicle.	6
CLO 4	Program the energy management for Hybrid Electric Vehicles.	4
CLO 5	Design the propulsion unit for the Hybrid Electric Vehicles.	6
CLO 6	Implement the Electrical Drive for Hybrid Electric Vehicles.	3

i. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00
CLO 2	2.00	2.00	2.00	1.00	2.00	2.00	1.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00
CLO 3	3.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 4	3.00	2.00	2.00	3.00	2.00	2.00	1.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00
CLO 5	2.00	3.00	2.00	2.00	3.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00
CLO 6	3.00	2.00	2.00	3.00	2.00	3.00	3.00	2.00	1.00	2.00	2.00	3.00	2.00	3.00
Weighted Average	2.50	2.16	2.00	2.16	2.33	1.66	2.16	1.83	2.16	2.16	2.16	2.16	2.00	2.00

j. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

k. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**INTRODUCTION** Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	22%	10
2	**ELECTRIC TRAINS** Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies and hybrid drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	29%	13
3	**ENERGY STORAGE**	29%	13

	Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.		
4	**ENERGY MANAGEMENT STRATEGIES** Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	**20%**	**9**

l. Text Book and Reference Book:

1. "Hybrid Electric Vehicles Principles And Applications With Practical Perspectives" by Chris Mi, M. Abul Masrur & David Wenzhong Gao | Wiley Publication
2. "Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain | CRC Press
3. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design " by M. Ehsani, Y. Gao, S. Gay and Ali Emadi | CRC Press

a. Course Name: Electrical Hybrid Vehicles Lab

b. Course Code: 303106484

c. Prerequisite: Control Systems Engineering, Electrical Machines-I, Electrical Machines-II, Power Electronics

d. Rationale: This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles. A hybrid vehicle is a vehicle with multiple distinct energy sources which could be separately or simultaneously operated to propel the vehicle. Many hybridization configurations such as fuel cell, gas turbine, solar, hydraulic, pneumatic, ethanol, electric and many more are proposed over the years. Among these, the hybrid electric vehicles, integrating two technically and commercially proven and well established technologies of electric motors and I.C. engine, allowing drawing upon their individual benefits have been widely accepted by the technologies and users.

e. Course Learning Objective:

CLOBJ 1	Determine the appropriate sizing of components for hybrid electric vehicles based on a thorough understanding of vehicle dynamics and performance requirements.
CLOBJ 2	To model and simulate different configurations of hybrid electric vehicles, including series, parallel, and series-parallel systems, using appropriate simulation tools and techniques.
CLOBJ 3	To simulate torque control strategies for hybrid electric vehicles, allowing them to understand and manipulate the torque output of the vehicle's powertrain components.
CLOBJ 4	Analyzing and evaluating the overall performance of hybrid electric vehicles, considering factors such as energy efficiency, emissions, and drivability.

g. Course Learning Outcomes:

CLO 1	Determine the component sizing for hybrid electric vehicles based on vehicle dynamics.
CLO 2	Model and simulate the series, parallel and series-parallel Hybrid Electric Vehicles.

CLO 3	Simulate the torque control of Hybrid Electric Vehicles.
CLO 4	Analyze the performance of Hybrid Electric Vehicles.

h. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		**Bloom's Level**
CLO 1	Determine the component sizing for hybrid electric vehicles based on vehicle dynamics.	4
CLO 2	Model and simulate the series, parallel and series-parallel Hybrid Electric Vehicles.	5
CLO 3	Simulate the torque control of Hybrid Electric Vehicles.	3
CLO 4	Analyze the performance of Hybrid Electric Vehicles.	4

i. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00
CLO 2	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00
CLO 3	3.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CLO 4	3.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00
Weighted Average	2.50	2.00	2.00	2.00	2.00	2.25	2.0	2.25	2.00	2.25	2.25	2.00	1.75	1.75

j. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

k. Text Book and Reference Book:

1. "Hybrid Electric Vehicles Principles And Applications With Practical Perspectives" by Chris Mi, M. Abul Masrur & David Wenzhong Gao | Wiley Publication
2. "Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain | CRC Press
3. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design " by M. Ehsani, Y. Gao, S. Gay and Ali Emadi | CRC Press

l. List of Experiment:

1. Determine the component sizing of Hybrid Electric Vehicles.
2. Modeling the acceleration of Electric Vehicle.
3. Range simulation of Electric Vehicle.
4. To plot motor efficiency plot.
5. Super capacitors and Battery power management for Hybrid Electric Vehicles.
6. Modeling and simulation of Series Hybrid Electric Vehicles.
7. Modeling and simulation of Parallel Hybrid Electric Vehicles.
8. Simulation of Torque Control in a Series-Parallel HEV.
9. Demonstration of working of automotive hybrid car.

