Course Name: Electrical Energy Generation System

Course Code: 23EL1301

Semester: Third

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Electrical Energy Generation System (23EL1301)

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

CO	Statement	Blooms Level
CO-1	Describe types of renewable energy sources and different factors associated with a generating station.	L2
CO-2	Cite various parameters related to selection and application of Solar, Wind Energy and Biogas .	L2
CO-3	Analyze various parameters for Hydro and Thermal Power generating Systems	L4
CO-4	Explain various parameters related to generation of Nuclear Power .	L3

COURSE ARTICULATION MATRIX

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

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	This course outcome involves description of types of Renewable energy sources and various factors associated with a generating station. Hence mapped with PO-1 with high level, i.e., 3..
CO-2		3	Cite various parameters related to selection and application of Solar, Wind Energy and Biogas, this course outcome involves application. Attainment Hence map of these parameters. Mapped with PO-1 with high level, i.e., 3.
CO-3		3	This course outcome involves analysis of knowledge of hydro and thermal power plants. Mapped with PO-1 with high level, i.e., 3
CO-4		3	This course outcome involves in depth knowledge of parameters of nuclear power plants. Hence mapped with PO-1 with high level, i.e., 3.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Through the material presented in this course, students will learn to identify, formulate and analyze problems related with generating stations, and solar, hydro, wind and thermal energy. Therefore, all CO's are mapped with PO-2 with level, 3.
CO-2		3	
CO-3		3	
CO-4		3	

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	For designing creative solutions for complex engineering problems, students will learn designing power plant parameters. Hence all CO's are mapped with PO-3 with level 2.
CO-2		2	
CO-3		2	
CO-4		2	

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Students will learn about solar and wind data analysis and interpret it through experimental data problems,. This will help them in carrying investigations on complex problems. Hence all CO's are mapped with PO-4 with moderate level, i.e., 2..
CO-2		2	
CO-3		2	
CO-4		2	

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark

CO-1	PO-5	-	As no software tools are taught or used in the CO's cannot be mapped with PO-5.
CO-2		-	
CO-3		-	
CO-4		-	

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	3	Student learns importance of Renewable energy and clean energy and its importance for society. Therefore, all CO's are mapped with PO-6 with level 3.
CO-2		3	
CO-3		3	
CO-4		3	

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	-	As subject does not deal with finance. Therefore, all CO's are not mapped with PO-10.
CO-2		-	
CO-3		-	
CO-4		-	

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Knowledge is continuously gained throughout life. Thermal, hydro, and nuclear technology is well established. Wind and solar energy methods are evolving and student will have to acquire new knowledge with time Therefore all CO's are mapped with PO-11 with moderate level, i.e., 2.
CO-2		2	
CO-3		2	
CO-4		2	

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	The courses on Electrical Energy Generation Systems arerelated to power system operation, control and design. Hence all CO's are mapped with PSO-1 with high level, i.e., 3.
CO-2		3	
CO-3		3	
CO-4		3	

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	The course deals with electrical systems ut marginally with electronic systems. Hence CO's are mapped with PSO-2 with a low level, i.e., 1.
CO-2		1	
CO-3		1	
CO-4		1	

(S. S. GOKHALE)

Course Coordinator

(Dr. S. P. GAWANDE)

HOD

Course Name: Renewable Energy Sources Lab

Course Code: 23EL1302

Semester: Third

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Renewable Energy Sources Lab (23EL1302)

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

CO	Statement	Blooms Level
CO-1	Discuss the performance of solar photovoltaic system.	L2
CO-2	Analyze the performance of Solar Water Heater system.	L4
CO-3	Explain the working of Solar Wind Hybrid system.	L4
CO-4	Justify Biomass energy conversion systems.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	3	3	3						2	2	
CO-2	3	2	2	3	2						2	2	
CO-3	3	1	1	3	2	3					2	2	
CO-4	3	1	1	3	2	3					2	2	
Average	3	1.5	1.75	3	2.25	1.5					2	2	

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

<table>
<tr><th>CO</th><th>PO</th><th>Mapping</th><th>Remark</th></tr>
<tr><td>CO-1</td><td rowspan="4">PO-1</td><td>3</td><td>While understanding fluctuation in parameters due to intermittent nature of sources, knowledge of natural sciences and engineering basics . Hence strong mapping.</td></tr>
<tr><td>CO-2</td><td>3</td><td>Experimentation leads to develop solution of complex engineering problemst.. Hence strong mapping.</td></tr>
<tr><td>CO-3</td><td>3</td><td>To develop designs of different power generating units and analyse its performance, knowledge of mathematics, computing and, engineering fundamentals are required. Hence strong mapping.</td></tr>
<tr><td>CO-4</td><td>3</td><td>To develop designs of different power generating units and analyse its performance, knowledge of mathematics, computing and, engineering fundamentals are required. Hence strong mapping.</td></tr>
</table>

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

<table>
<tr><th>CO</th><th>PO</th><th>Mapping</th><th>Remark</th></tr>
<tr><td>CO-1</td><td rowspan="4">PO-2</td><td>2</td><td>While plotting characteristics substantiated conclusions with consideration for sustainable development is obtained. Hence moderate mapping</td></tr>
<tr><td>CO-2</td><td>2</td><td>While plotting characteristics substantiated conclusions with consideration for sustainable development is obtained. Hence moderate mapping</td></tr>
<tr><td>CO-3</td><td>1</td><td rowspan="2">System parameters are identified, methodology is formulated. Hence WEAK mapping.</td></tr>
<tr><td>CO-4</td><td>1</td></tr>
</table>

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

<table>
<tr><th>CO</th><th>PO</th><th>Mapping</th><th>Remark</th></tr>
<tr><td>CO-1</td><td rowspan="4">PO-3</td><td>3</td><td>While understanding simulation environment, specific toolboxes of power system only are explored. Hence strong mapping.</td></tr>
<tr><td>CO-2</td><td>2</td><td>Solutions for engineering problems in power systems are obtained for developed systems to meet identified needs for society in terms of economy, and in consideration of the environment. Hence moderate mapping.</td></tr>
<tr><td>CO-3</td><td>1</td><td rowspan="2">System is studied for performance analysis. Hence weak mapping.</td></tr>
<tr><td>CO-4</td><td>1</td></tr>
</table>

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

<table>
<tr><th>CO</th><th>PO</th><th>Mapping</th><th>Remark</th></tr>
<tr><td>CO-1</td><td rowspan="4">PO-4</td><td>3</td><td rowspan="4">Experimentation is conducted for interpretation of data and results are obtained for valid conclusions. Hence strong mapping.</td></tr>
<tr><td>CO-2</td><td>3</td></tr>
<tr><td>CO-3</td><td>3</td></tr>
<tr><td>CO-4</td><td>3</td></tr>
</table>

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	3	Appropriate techniques have been applied to recognize limitations of system. Hence, strong mapping.
CO-2		2	
CO-3		2	Study of system is done to predict approximate design of models which will be utilized for generation.Hence moderate mapping.
CO-4		2	

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Being a laboratory of Sustainable Energy, which are used extensively in academics and industries alike, graduates are expected to extend learning experience throughout their professional career. Hence moderate mapping.
CO-2		2	
CO-3		2	
CO-4		2	

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	The electrical system parameters are observed for design purpose, operation and control. Hence, moderate mapping.
CO-2		3	
CO-3		3	
CO-4		3	

(X. R. POTE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Network Analysis

Course Code: 23EL1303

Semester: Third

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Network Analysis (23EL1303)

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

CO	Statement	Blooms Level
CO-1	Apply node voltage and mesh current analysis methods to electric circuits.	L3
CO-2	Apply network theorems to analyze and solve electrical circuits, including those with dependent and independent sources.	L3
CO-3	Determine initial and final values of current and voltage of electric circuits containing energy storage elements.	L3
CO-4	Apply Laplace transform to electric circuits for calculation of time response, driving point and transfer functions etc.	L3
CO-5	Calculate and relate different two port network parameters, simplify the complex network such as cascade, parallel networks using fundamental two port network parameters.	L3

COURSE ARTICULATION MATRIX

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

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	This course outcome involves application of KCL and KVL to dc circuits, ac circuits, coupled circuits, and circuits with controlled or dependent sources. Course knowledge along with differential and integral calculus, determinants and matrices will be required. Attainment will be done completely through problems. Hence mapped with PO-1 with high level, i.e., 3.
CO-2		3	In addition to KCL and KVL, this course outcome involves application of network theorems for the analysis of complex electrical circuits. Attainment will be done completely through problems. Hence mapped with PO-1 with high level, i.e., 3.
CO-3		3	This course outcome involves application of course knowledge related to behavior of inductor and capacitor during transient and steady state conditions. Attainment will be done completely through problems. Hence mapped with PO-1 with high level, i.e., 3.
CO-4		3	This course outcome involves application of Laplace transform and inverse Laplace transform for the analysis of electrical circuits. Attainment will be done completely through problems based on time response of electric circuits, waveform synthesis, and network functions. Hence mapped with PO-1 with high level, i.e., 3.
CO-5		3	This course outcome involves application of KCL, KVL, and Laplace transform for the analysis of two port networks. Attainment will be done completely through problems based on two port networks. Hence mapped with PO-1 with high level, i.e., 3.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