m. Laboratory Equipment: MATLAB Software

a. **Course Name:** Advance Controller

b. **Course Code:** 303106489

c. **Prerequisite:** Basic Knowledge of Microprocessor Architecture and Programming

d. **Rationale:** This course will provide an opportunity to the students to become familiar with ARM microprocessor architecture, instruction set and programming.

e. **Course Learning Objective:**

CLOBJ 1	Describe the fundamental components and architecture of ARM processors
CLOBJ 2	Understand ARM assembly language code for basic operations
CLOBJ 3	Explain ARM's memory management features
CLOBJ 4	Identify and differentiate between various ARM instruction sets
CLOBJ 5	Develop software in C/C++ that targets ARM processors
CLOBJ 6	Apply ARM knowledge to real-world projects and case studies

f. **Course Learning Outcomes:**

CLO 1	Become familiar with importance and applications of advance microprocessor
CLO 2	Understand architecture of ARM processor
CLO 3	Understand instruction set of ARM processor
CLO 4	Be able to write hybrid (assembly & C) program for ARM microprocessor
CLO 5	Analyze given program to find out program output

g. **Mapping of Course Learning Outcomes and Bloom's Taxonomy:**

Course Learning Outcomes	**Bloom's Level**

CLO 1	Become familiar with importance and applications of advance microprocessor	1,2
CLO 2	Understand architecture of ARM processor	2
CLO 3	Understand instruction set of ARM processor	2
CLO 4	Be able to write hybrid (assembly & C) program for ARM microprocessor	2,3
CLO 5	Analyse given program to find out program output	4

h. Mapping of Course Learning Outcomes and Program Learning Outcomes and Program Specific Learning Outcomes:

CLOs	**PLOs**												**PSLO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	3.00	3.00	2.00	3.00	1.00	3.00			2.00	2.00	2.00	2.00	2.00	2.00
CLO 2	3.00	2.00	2.00	2.00	1.00	1.00			2.00	3.00	2.00	2.00	1.00	3.00
CLO 3	2.00	2.00	2.00	2.00	1.00	1.00			2.00	3.00	2.00	2.00	1.00	3.00
CLO 4	3.00	3.00	3.00	3.00	2.00	3.00			2.00	2.00	3.00	3.00	3.00	3.00
CLO 5	2.00	3.00	3.00	3.00	2.00	3.00			2.00	2.00	3.00	3.00	3.00	3.00
Weighted Average	2.60	2.60	2.40	2.60	1.40	2.20	0.00	0.00	2.00	2.40	2.40	2.40	2.00	2.80

i. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**		**60**		**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**INTRODUCTION:** Need of advance microprocessors, Difference between RISC and CISC, RISC Design philosophy, ARM Design Need of advance microprocessors, Difference between RISC and CISC, RISC Design philosophy, ARM Design Philosophy, History of ARM microprocessor, ARM processor family, Development of ARM architecture, History of ARM microprocessor, ARM processor family, Development of ARM architecture	**10%**	**6**
2	**THE ARM ARCHITECTURE AND PROGRAMMERS MODEL:** The Acorn RISC Machine, ARM Core data flow model, Architectural inheritance, The ARM7TDMI programmers' model: General purpose registers, CPSR, SPSR, ARM memory map, data format, load and store architecture, Core extensions, Architecture revisions, ARM development tools	**25%**	**10**
3	**ARM INSTRUCTION SET:** Data processing instructions, Arithmetic and logical instructions, Rotate and barrel shifter, Branch instructions, Load and store instructions, Software interrupt instructions, Program status register instructions, Conditional execution, Multiple register load and store instructions, Stack instructions, Thumb instruction set, advantage of thumb instructions, Assembler rules and directives, Assembly language programs for shifting of data, factorial calculation, swapping register contents, moving values between integer and floating point reg	**25%**	**10**
4	**C PROGRAMMING FOR ARM:** Overview of C compiler and optimization, Basic C data types, C Looping structures, Register allocations, function calls, pointer aliasing, structure arrangement, bitfields, unaligned data and Endianness, Division, floating point, Inline functions and inline assembly, Portability issues. C programs for General purpose I/O, general	**25%**	**10**

	purpose timer, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC		
5	**Advanced Microprocessor Bus Architecture** Advanced Microprocessor Bus Architecture (AMBA) Bus System, User peripherals, Exception handling in ARM, ARM optimization techniques	**15%**	**08**

k. Text Book and Reference Book:

1. "ARM Assembly Language Programming & Architecture" by Muhammad Ali Mazidi Kindle edition
2. "Arm Assembly Language, Fundamentals and Techniques" by William Hohl, Christppher Hinds | CRC Press | 2nd edition
3. "Arm System Developer's Guide, Designing and Optimizing Software" by Andrew N. Sloss, Dominic Symes, Chris W wight | Elsevier
4. "ARM System on Chip Architecture" by Steve Furber | Pearson Education | 2nd
5. "Embedded systems Architecture, Programming and Design" by Rajkamal | TMH

a. Course Name: Advance Controller lab

b. Course Code: 303106490

c. Prerequisite: Basic Knowledge of Microprocessor Architecture and Programming

d. Rationale: This course will provide an opportunity to the students to become familiar with ARM microprocessor instruction set and programming.

e. Course Learning Objective:

CLOBJ 1	Understand and apply ARM assembly language syntax.
CLOBJ 2	Simulate and debug C code for ARM microprocessors.
CLOBJ 3	Understand basic digital output control.
CLOBJ 4	Understand analog-to-digital conversion and sensor interfacing.
CLOBJ 5	Gain experience in character and string handling for displays.
CLOBJ 6	Gain experience in project management, documentation, and presentation skills.

f. Course Learning Outcomes:

CLO 1	Understand instruction set of ARM processor
CLO 2	Ability to understand how various co-processors are interfaced in an SoC
CLO 3	Be able to write hybrid (assembly & C) program for ARM microprocessor
CLO 4	Good understanding and issues to be handled in using any processor SW tools chain for embedded software solution development.
CLO 5	Be able to interface input/output devices like Keyboard, LED, LCD, sensors with ARM7TDMI

g. Mapping of Course Learning Outcomes and Bloom's Taxonomy:

Course Learning Outcomes		Bloom's Level
CLO 1	Understand instruction set of ARM processor	2,1
CLO 2	Ability to understand how various co-processors are interfaced in an SoC	2
CLO 3	Be able to write hybrid (assembly & C) program for ARM microprocessor	2.3
CLO 4	Good understanding and issues to be handled in using any processor SW tools chain for embedded software solution development.	2.3
CLO 5	Be able to interface input/output devices like Keyboard, LED, LCD, sensors with ARM7TDMI	3,4

h. Mapping of Course Learning Outcomes and Program Outcomes and Program Specific Outcomes:

CLOs	PLOs												PSLO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CLO 1	2.00	2.00	2.00	2.00	1.00	1.00			2.00	3.00	2.00	2.00	1.00	3.00
CLO 2	3.00	2.00	3.00	3.00	2.00	2.00			2.00	3.00	2.00	3.00	2.00	3.00
CLO 3	2.00	2.00	3.00	2.00	3.00	3.00			1.00	2.00	2.00	3.00	2.00	2.00
CLO 4	3.00	2.00	3.00	3.00	2.00	2.00			2.00	3.00	2.00	3.00	3.00	3.00
CLO 5	2.00	2.00	3.00	2.00	3.00	3.00			2.00	2.00	2.00	3.00	3.00	2.00
Weighted Average	2.40	2.00	2.80	2.40	2.20	2.20			1.80	2.60	2.00	2.80	2.20	2.60

i. Teaching & Examination Scheme:

Teaching Scheme	Evaluation Scheme

L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

j. Text Book and Reference Book:

"ARM Assembly Language Programming & Architecture" by Muhammad Ali Mazidi Kindle edition

"Arm Assembly Language, Fundamentals and Techniques" by William Hohl, Christppher Hinds | CRC Press | 2nd edition

"Arm System Developeṙs Guide, Designing and Optimizing Software" by Andrew N. Sloss, Dominic Symes, Chris W wight | Elsevier

"ARM System on Chip Architecture" by Steve Furber | Pearson Education | 2nd

"Embedded systems Architecture, Programming and Design" by Rajkamal | TMH

k. List of Experiment:

1. To write and simulate ARM assembly language programs for data transfer, arithmetic and logical operations.
2. To write and simulate C Programs for ARM microprocessor in KEIL
3. To interface LED with ARM microprocessor and write program to blink LED at the interval of 1 second
4. To interface switch with ARM microprocessor and write program in C language to read status of the switch
5. To interface LCD with ARM microprocessor. Write and execute programs in C language for displaying text messages and numbers on LCD
6. To interface DC motor with ARM microprocessor. Write program to rotate DC motor in clockwise and anticlockwise direction with different speed
7. Interfacing of temperature sensor with ARM freedom board (or any other ARM microprocessor board) and display temperature on LCD.
8. Student mini project based on ARM microprocessor

l. Laboratory Equipment: u KEIL SOFTWARE ,ARM MICROPROCESSOR