<table>
<tr><th>CO</th><th>PO</th><th>Mapping</th><th>Remark</th></tr>
<tr><td>CO-1</td><td rowspan="5">PO-2</td><td>2</td><td rowspan="5">Through the material presented in this course, students will learn to identify, formulate and analyze problems in electrical circuit analysis. It will inculcate habit of logical thinking and will improve their numerical ability. These two important qualities will make the students more successful in the field of engineering research. Hence all CO's are mapped with PO-2 with moderate level, i.e., 2.</td></tr>
<tr><td>CO-2</td><td>2</td></tr>
<tr><td>CO-3</td><td>2</td></tr>
<tr><td>CO-4</td><td>2</td></tr>
<tr><td>CO-5</td><td>2</td></tr>
</table>

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

<table>
<tr><th>CO</th><th>PO</th><th>Mapping</th><th>Remark</th></tr>
<tr><td>CO-1</td><td rowspan="5">PO-3</td><td>1</td><td rowspan="5">As a first step towards designing creative solutions for complex engineering problems, students will learn designing electric circuits for specified voltage, current, power, for maximum power transfer to load, and for specified transfer function through poles and zeros.. Hence all CO's are mapped with PO-3 with low level, i.e., 1.</td></tr>
<tr><td>CO-2</td><td>1</td></tr>
<tr><td>CO-3</td><td>1</td></tr>
<tr><td>CO-4</td><td>1</td></tr>
<tr><td>CO-5</td><td>1</td></tr>
</table>

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Students will learn data analysis and data interpretation through experimental data problems,. This will help them in conducting investigations of complex problems. Hence all CO's are mapped with PO-4 with low level, i.e., 1.
CO-2		1	
CO-3		1	
CO-4		1	
CO-5		1	

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Students will use software tool such as Matlab, for simulation and modelling of circuit analysis problems and can verify their earlier obtained solutions. The attainment will be carried out indirectly through course completion report. Hence all CO's are mapped with PO-5 with low level, i.e., 1.
CO-2		1	
CO-3		1	
CO-4		1	
CO-5		1	

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7	1	As a part of professional ethics and responsibilities, it is mandatory for all the students to maintain academic honesty. They will not involve in any unfair means, ragging etc. The attainment is carried out indirectly through course completion report. Hence all CO's are mapped with PO-7 with low level, i.e., 1.
CO-2		1	
CO-3		1	
CO-4		1	
CO-5		1	

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	"The education of a man is never completed until he dies." Being one of the basic and interesting course of Electrical engineering, the students will be motivated for lifelong learning. Hence all CO's are mapped with PO-12 with high level, i.e., 3.
CO-2		3	
CO-3		3	
CO-4		3	
CO-5		3	

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Most of the courses related to power system operation, control and design, need basics from the course of network analysis. Hence all CO's are mapped with with PSO-1 with high level, i.e., 3.
CO-2		3	
CO-3		3	
CO-4		3	
CO-5		3	

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	KVL and KCL are used in the mathematical modelling of electrical and electronic systems. Transfer function is used in describing input – output of control systems. Two port networks are used in electrical and electronic system analysis. Students will demonstrate their knowledge regarding electrical and electronic systems through all five course outcomes. Hence CO's are mapped with PSO-2 with high level, i.e., 3.
CO-2		3	
CO-3		3	
CO-4		3	
CO-5		3	

(R. N. NAGPURE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electrical Engineering Workshop

Course Code: 23EL1304

Semester: Third

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Electrical Engineering Workshop Lab (23EL1304)

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

CO	Statement	Blooms Level
CO-1	Identify and explain the construction, working principles, and troubleshooting of common electrical appliances, including ceiling fans, electric irons, and mixers.	L2
CO-2	Demonstrate the measurement of earth resistance, insulation resistance, and testing of electrical components like DC motors and transformers.	L3
CO-3	Analyze and assemble electrical systems, including starters (DOL and Star-Delta), solar rooftop installations, and center-tapped transformers, to meet functional requirements.	L4
CO-4	Evaluate the design and functionality of electrical infrastructure, including transmission towers, insulators, and power cables, ensuring reliability and safety in power systems.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	1		2	2						2	3
CO-2	3	3	2	3	3	2						3	3
CO-3	3	3	3	3	3	3					2	3	3
CO-4	3	2	2	2	3	3					2	3	3
Average	3.00	2.50	2.00	2.67	2.75	2.50					2.00	2.75	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Understanding appliance working involves core electrical principles.
CO-2		3	Measurement and testing requires solid foundational knowledge.
CO-3		3	Designing/assembling systems is based on deep electrical theory.
CO-4		3	Evaluating infrastructure demands engineering knowledge of power systems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Identifying faults in appliances involves basic problem-solving.
CO-2		3	Analysis during resistance testing reflects diagnostic skill.
CO-3		3	Fault detection and functional verification requires problem-solving.
CO-4		2	Recognizing faults in infrastructure reflects moderate analysis.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Very basic design inference from appliances.

CO-2		2	Setup and troubleshooting reflect applied design knowledge.
CO-3		3	Practical system design and integration is demonstrated.
CO-4		2	Designing for safety and reliability in infrastructure components.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4		
CO-2		3	Measurement tasks mirror real-world field investigation.
CO-3		3	Validating installations and connections requires experimental investigation.
CO-4		2	Field analysis of power systems includes data collection and evaluation.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Tools are used for testing appliances.
CO-2		3	Measuring earth/insulation resistance involves modern meters.
CO-3		3	Use of tools like multimeters, solar kits, etc.
CO-4		3	Application of modern tools in analyzing infrastructure performance.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Appliance safety has direct social implications.
CO-2		2	Earth testing contributes to residential/industrial safety.
CO-3		3	Solar and infrastructure systems directly serve society.
CO-4		3	Infrastructure ensures reliable societal power access.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11		
CO-2			
CO-3		2	Planning solar and starter installations.
CO-4		2	Infrastructure setup requires budgeting, planning, and resource use.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Appliance basics support foundational system learning.
CO-2		3	Strong mapping with field, transformer, and infrastructure knowledge.
CO-3		3	Strong mapping with field, transformer, and infrastructure knowledge.
CO-4		3	Strong mapping with field, transformer, and infrastructure knowledge.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	All outcomes cover testing, installation, and evaluation of electrical systems thoroughly.
CO-2		3	All outcomes cover testing, installation, and evaluation of electrical systems thoroughly.
CO-3		3	All outcomes cover testing, installation, and evaluation of electrical systems thoroughly.
CO-4		3	All outcomes cover testing, installation, and evaluation of electrical systems thoroughly.

(A. S. LILHARE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electrical Machines

Course Code: 23EL1305

Semester: Third

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Electrical Machines (23EL1305)

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

CO	Statement	Blooms Level
CO-1	Analyze the performance of Transformers.	L4
CO-2	Illustrate proficiency in understanding the performance of D.C. Machines	L4
CO-3	Evaluate the performance of Induction Motors.	L4
CO-4	Explain working of Special Machines.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	2	2	2	1	1	1					2	3	3
CO-2	3	3	3	2	2	1					2	3	3
CO-3	3	3	3	2	2	1					2	2	3
CO-4	3	3	3	2	2	1					2	2	3
Average	2.75	2.75	2.75	1.75	1.75	1.00					2.00	2.50	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	2	Applies fundamental concepts of electrical engineering, electromagnetism, and circuit theory to analyze transformer performance.
CO-2		3	Applies core concepts of electromagnetic theory and mechanics to D.C. machines.
CO-3		3	Applies advanced concepts of electromagnetic induction and machine theory to assess induction motor performance.
CO-4		3	Integrates knowledge of electrical and magnetic principles to explain the operation of special machines.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Identifies and interprets performance characteristics of transformers using analytical methods.
CO-2		3	Analyzes machine behavior and performance through characteristics and testing.
CO-3		3	Analyzes performance characteristics through testing, modeling, and evaluation.
CO-4		3	Analyzes control strategies and performance characteristics of machines like BLDC, stepper, and SRM.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Supports design-based understanding for transformer applications in electrical networks.
CO-2		3	Enhances understanding of D.C. machine design and control applications.
CO-3		3	Supports design-oriented understanding for applications in industrial motor systems.
CO-4		3	Supports design and application of special machines in modern systems such as robotics and electric vehicles.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Involves basic analysis and interpretation of test results and transformer characteristics.
CO-2		2	Involves systematic investigation and performance testing of D.C. motors and generators.
CO-3		2	Involves experimental validation and interpretation of performance parameters
CO-4		2	Involves modeling, simulation, and analysis through experimental methods.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Utilizes basic software tools and simulations to model transformer performance.
CO-2		2	Employs simulation and lab tools to assess machine behavior and efficiency.
CO-3		2	Utilizes engineering software and hardware tools to model and simulate induction motor operations.
CO-4		2	Applies engineering tools and software to simulate the working of special machines.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Considers environmental and societal implications such as energy efficiency and power loss
CO-2		1	Evaluates energy losses and environmental impact in D.C. systems.
CO-3		1	Assesses sustainability through energy-efficient motor selection and application.
CO-4		1	Highlights use of special machines in sustainable and green technologies.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Recognizes the importance of adapting to evolving transformer technologies.
CO-2		2	Promotes life-long learning through exposure to evolving motor technologies.
CO-3		2	Encourages continuous learning of modern induction motor control systems.
CO-4		2	Encourages adaptability to emerging special machine technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Directly contributes to analyzing power system components and transformer behavior.
CO-2		3	Builds competence in analyzing D.C. machine operations in power systems.
CO-3		2	Supports understanding of induction motor behavior in power system operations.
CO-4		2	Enhances ability to analyze advanced machines used in power and control systems.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Strengthens the ability to evaluate and control electrical systems involving transformers.
CO-2		3	Develops proficiency in controlling and evaluating D.C. electrical systems.
CO-3		3	Strengthens ability to evaluate and control industrial electrical systems.
CO-4		3	Strengthens skills in assessing and controlling complex electrical systems.

(S. L. TIWARI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electrical Machines Lab

Course Code: 23EL1306

Semester: Third

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Electrical Machines Lab (23EL1306)

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

CO	Statement	Blooms Level
CO-1	Analyze the performance of three phase transformers.	L4
CO-2	Illustrate proficiency in understanding the performance of dc machines.	L4
CO-3	Evaluate the performance of Induction motors.	L5
CO-4	Evaluate the operation of Induction Generator.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	2	2	1					2	2	2
CO-2	3	3	3	2	2	1					2	2	2
CO-3	3	3	3	2	2	1					2	2	2
CO-4	3	3	3	2	2	1					2	2	2
Average	3.00	3.00	3.00	2.00	2.00	1.00					2.00	2.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires fundamental engineering knowledge for transformer analysis.
CO-2		3	Strong engineering knowledge is required to understand DC machine operation.
CO-3		3	Strong relevance to motor analysis and engineering knowledge.
CO-4		3	Requires engineering fundamentals and design principles.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves solving transformer performance-related challenges.
CO-2		3	Strong engineering knowledge is required to understand DC machine operation.
CO-3		3	Strong relevance to motor analysis and engineering knowledge.
CO-4		3	Requires engineering fundamentals and design principles.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Understanding transformer efficiency supports electrical system design.
CO-2		3	Strong engineering knowledge is required to understand DC machine operation.
CO-3		3	Strong relevance to motor analysis and engineering knowledge.
CO-4		3	Requires engineering fundamentals and design principles.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Transformer performance analysis involves experimental approaches.
CO-2		2	Involves investigations into machine efficiency.
CO-3		2	Performance evaluation requires analytical techniques.
CO-4		2	Experimental investigations are needed for induction generators.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Simulation tools are used for performance testing.
CO-2		2	Basic application of tools and ethical considerations.
CO-3		2	Use of modern testing tools for motor efficiency studies.
CO-4		2	Simulation tools play a role in generator operation studies.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Indirect contribution to ethical and environmental engineering aspects.
CO-2		1	Basic application of tools and ethical considerations.
CO-3		1	Ethical and sustainability impact related to motor selection.
CO-4		1	Ethical and environmental considerations impact generator use.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Transformer selection and optimization affect project execution.
CO-2		2	Team collaboration and project-based knowledge are crucial.

CO-3		2	Involves collaboration, communication, and project management.
CO-4		2	Collaboration and project execution in generator applications.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Key application in electrical machine performance evaluation..
CO-2		2	DC machine performance impacts electrical machine applications.
CO-3		2	Induction motor control and optimization for electrical applications.
CO-4		2	Crucial for understanding electrical power generation.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Key application in electrical machine performance evaluation.
CO-2		2	DC machine performance impacts electrical machine applications.
CO-3		2	Induction motor control and optimization for electrical applications.
CO-4		2	Crucial for understanding electrical power generation.

(P. S. SHETE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Introduction to Electric Vehicles

Course Code: MDM1EL101

Semester: Third

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Introduction to Electric Vehicles (MDM1EL101)

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

CO	Statement	Blooms Level
CO-1	Discuss the classification of electric vehicles (EVs), and compare them with internal combustion engines (ICEs).	L2
CO-2	Explain different types of EV chargers and their design ratings.	L3
CO-3	Analyze charging connectors and communication protocols for AC and DC chargers as per international standards.	L4
CO-4	Design a preliminary EV charging station, including the selection and sizing of electrical components.	L6

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	2	1	1	2	2				1	3	2
CO-2	3	3	3	2	2	1	2				1	3	3
CO-3	3	3	3	3	3	1	2				1	3	3
CO-4	3	3	3	3	2	2	3				2	3	3
Average	3.00	2.75	2.75	2.25	2.00	1.50	2.25				1.25	3.00	2.75

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires fundamental understanding of vehicle physics, mechanics, and systems based on engineering science.
CO-2		3	Demands application of engineering knowledge (electrical ratings, standards).
CO-3		3	Applies technical knowledge related to electrical connectors and data communication.
CO-4		3	Requires deep application of foundational electrical engineering knowledge.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves analyzing the pros and cons of EVs vs ICEs considering sustainability.
CO-2		3	Analysis of technical specifications and performance under constraints.
CO-3		3	Involves analyzing complex standards and protocols (e.g., CCS, CHAdeMO).
CO-4		3	Complex problem-solving in designing real-life systems.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Slight exposure to design-oriented thinking when comparing technologies for improvement.
CO-2		3	Implied design considerations for choosing and rating EV chargers.
CO-3		3	Practical understanding supports real-world compliant system design.
CO-4		3	Involves creative and sustainable design of charging infrastructure

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Basic comparative analysis implies a minimal level of investigation.
CO-2		2	Evaluation of real charger data and models as part of analysis.
CO-3		3	Protocol implementation requires investigation of real-time communication behavior.
CO-4		3	Requires simulation, modeling, and selection based on data-driven analysis.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Limited use of tools or simulations; mainly conceptual.
CO-2		2	Use of tools or datasheets in understanding chargers' characteristics.
CO-3		3	Heavy use of simulation tools or testing frameworks (CAN, PLC, etc.) expected.
CO-4		2	Use of CAD/simulation tools in component sizing and station layout.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Encourages evaluation of societal/environmental benefits of EVs over ICEs.
CO-2		1	Some awareness of environmental impact from charger efficiency or infrastructure.
CO-3		1	Limited but present understanding of global protocol choices impacting society.
CO-4		2	Consideration of social/environmental impact in siting and capacity planning

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7	2	Encourages ethical thinking regarding pollution, sustainability, and energy usage.
CO-2		2	Consideration of compliance with safety and international charging standards.
CO-3		2	Adherence to international standards requires ethical compliance.
CO-4		3	Complies with electrical codes and standards for safety and human values.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Awareness of trends suggests potential for self-learning but with minimal focus.
CO-2		1	Limited, but understanding charger evolution supports lifelong learning.
CO-3		1	Knowledge of new protocols encourages lifelong learning, though indirectly.
CO-4		2	Involves elements of project management, cost analysis, and future upgrades.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Directly related to understanding EV systems and their operation.
CO-2		3	Strong connection to power systems and charger infrastructure.
CO-3		3	Protocols directly relate to EV operation and communication within power systems.
CO-4		3	Strong match with power system component sizing and load estimation.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Involves interpretation of components relevant to electrical and electronic vehicle systems.
CO-2		3	High relevance in evaluating and assessing electrical components of chargers.
CO-3		3	High relevance in assessing and integrating electrical and communication systems.
CO-4		3	Demonstrates complete integration of electrical systems into a real-world application.

(J. M. KUMBHARE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Introduction to Solar-Thermal Energy

Course Code: MDM1EL102

Semester: Third

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Introduction to Solar-Thermal Energy (MDM1EL102)

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

CO	Statement	Blooms Level
CO-1	Illustrate the properties and thermal analysis of flat plate collectors	L2
CO-2	Classify the properties and thermal analysis of concentrating collectors	L2
CO-3	Discuss different systems of thermal energy storage	L2
CO-4	Explain the concept of solar pond and its applications	L3

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	3		2					3	1	1
CO-2	3	3	2	3		2					3	1	1
CO-3	3	3	2	3		2					3	1	1
CO-4	1	1	1	1		1					3	1	1
Average	2.5	2.5	1.75	2.5		1.75					3	1	1

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Flat plate solar collectors' properties and thermal analysis require a basic understanding of the fundamentals of mathematics, engineering sciences. Hence strong mapping
CO-2		3	To understand the properties and carry out thermal analysis of concentrating type solar collectors requires a basic understanding of the fundamentals of mathematics, engineering sciences. Hence strong mapping
CO-3		3	Designing an efficient thermal storage system requires a basic understanding of the fundamentals of mathematics, engineering sciences. Hence strong mapping
CO-4		1	To comprehend different types of solar ponds and their applications requires an understanding of chemical reactions. Hence weak mapping

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Flat plate solar system parameters are identified, and the methodology is expressed to deduce thermal efficiency. The results obtained are evaluated for the performance of the system. Hence strong mapping
CO-2		3	Concentrating type solar system parameters are identified, and the

			methodology is stated to deduce thermal efficiency. The results obtained are evaluated for the performance of the system. Hence strong mapping
CO-3		3	To assess the efficiency of thermal storage systems, limitations are identified, and the method is specified. The results obtained are estimated for the performance of the system. Hence strong mapping
CO-4		1	Different solar ponds across the countries and in the Indian context are studied to understand the advantages and disadvantages of the systems. Hence weak mapping

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Solutions for flat plate collector thermal efficiency are obtained to meet the identified needs of society with consideration for public health, whole-life cost, net-zero carbon, and the environment. Hence moderate mapping
CO-2		2	Solutions for concentrated-type collector thermal efficiency are obtained to meet the identified needs of society with consideration for public health, whole-life cost, net-zero carbon, and the environment. Hence moderate mapping
CO-3		2	Solutions for thermal storage efficiency are obtained to meet the identified needs of society with consideration for public health, whole-life cost, net-zero carbon, and the environment. Hence moderate mapping
CO-4		1	Solar ponds are compared and classified based on their applications. The extent to which solar ponds can be integrated into the solar ecosystem is understood to meet the identified needs of society with consideration for public health, whole-life cost, net-zero carbon, and the environment. Hence weak mapping

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Flat plate collector data is analysed and interpreted to provide solutions for the solar systems. Hence, strong mapping.
CO-2		3	Concentrating type collector data is analysed and interpreted to provide solutions for thermal efficiency of the solar systems. Hence, strong mapping.
CO-3		3	Thermal storage data is assessed and investigated to provide solutions for the efficiency of thermal storage systems. Hence, strong mapping.
CO-4		1	Review of solar ponds is taken to know their application to various industries. Hence, weak mapping.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Solutions to simple problems are provided for the performance of flat plate, concentrating type solar collectors as well as thermal storage systems with reference to economy, health, and environment. Hence, moderate mapping.
CO-2		2	
CO-3		2	
CO-4		1	The applications of solar ponds and their viability is discussed. Hence, weak mapping

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	The course offers a basic understanding of solar system thermal properties. It is expected that the knowledge gained will be useful for individuals' professional growth after graduation, since solar systems are slowly replacing traditional energy sources
CO-2		3	
CO-3		3	
CO-4		3	

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	The solar systems based on flat plate collectors, concentrated type collectors and thermal storage system problems are analysed and evaluated for operation of the system. Hence weak mapping.
CO-2		1	
CO-3		1	
CO-4		1	

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	The knowledge of the thermal properties of solar collectors and thermal storage systems forms the basis to control and assess the complex solar systems. Hence, weak mapping.
CO-2		1	
CO-3		1	
CO-4		1	

(B. Y. BAGDE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Basic Electrical and Electronics Engineering

Course Code: 23EL1101

Semester: First/second

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Basic Electrical and Electronics Engineering (23EL1101)

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

CO	Statement	Blooms Level
CO-1	Discuss electric circuits for voltage, current and power etc.	L2
CO-2	Describe construction, working principal and its types and uses of different electrical machinery.	L2
CO-3	Explain the working principles, characteristics, and applications of electronic circuits.	L3
CO-4	Illustrate measurement systems, characteristics, and error analysis.	L3

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2		2							3	
CO-2	3	2	2			2						2	2
CO-3	3	2			2				2				3
CO-4				2	2				2		2		3
Average	3.00	2.33	2.00	2.00	2.00	2.00			2.00		2.00	2.50	2.67

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strongly relevant, as the analysis of circuits requires application of foundational electrical engineering principles (Ohm's Law, KCL, KVL, etc.).
CO-2		3	Understanding the construction and operation of electrical machines requires a solid foundation in core electrical engineering principles.
CO-3		3	Strong mapping as students need a solid foundation in semiconductor theory and circuit behavior to understand electronic devices like diodes, BJTs, and op-amps.
CO-4		-	-

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Essential to solving and analyzing problems in voltage, current, and power which involves identifying and interpreting circuit behavior.
CO-2		2	Basic understanding of machines supports identifying functional issues or differentiating between machine types and their applications.
CO-3		2	Moderate mapping as students are expected to interpret device behavior and predict circuit responses under different input conditions.
CO-4		-	

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Circuit analysis supports design insights, though not full-fledged design — hence a moderate level.
CO-2		2	Students interpret various machines' characteristics and usage, which aids in selecting suitable machines in broader engineering solutions.
CO-3		-	-
CO-4		-	-

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	-	-
CO-2		-	-
CO-3		-	-
CO-4		2	Students analyze measurement parameters, sources of error, and interpret results, which is essential for engineering investigations.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Simulations (e.g., Multisim, PSPICE) or lab tools (multimeters, oscilloscopes) are moderately used to analyze circuits.
CO-2		-	-
CO-3		2	Use of circuit simulation software (e.g., LTspice, Multisim) to model and analyze electronic circuits justifies this mapping.
CO-4		2	Students use instruments and software tools for data acquisition, error analysis, and calibration, aligning with moderate tool usage.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Knowledge of machines is essential to understanding how engineering decisions impact industry and society (e.g., use of motors in public infrastructure).
CO-2		-	-
CO-3		-	-
CO-4		-	-

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

CO	PO	Mapping	Remark
CO-1	PO-09		
CO-2			
CO-3		2	Practical lab sessions or assignments may involve collaborative efforts in analyzing and presenting circuit behaviors.
CO-4		2	Working in labs and preparing reports or performing group measurements fosters teamwork and collaborative learning.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	-	-
CO-2		-	-
CO-3		-	-
CO-4		2	Understanding measurement systems supports basic project evaluation, budgeting of instrumentation, and efficient resource management.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Circuit analysis forms a foundational competence in understanding and solving problems in power system behavior, stability, and control, making a strong alignment with PSO1 appropriate.
CO-2		2	Understanding machine construction and function is foundational to power system design, control, and fault analysis.
CO-3		-	-
CO-4		-	-

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2		
CO-2		2	Electrical machines are integral to many electro-mechanical systems, aligning this CO with PSO2 moderately.
CO-3		3	Strong mapping because this CO directly aligns with understanding, evaluating, and applying knowledge of electronic systems.
CO-4		3	Measurement and error analysis are critical for testing and validating system performance, strongly supporting PSO2.

(A. S. LILHARE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Basic Electrical Engineering (BEL)

Course Code: 23EL1102

Semester: First/Second

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Basic Electrical Engineering (BEL) (23EL1102)

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

CO	Statement	Blooms Level
CO-1	Describe the basics of dc circuits and calculate electrical parameters and variables	L2
CO-2	Estimate electrical quantities for single phase and three phase ac circuits	L2
CO-3	Explain construction and working of AC machines and determine various parameters thereof	L4
CO-4	Evaluate various parameters of the AC machines such as transformers and Induction motors.	L4
CO-5	Illustrate construction, working and applications of DC Machines	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	1	1	1					2	1	1
CO-2	3	3	3	1	1	1					2	1	1
CO-3	3	3	3	1	1	1					2	1	1
CO-4	3	3	3	1	1	1					2	1	1
CO-5	3	3	3	1	1	1					2	1	1
Average	3.00	3.00	2.80	1.00	1.00	1.00					2.00	1.00	1.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strongly contributes by reinforcing fundamental electrical engineering knowledge.
CO-2		3	: Reinforces core engineering knowledge of AC systems.
CO-3		3	Strong relevance in understanding and analyzing AC machine operations.
CO-4		3	Strongly contributes by applying foundational knowledge in electrical engineering to AC machine systems
CO-5		3	Strongly contributes to knowledge and analysis of DC machines.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Strong contribution by enabling analysis of simple DC circuits.
CO-2		3	Strong analytical involvement in evaluating circuit behavior.
CO-3		3	Strong relevance in understanding and analyzing AC machine operations
CO-4		3	Supports analytical and evaluative capabilities in understanding transformer and motor performance.
CO-5		3	Strongly contributes to knowledge and analysis of DC machines.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Supports preliminary design or estimation in DC circuits.
CO-2		3	Encourages understanding of phase relationships and power calculations
CO-3		3	Strong relevance in understanding and analyzing AC machine operations.
CO-4		3	Enables students to design and assess practical electrical systems involving AC machines.
CO-5		3	Strongly contributes to knowledge and analysis of DC machines.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Limited contribution through basic data interpretation..
CO-2		1	Basic interpretation of computed results.
CO-3		1	Basic contribution through explanation of performance data.
CO-4		1	Provides limited support through interpretation of technical data and experimental results.
CO-5		1	Supports basic evaluation of machine specifications.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Minimal contribution as advanced tools or societal aspects are not directly involved.
CO-2		1	Limited relevance; minor connection to ethics and environmental impact.
CO-3		1	General awareness encouraged regarding energy and environmental aspects.
CO-4		1	Reinforces use of basic tools and sustainable practices in electrical system evaluation.
CO-5		1	Indirect awareness of safety, ethical use, and societal relevance.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Minimal contribution as advanced tools or societal aspects are not directly involved.
CO-2		1	Limited relevance; minor connection to ethics and environmental impact.
CO-3		1	General awareness encouraged regarding energy and environmental aspects
CO-4		1	Reinforces use of basic tools and sustainable practices in electrical system evaluation.
CO-5		1	Indirect awareness of safety, ethical use, and societal relevance.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Being a laboratory of Sustainable Energy, which are used extensively in academics and industries alike, graduates are expected to extend learning experience throughout their professional career. Hence moderate mapping.
CO-2		2	Enhances communication and reporting through assignments.
CO-3		2	Helps develop presentation and discussion skills.
CO-4		2	Basic involvement through reporting and documentation of experiments.
CO-5		2	Encourages collaboration and communication through lab or assignment work.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Introductory level exposure to discipline-specific concepts.
CO-2		1	Supports discipline knowledge in electrical measurements.
CO-3		1	Contributes to practical understanding of electrical machinery
CO-4		1	Strong alignment with discipline-specific skills in transformer and motor diagnostics.
CO-5		1	Provides foundational knowledge in electrical machine applications.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	Introductory level exposure to discipline-specific concepts..
CO-2		1	Supports discipline knowledge in electrical measurements.
CO-3		1	Contributes to practical understanding of electrical machinery
CO-4		1	Strong alignment with discipline-specific skills in transformer and motor diagnostics.
CO-5		1	Provides foundational knowledge in electrical machine applications.

(A. P. MUNSHI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Fundamentals of Electrical Engineering

Course Code: 23EL1103

Semester: First

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Fundamentals of Electrical Engineering (23EL1103)

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

CO	Statement	Blooms Level
CO-1	Discuss the concept of DC circuit,magnetic circuits and solve circuits to find parameters	L2
CO-2	Estimate basic electrical quantities for single phase ac circuits	L2
CO-3	Calculate basic electrical quantities for three phase ac circuits	L3
CO-4	Explain and determine performance parameters of single phase transformer	L3

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	1							2	2	
CO-2	3	3	2	1							2	2	
CO-3	3	3	2	1		2					2	2	
CO-4	3	3	2	1		2					2	2	
Average	3.00	3.00	2.00	1.00		2					2.00	2.00	

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strongly relevant, as the analysis of circuits requires application of foundational electrical engineering principles (Ohm's Law, KCL, KVL, etc.).
CO-2		3	Very important as it involves basic mathematical relations and knowledge to solve circuits based on single phase system
CO-3		3	Strong mapping as students need a solid foundation in electric circuits to understand star and delta connection
CO-4		3	Strongly applicable as basic knowledge is required to understand principle of working of transformer

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Students must be able to analyze DC Circuit problems using principles of mathematics
CO-2		3	Students must be able to formulate numericals on series and parallel AC Circuits
CO-3		3	Students must be able to identify type of star and delta connection by using engineering science
CO-4		3	Strongly mapped as students must be able to analyze engineering problems related to transformer

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Students should be able to design Dc circuits with respect to requirement of voltage and current
CO-2		2	Students should be able to decide the selection of components like resistor,inductor and capacitor
CO-3		2	Mediumly mapped as system components of star or delta connection can be decided depending on circuit requirement
CO-4		2	Involves determination of design parameters like reactance,impedance to meet specified needs of transformer

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Involves experimentation to verify the laws of DC Circuits(low contribution)
CO-2		1	Investigating various combinations of series and parallel combination of circuit parameters requires systematic problem-solving and research-based approaches
CO-3		1	Involves experimentation to verify the relationship between parameters for each type of connection(low contribution)
CO-4		1	Conducting investigations of behaviour of transformer for different applications requires basic theoretical knowledge and interpretation of results

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	-	-
CO-2		-	-
CO-3		2	The knowledge of three phase AC Circuits can be applied to ensure safety issues as Engineering professional
CO-4		2	The knowledge of transformers can be utilized to ensure safety issues considering responsibilities relevant to the professional engineering

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Staying updated on types of DC Circuits alongwith types of connections and its applications is must for lifelong learning.
CO-2		2	Understanding single phase AC Circuits alongwith types of connections and its applications is must for lifelong learning.
CO-3		2	Staying updated on types of three phase AC Circuits alongwith types of connections and its applications is must for lifelong learning.
CO-4		2	Understanding types of transformer Circuits alongwith types of connections and its applications is must for lifelong learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	DC Circuit analysis forms a foundational competence in understanding and solving problems in power system behavior, making a moderate alignment with PSO1 appropriate.
CO-2		2	AC Circuit analysis forms a foundational competence in understanding and solving problems in circuit behavior, making a moderate alignment with PSO1 appropriate.
CO-3		2	Three phase Circuit analysis forms a foundational competence in understanding and solving problems in power system making a strong alignment with PSO1 appropriate.
CO-4		2	Transformer Circuit analysis forms a foundational competence in understanding and solving problems in power system behavior, making a moderate alignment with PSO1 appropriate.

(X. R. POTE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Fundamentals of Electrical Engineering Lab

Course Code: 23EL1104

Semester: First/Second

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Fundamentals of Electrical Engineering Lab (23EL1104)

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

CO	Statement	Blooms Level
CO-1	Apply fundamental circuit laws and theorems, for DC Circuits to analyze electrical circuits.	L3
CO-2	Analyze the behavior of series and parallel AC circuits and determine electrical parameters such as impedance, current, and phase angle.	L4
CO-3	Evaluate the performance of three-phase systems, including balanced star (Y) and delta (Δ) connected loads, by measuring and interpreting electrical quantities.	L4
CO-4	Experiment on single-phase transformers, to determine transformation ratio, efficiency, regulation	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	1					3	2	2	2	2
CO-2	3	3	2	1					3	2	2	2	2
CO-3	3	3	3	1					3	2	2	2	2
CO-4	3	3	3	1					3	2	2	3	3
Average	3.00	3.00	2.50	1.00					3.00	2.00	2.00	2.25	2.25

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Utilizes foundational knowledge of electrical engineering to solve DC circuit problems.
CO-2		3	Involves detailed analysis of electrical behavior in complex AC circuits. |
CO-3		3	Applies engineering knowledge to analyze three-phase systems.
CO-4		3	Applies electrical engineering principles to understand transformer operations.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	.Requires understanding of AC theory and circuit fundamentals.
CO-2		3	Involves analyzing circuits using theoretical laws, requiring strong problem-solving skills
CO-3		3	Develops analytical skills to solve balanced three-phase circuit problems
CO-4		3	Develops analytical skills for evaluating transformer performance parameters

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Designs and interprets circuit behavior; relates to basic design understanding.
CO-2		2	Connects to designing and modeling AC circuits under various conditions
CO-3		3	Enhances understanding of system configuration for effective power distribution
CO-4		3	Facilitates design insight through performance analysis of real equipment. |

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Requires conducting practical verification of theoretical laws in the lab.
CO-2		1	Relies on experimental validation and data analysis of AC parameters. |
CO-3		1	Involves conducting experiments and analyzing the output to reach valid conclusions
CO-4		1	Involves experimental analysis, data interpretation, and validation of transformer behavior

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

CO	PO	Mapping	Remark
CO-1	PO-09	3	Lab tasks are performed in teams, enhancing team collaboration.
CO-2		3	Enhances collaboration and teamwork in experimental setups
CO-3		3	Strengthens ability to function in diverse lab teams
CO-4		3	Requires collaboration in executing transformer experiments.

PO10: Project Management and Finance Life: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	2	Emphasis on effective documentation and communication of experimental results.
CO-2		2	Encourages effective technical reporting and communication
CO-3		2	Requires clear and precise communication of technical findings
CO-4		2	Emphasizes clear documentation of experimental procedures and results

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Involves managing lab activities, adhering to protocols and resources.
CO-2		2	Requires managing tasks and resources efficiently in lab sessions
CO-3		2	Promotes project and task management in the lab environment.
CO-4		2	Involves coordination and efficient use of lab time and resources.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Involves analyzing problems in basic electrical systems, relevant to power systems.
CO-2		2	Involves interpretation and analysis of AC systems critical to power networks.
CO-3		2	Directly relates to power system operation and performance evaluation
CO-4		3	Essential for analyzing and evaluating power systems' components

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Involves control and assessment of DC circuits which are core to electrical systems.
CO-2		2	Applies control and assessment in AC system experiments.
CO-3		2	Supports development and assessment of three-phase electrical systems
CO-4		3	Core knowledge for assessing electrical equipment in practical systems

(X. R. POTE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electrical and Electronics Workshop (FAB Lab)

Course Code: 23EL1105

Semester: First/Second

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Electrical and Electronics Workshop (FAB Lab) (23EL1105)

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

CO	Statement	Blooms Level
CO-1	Explain the purpose and functionality of basic electrical components.	L2
CO-2	Illustrate the construction and operation of electrical systems, including DC power supplies, electrical distribution boards, and wiring.	L3
CO-3	Analyze the working of solar-powered devices to understand renewable energy applications.	L4
CO-4	Evaluate the role of protection devices and earthing for safety in electrical circuits.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	1		2	1					1	2	3
CO-2	3	2	3	1	3	2					1	2	3
CO-3	3	3	3	3	3	3					1	2	3
CO-4	3	3	3	1	3	3					1	2	3
Average	3	2.50	2.50	1.25	2.75	1					1	2	3

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Students understand the fundamental concepts of electrical components like resistors, inductors, and capacitors.
CO-2		3	Students apply knowledge to analyze and construct systems such as DC supplies and wiring systems.
CO-3		3	Comprehensive knowledge needed to understand solar-powered devices and renewable energy applications.
CO-4		3	Students apply core knowledge to understand protection devices and earthing mechanisms.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Students apply basic laws (Ohm’s, KCL, KVL) for analyzing circuits.
CO-2		2	Students analyze system elements like boards, wiring, and circuits.
CO-3		3	Students solve problems related to solar energy, circuit integration, and efficiency.
CO-4		3	Analysis of fault conditions and evaluating protection strategies is essential.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Limited involvement; understanding component functionality.
CO-2		3	Students demonstrate complete electrical setups, resembling design processes.
CO-3		3	Students assess and propose solar-based solutions.
CO-4		3	Evaluating safety systems supports design decisions in protection schemes.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4		
CO-2		1	Basic investigative tasks like circuit testing.
CO-3		3	Students investigate solar system output and response to environmental variables.
CO-4		1	Investigation of system behavior during faults or protective actions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Use of instruments like multimeters or simulators.
CO-2		3	Practical system setup and testing require tools.
CO-3		3	Students use solar measurement tools, performance analyzers.
CO-4		3	Use of diagnostic and protection testing tools.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Awareness of how components affect consumer systems.
CO-2		2	Construction of systems directly relates to public electrical safety.
CO-3		3	Solar energy has societal implications (green energy, energy access).
CO-4		3	Electrical safety is vital to public safety and system integrity.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Awareness of resource use, component costing, and efficient lab/project execution.
CO-2		2	Awareness of resource use, component costing, and efficient lab/project execution.
CO-3		2	Awareness of resource use, component costing, and efficient lab/project execution.
CO-4		2	Awareness of resource use, component costing, and efficient lab/project execution.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Students understand and apply knowledge to power-related hardware and concepts.
CO-2		1	Students understand and apply knowledge to power-related hardware and concepts.
CO-3		1	Students understand and apply knowledge to power-related hardware and concepts.
CO-4		1	Students understand and apply knowledge to power-related hardware and concepts.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Strong mapping as all COs relate directly to electronics and electrical system knowledge.
CO-2		3	Strong mapping as all COs relate directly to electronics and electrical system knowledge.
CO-3		3	Strong mapping as all COs relate directly to electronics and electrical system knowledge.
CO-4		3	Strong mapping as all COs relate directly to electronics and electrical system knowledge.

(A. S. LILHARE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electrical Measurement and Instrumentation

Course Code: 23EL1401

Semester: Fourth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Electrical Measurement and Instrumentation (23EL1401)

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

CO	Statement	Blooms Level
CO-1	Explain the measurement of voltage, current and impedance.	L2
CO-2	Calculate power and energy measurement and solve issues related to them.	L3
CO-3	Estimate use of Instrument Transformers in high power measurement.	L5
CO-4	Apply transducers for various measurements.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	-	2	3	-					2	3	2
CO-2	3	3	3	2	3	2					2	3	3
CO-3	3	2	3	2	3	-					2	3	3
CO-4	3	2	-	2	3	-					2	2	3
Average	3	2.5	2	2	3	2					2	2.75	2.75

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strong engineering knowledge to explain measurements.
CO-2		3	Advanced knowledge to evaluate power and energy.
CO-3		3	Fundamental knowledge to apply instrument transformers.
CO-4		3	Applying transducer knowledge effectively.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzing measurement concepts.
CO-2		3	Problem analysis to resolve measurement issues.
CO-3		2	Analytical skills to measure power accurately.
CO-4		2	Problem-solving with transducer applications.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	-	
CO-2		3	Designing solutions to power measurement challenges.
CO-3		3	Designing setups for high-power measurement.
CO-4		-	

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Investigation of measurement techniques.
CO-2		2	Investigative techniques to validate results.
CO-3		2	Verifying measurement accuracy.
CO-4		2	Investigating measurement accuracy with transducers.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	3	High-level tool usage for voltage, current, and impedance.
CO-2		3	Extensive tool usage for precise measurements.
CO-3		3	Use of precise measurement tools.
CO-4		3	Proficient use of transducers for measurement.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	-	
CO-2		2	Analyzing environmental aspects of power measurement.
CO-3		-	
CO-4		-	

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Ongoing learning in measurement technologies.
CO-2		2	Continual learning in power measurement.
CO-3		2	Keeping updated with instrument transformers with high power measurements.
CO-4		2	Keeping updated with transducer advancements.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Critical for power system parameter interpretation.
CO-2		3	Essential for analyzing power system efficiency.
CO-3		3	Identifying issues in power measurement.
CO-4		2	Measurement technique development.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Related to electrical system measurement.
CO-2		3	Integral to evaluating energy in electrical systems.
CO-3		3	Applying transformers in electrical measurement.
CO-4		3	Ensuring measurement accuracy in systems.

(Dr. S. P. ADHAU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electrical Measurement and Instrumentation Lab

Course Code: 23EL1402

Semester: Fourth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Electrical Measurement and Instrumentation Lab (23EL1402)

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

CO	Statement	Blooms Level
CO-1	Compute impedance with various types of bridges.	L3
CO-2	Analyze active and reactive power in three-phase circuits.	L4
CO-3	Operate instrument transformers for measurement of power.	L4
CO-4	Illustrate the application of various transducers.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	2	-	3	-					2	3	2
CO-2	3	3	-	2	2	-					2	3	2
CO-3	2	3	3	2	3	-					2	3	3
CO-4	2	-	-	2	3	-					2	2	3
Average	2.5	2.67	2.5	2	2.75						2	2.75	2.5

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires high-level engineering knowledge to compute impedance accurately.
CO-2		3	Deep engineering knowledge to analyze active/reactive power.
CO-3		2	Sufficient foundational knowledge to operate transformers.
CO-4		2	Basic knowledge application to demonstrate transducers.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Moderate analytical skills to address complex bridge impedance calculations.
CO-2		3	High problem-solving skills to address three-phase power complexities.
CO-3		3	Strong analytical skills to measure power using transformers.
CO-4		-	

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Moderate design skills to set up impedance measurement circuits.
CO-2		-	
CO-3		3	Design and development required to configure measurement systems.
CO-4		-	

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	-	
CO-2		2	Investigative skills to validate power calculations.
CO-3		2	Investigation of transformer accuracy.
CO-4		2	Investigate the application through demonstrations.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	3	High-level tool usage for accurate impedance computation.
CO-2		2	Adequate tool usage for power analysis.
CO-3		3	Extensive use of measurement tools and devices.
CO-4		3	High-level use of transducers for signal measurement.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Ongoing learning in computation techniques.
CO-2		2	Lifelong learning to stay updated with power analysis methods.
CO-3		2	Lifelong learning in instrument transformers for high power measurements.
CO-4		2	Lifelong learning to adapt to new transducer technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Directly linked with interpreting power system impedance.
CO-2		3	Critical for analyzing power system performance.
CO-3		3	Essential for identifying measurement issues in power systems.
CO-4		2	Involves understanding measurement methods in power systems.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Involves electrical system assessment through impedance calculation.
CO-2		2	Important for evaluating electrical system efficiency.
CO-3		3	Direct application in electrical measurement systems.
CO-4		3	Crucial for electrical system measurement and analysis.

(Dr. S. P. ADHAU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electrical Machines in Power System

Course Code: 23EL1403

Semester: Fourth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Electrical Machines in Power System (23EL1403)

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

CO	Statement	Blooms Level
CO-1	Explain steady state performance of synchronous machines.	L3
CO-2	Illustrate Synchronization, load sharing and effect of variable excitation in parallel operation of alternators.	L3
CO-3	Evaluate the performance of Synchronous machine connected to infinite bus.	L4
CO-4	Evaluate the transient behaviour of Synchronous Machine.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	2	2	1					2	3	3
CO-2	3	3	2	2	2	2					2	3	3
CO-3	3	3	3	3	1		1				2	3	3
CO-4	2	2	2	1	1		1				2	3	3
Average	2.75	2.75	2.50	2.00	1.50	1.50	1.00				2.00	3.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	CO1 applies engineering knowledge of synchronous machines' steady-state performance, aligned with WK1-WK4.
CO-2		3	Applies fundamental principles of load sharing and synchronization in alternators.
CO-3		3	Evaluates complex problems involving infinite bus systems using engineering concepts.
CO-4		2	Describes transient behavior applying basic engineering knowledge.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves analysis of steady-state performance requiring problem formulation.
CO-2		3	Analyzes synchronization & excitation for load sharing, needing critical evaluation.
CO-3		3	Evaluates machine performance against an infinite bus system.
CO-4		2	Identifies dynamic response behavior of machines.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Designs steady-state models of synchronous machines.
CO-2		2	Demonstrates synchronization design considerations.
CO-3		3	Designs simulation or theoretical models for infinite bus behavior.
CO-4		2	Designs response models for transient conditions.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Involves data-based investigation of machine performance.
CO-2		2	Investigates synchronization impact analytically.
CO-3		3	In-depth investigation into infinite bus interaction.
CO-4		1	Limited to description of machine response.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Utilizes modeling and simulation tools.
CO-2		2	Applies tools for load sharing simulations.
CO-3		1	Uses prediction tools to assess infinite bus system.
CO-4		1	Limited use of tools for transient modeling.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Evaluates machine use in societal systems (e.g., power grids).
CO-2		2	Assesses safety and sustainability in alternator operation.
CO-3		-	
CO-4		-	

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7		
CO-2			
CO-3		1	Generic skills like teamwork, communication, ethics and project management are moderately involved.
CO-4		1	

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Generic skills like teamwork, communication, ethics and project management are moderately involved.
CO-2		2	
CO-3		2	
CO-4		2	

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Strong alignment with evaluation of power system operation.
CO-2		3	Synchronization/load sharing are core to power system control.

CO-3		3	Analyzes interaction with power system (infinite bus).
CO-4		3	Evaluates transient behavior relevant to system reliability.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Knowledge of electrical systems behavior and control.
CO-2		3	Alternator control & excitation systems.
CO-3		3	System stability analysis.
CO-4		3	Dynamics of synchronous machines.

(S. L. TIWARI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electrical Machines in Power System Lab

Course Code: 23EL1404

Semester: Fourth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Electrical Machines in Power System Lab (23EL1404)

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

CO	Statement	Blooms Level
CO-1	Determine of steady state performance of synchronous machine	L3
CO-2	Experiment on synchronization 3-Phase alternator to infinite bus bar.	L4
CO-3	Analyze the behavior of synchronous motor.	L4
CO-4	Explain the transient state parameters of synchronous machine.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	2	2		1				3	3	1
CO-2	3	3	2	2	2	2	1				3	3	1
CO-3	3	3	3	3	1		1				3	3	1
CO-4	3	3	2	2	2		1				3	3	1
Average	3.00	3.00	2.50	2.25	1.75	2.00	1.00				3.00	3.00	1.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires fundamental engineering knowledge for understanding synchronous machine operation.
CO-2		3	Synchronization techniques require in-depth engineering and problem-solving skills.
CO-3		3	Strong engineering knowledge required for motor performance analysis.
CO-4		3	Engineering and analytical skills are essential for transient analysis.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves analyzing steady-state parameters and diagnosing machine performance issues.
CO-2		3	Synchronization techniques require in-depth engineering and problem-solving skills.
CO-3		3	Strong engineering knowledge required for motor performance analysis.
CO-4		3	Engineering and analytical skills are essential for transient analysis.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Contributes to designing efficient synchronous machines with optimized characteristics.
CO-2		2	Synchronization techniques require in-depth engineering and problem-solving skills.
CO-3		3	Strong engineering knowledge required for motor performance analysis.
CO-4		2	Engineering and analytical skills are essential for transient analysis.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Includes detailed performance studies and experimental investigations.
CO-2		2	Involves experimental validation of synchronization parameters.
CO-3		3	Investigations involve practical observations and analytical techniques.
CO-4		2	Investigative methods required for measuring and interpreting machine response.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Utilizes measurement instruments and software tools for performance evaluation.
CO-2		2	Utilizes modern tools for voltage and frequency control during synchronization.
CO-3		1	Basic software tools are used for motor analysis.
CO-4		2	Simulation tools aid in transient response evaluation.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	-	
CO-2		2	Directly impacts power system stability and reliability.
CO-3		-	
CO-4		-	

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7	1	Ethical considerations in power system operation and machine design.
CO-2		1	Efficiency improvements contribute to reduced energy consumption.
CO-3		1	Optimizing motor operation improves sustainability.
CO-4		1	Transient performance optimization supports energy efficiency and sustainability.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Machine performance analysis impacts system design and financial considerations.
CO-2		2	Requires teamwork, communication, and project execution for successful synchronization.
CO-3		2	Requires teamwork and communication in motor performance analysis projects.
CO-4		2	Teamwork, documentation, and project planning are crucial for transient studies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Provides essential knowledge for electrical machine optimization.
CO-2		3	Fundamental for real-world power system operation.
CO-3		3	Contributes to motor efficiency knowledge for electrical machine applications.
CO-4		3	Helps in understanding machine behavior in dynamic conditions.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	Provides essential knowledge for electrical machine optimization.
CO-2		1	Fundamental for real-world power system operation.
CO-3		1	Contributes to motor efficiency knowledge for electrical machine applications.
CO-4		1	Helps in understanding machine behavior in dynamic conditions.

(P. S. SHETE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Digital Signal Processing

Course Code: 23EL1406

Semester: Fourth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Digital Signal Processing (23EL1406)

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

CO	Statement	Blooms Level
CO-1	Classify mathematical representation of signals and systems in various domains	L2
CO-2	Determine and analyze signals in time and frequency domain using Fourier series and Fourier transform	L2
CO-3	Evaluate and analyze signals using Z-transform	L2
CO-4	Analyze and design digital filter	L3

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	1	1	1						2	2	3
CO-2	3	3	1	1	1						2	2	3
CO-3	3	3	1	1	1						2	2	3
CO-4	3	3	1	1	1						2	2	3
Average	3.00	3.00	1.00	1.00	1.00						2.00	2.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Students apply mathematical knowledge to solve basic operations of continuous and discrete signals
CO-2		3	Students apply mathematical knowledge to Fourier series and Fourier Transform problems
CO-3		3	Students apply mathematical knowledge to solve Z_Transform
CO-4		3	Students apply mathematical knowledge to solve digital filter design

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Students analyze continuous and discrete signal operations
CO-2		3	Students analyze signals using Fourier series and Fourier Transform
CO-3		3	students analyze discrete signals using Z-Transform
CO-4		3	Students analyze digital filters using Z Transform

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Students develop electrical systems after analyzing it with continuous time and discrete signals by solving its mathematical model using IT tools
CO-2		1	Students develop electrical systems after simulating system using Fourier series and Fourier Transform using IT tools
CO-3		1	Students develop electrical systems after simulating system using Z Transform using IT tools
CO-4		1	Students develop electrical systems using Digital signals

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Students solve continuous and discrete signal problems
CO-2		1	Students solve Fouerier series and Fourier transform problems in continuous and discrete signal
CO-3		1	Students solve Z transform problems
CO-4		1	Students solve basic Z Transform for signal processing

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Students write program in SCILAB to solve basic operations of a signal
CO-2		1	Students write program in SCILAB to solve Fourier series and Fourier Transform problems
CO-3		1	Students write program in SCILAB to simulate Z Tranform
CO-4		1	Students write program in SCILAB to design digital filters

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Students get knowledge of signals which will be lifelong learning
CO-2		2	Students knowledge of Fourier Transform and Fourier series can be applied to solve complex mathematical problems in practical systems
CO-3		2	Students get to know Z transform which can be applied for discrete signal only
CO-4		2	Students develop Z Transform details to design digital filter

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Students can apply continuous signal and discrete signal fundamentals in power system operation and control
CO-2		2	Students apply Fourier series and Fourier Transform in analysing power system control
CO-3		2	Students apply Fourier series and Z Transform in analysing power system control
CO-4		2	Students can design digital filters in power system operation

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	student develop, control and access
CO-2		3	continuous and discrete signals in practical Electrical systems
CO-3		3	student apply Fourier series and Fourier Transform knowledge in analysing practical Electrical systems
CO-4		3	student apply Z Transform knowledge in analysing practical Electrical systems

(Dr. S. R. GAIGOWAL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Energy Storage Devices

Course Code: MDM2EL201

Semester: Fourth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Energy Storage Devices (MDM2EL201)

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

CO	Statement	Blooms Level
CO-1	Express the fundamentals of advanced batteries, their sizing, and applications of super-capacitors	L2
CO-2	Identify the aspects of battery hybridization, and fuel reforms	L2
CO-3	Explain the various battery recycling, testing procedures, and verification of battery performances	L3
CO-4	Apply the battery management systems, thermal management systems, and aspects of battery safety	L3

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	1	2	3	2	3	1				3	1	3
CO-2	3	2	3	3	3	3	1				3	3	3
CO-3	3	3	3	3	3	3	3				3	3	3
CO-4	3	3	3	3	3	3	3				3	3	3
Average	3.00	2.25	2.75	3.00	2.75	3.00	2.00				3.00	2.50	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strongly contributes through fundamental knowledge aligned with engineering sciences.
CO-2		3	Builds engineering knowledge for hybrid systems..
CO-3		3	Strongly supports core engineering skills via analysis, testing, and recycling..
CO-4		3	High-level application skills aligned with system design and evaluation.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	1	Supports problem analysis in battery sizing.
CO-2		2	Enables analysis of hybrid energy systems.
CO-3		3	Strongly supports core engineering skills via analysis, testing, and recycling.
CO-4		3	High-level application skills aligned with system design and evaluation.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Facilitates understanding of preliminary design considerations.
CO-2		3	Strong contribution towards designing hybrid technologies
CO-3		3	Strongly supports core engineering skills via analysis, testing, and recycling.
CO-4		3	High-level application skills aligned with system design and evaluation.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Encourages investigation into battery characteristics and performance.
CO-2		3	Enhances research and inquiry into fuel reforms.
CO-3		3	Strongly supports core engineering skills via analysis, testing, and recycling.
CO-4		3	High-level application skills aligned with system design and evaluation..

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Supports tool usage in battery modeling and simulation.
CO-2		3	Encourages modern tool usage for hybrid simulations.
CO-3		3	Strongly supports core engineering skills via analysis, testing, and recycling.
CO-4		3	High-level application skills aligned with system design and evaluation.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	3	Raises awareness on societal relevance through application contexts.
CO-2		3	Promotes awareness of environmental, ethical, and societal issues in fuel reform applications.
CO-3		3	Promotes ethical, environmental, and societal considerations in recycling practices.
CO-4		3	Strongly contributes through focus on safety, environmental management, and professional ethics.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7	1	Introduces environmental concerns at a basic level.
CO-2		1	Promotes awareness of environmental, ethical, and societal issues in fuel reform applications.
CO-3		3	Promotes ethical, environmental, and societal considerations in recycling practices.
CO-4		3	Strongly contributes through focus on safety, environmental management, and professional ethics.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Promotes team collaboration and communication during discussions and assignments.
CO-2		3	Strengthens teamwork, communication, and technical documentation.
CO-3		3	Enhances collaborative skills through testing-based projects.
CO-4		3	Reinforces project-based communication and teamwork.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Introduces program-specific tools.
CO-2		3	Direct relevance to program-specific hybrid energy technologies.
CO-3		3	Aligned with diagnostic and performance verification tasks in the program.
CO-4		3	Directly supports tools and techniques for thermal and battery system management.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Strongly aligns with applications of supercapacitors in engineering systems.
CO-2		3	Direct relevance to program-specific hybrid energy technologies.
CO-3		3	Aligned with diagnostic and performance verification tasks in the program.
CO-4		3	Directly supports tools and techniques for thermal and battery system management.

(Dr. A. P. MUNSHI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Semiconductor material for Solar Photovoltaic Cells

Course Code: MDM2EL202

Semester: Fourth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Semiconductor material for Solar Photovoltaic Cells (MDM2EL202)

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

CO	Statement	Blooms Level
CO-1	Illustrate the fundamental principles of semiconductors and their role in solar cell materials	L2
CO-2	Explain the functioning of P-N junctions under various conditions, including equilibrium, non-equilibrium, and illumination, and derive the I-V characteristics of solar cells	L2
CO-3	Identify the design parameters and efficiency of solar cells by understanding losses and the upper limits of performance.	L3
CO-4	Classify advanced solar cell technologies, including Si wafer production, anti-reflective coatings, and bifacial solar cells, to propose sustainable solutions.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	2							2	2	2
CO-2	3	3	2	2							2	2	2
CO-3	3	3	2	2							2	2	2
CO-4	3	3	2	2							2	2	2
Average	3.00	3.00	2.00	2.00							2.00	2.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamental semiconductor physics and materials science in solar cell applications.
CO-2		3	Strong theoretical grounding in junction behavior and electronics,
CO-3		3	Understanding design parameters and losses involves deep scientific knowledge.
CO-4		3	In-depth study of modern photovoltaic technologies requires advanced knowledge

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves analysis and understanding of material behavior with sustainable energy relevance.
CO-2		3	Analysis of solar cell characteristics under various conditions.
CO-3		3	Analyzing losses and efficiency requires research literature review. .
CO-4		3	Requires classification and evaluation for sustainability solutions.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Supports foundational understanding for system/component design in solar applications.
CO-2		2	Deriving I-V curves links to performance understanding in design contexts.
CO-3		2	Applies design logic to assess system limitations and improvements.
CO-4		2	Supports proposing solutions though actual design is conceptual.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Basic application of scientific principles; minimal investigation.
CO-2		2	Light investigation emphasis; mostly analytical
CO-3		2	Limited to conceptual evaluation, not experimental.
CO-4		2	Discussion-based understanding of technologies, not experimental.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Requires effective reporting, basic project understanding, and lifelong learning mindset.
CO-2		2	Requires documentation, presentations, and adaptability to evolving technologies.
CO-3		2	Focus on lifelong learning and technical communication.
CO-4		2	Direct link to assessing cutting-edge solar technologies for energy systems.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Semiconductor principles are key to power and electronic system evaluation.
CO-2		2	Relevant for evaluating electrical behavior and circuit performance
CO-3		2	Critical to analyzing and improving power system performance.
CO-4		2	Direct link to assessing cutting-edge solar technologies for energy systems.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Semiconductor principles are key to power and electronic system evaluation.
CO-2		2	Relevant for evaluating electrical behavior and circuit performance
CO-3		2	Critical to analyzing and improving power system performance.
CO-4		2	Relevant for evaluating electrical behavior and circuit performance Direct link to assessing cutting-edge solar technologies for energy systems.

(S. S. KEWTE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Control System

Course Code: 22EL501

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Control System (22EL501)

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

CO	Statement	Blooms Level
CO-1	Develop mathematical model for physical systems and evaluate their transfer function by using block diagram, signal-flow graph techniques, and state – variable analysis.	L3
CO-2	Illustrate the need of negative feedback in control systems	L4
CO-3	Analyze control systems in time and frequency domain for their specifications and stablility	L4
CO-4	Calculate control system parameters by drawing the root locus plot.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	2	2	1						1	2	3
CO-2	3	2	2	2	1						1	2	3
CO-3	3	2	2	2	1						1	2	3
CO-4	3	2	2	2	1						1	2	3
Average	3.00	2.00	2.00	2.00	1.00						1.00	2.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Students write mathematical equations to represent physical system
CO-2		3	Students apply basic mathematical operations negative feedback system
CO-3		3	Students represent physical system by mathematical equation and analyse it in time and frequency domain
CO-4		3	Students write transfer function and draw root locus

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Students formulate mathematical equation of physical system and write transfer function
CO-2		2	Students analyse negative feedback system
CO-3		2	Students write transfer function of physical system and analyse its performance in time and frequency domaim
CO-4		2	Students analyse system by plotting root locus

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Students develop mathematical equations of physical system for analysis
CO-2		2	Student studies advantages and disadvantages of negative feedback system
CO-3		2	Students develop transfer function of system and analyse its performance
CO-4		2	Students draw root locus to analyse the system

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Students develop mathematical model of physical system
CO-2		2	Students investigate negative feedback system properties
CO-3		2	Students investigate time domain specifications
CO-4		2	Students investigate system from root locus

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Students use MATLAB IT tool to represent physical system into mathematical equation
CO-2		1	Students use MATLAB IT tool to analyse feedback control system
CO-3		1	Students simulate time response of the system and check system performance in

			MATLAB
CO-4		1	Students write MATLAB program to plot root locus

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Focused on standard techniques; lifelong learning is not explicitly embedded.
CO-2		1	Lifelong-learning skills (e.g., robust/adaptive control exposure) are optional, not assessed.
CO-3		1	The CO stays within textbook methods and does not demand independent learning of advanced modern methods.
CO-4		1	Root locus plotting is standard; advanced self-learning is outside this CO's scope.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Modeling supports understanding of power system dynamics and control at an intermediate level.
CO-2		2	Feedback understanding strengthens system operation and fault-tolerance skills.
CO-3		2	Provides essential insight into power system stability but at an intermediate level.

CO-4		2	Root-locus helps understand overall system operation but not at the highest depth.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Students develop knowledge to model physical system in practical electrical and electronic system
CO-2		3	Students can demonstrate knowledge of negative feedback system in electrical and electronic system
CO-3		3	Students develop system and investigate its performance in time and frequency domain
CO-4		3	Students develop root locus from the transfer function of physical system

(R. N. NAGPURE, S. R. GAIGOWAL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Control System Lab

Course Code: 22EL502

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Control System Lab (22EL502)

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

CO	Statement	Blooms Level
CO-1	Perform laboratory experiments and demonstrate competency in collecting, interpreting, and analyzing data; communicate and present effectively through laboratory journals.	L2
CO-2	Illustrate the operation of control system components.	L4
CO-3	Analyze control systems in time and frequency domain for their specifications and stability.	L4
CO-4	Justify the use of advanced tools such as MATLAB for the analysis of control systems.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	2	3	3						1	2	3
CO-2	3	2	2	3	3						1	2	3
CO-3	3	2	2	3	3						1	2	3
CO-4	3	2	2	3	2						1	2	3
Average	3.00	2.00	2.00	3.00	2.75						1.00	2.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamental knowledge of control systems during laboratory experiments.
CO-2		3	Applies EE fundamentals to explain control system component functionality.
CO-3		3	Applies fundamental concepts of time-domain analysis.
CO-4		3	Applies mathematical and EE fundamentals using advanced simulation tools.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Requires identifying and analyzing experimental data for control systems.
CO-2		2	Analyzes relationships among various control components.
CO-3		2	Involves identifying parameters and analyzing system response.
CO-4		2	Evaluates results and validates tool outputs critically.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Supports basic experimental design and interpretation.
CO-2		2	Develops understanding of component-level operation for system-level design.
CO-3		2	Relates findings to possible design improvements.
CO-4		2	Uses analysis to guide design decisions.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Involves investigating and validating experimental results.
CO-2		3	Uses experimentation and investigation to interpret component operations.
CO-3		3	Validates specifications using experimental or simulation results.
CO-4		3	Conducts investigative analysis using advanced tools.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	3	Uses basic laboratory tools and software for data acquisition.
CO-2		3	Demonstrates strong use of hardware and software tools in control component analysis.

CO-3		3	Uses advanced tools and plotting software to analyze time responses.
CO-4		2	Demonstrates high-level tool usage for control system analysis.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Exposure to self-directed learning in reporting and lab processes.
CO-2		1	Indirectly promotes continuous learning of component applications.
CO-3		1	Encourages learning to interpret specifications but not strongly focused on lifelong learning.
CO-4		1	Builds initial familiarity with tools but lifelong learning is not a primary focus.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Relates to analyzing experimental data relevant to power system and control applications.
CO-2		2	Related to understanding power system control elements.
CO-3		2	Supports power system and control applications through time-domain behavior analysis.
CO-4		2	Helps evaluate control applications in power system contexts using tools.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Strongly aligned with electrical and electronic system assessment and experimental validation.
CO-2		3	Highly relevant to analysis and operation of electrical/electronic control systems.
CO-3		3	Directly connected to assessment of electrical/electronic system responses.
CO-4		3	Strong alignment with assessment and simulation of electrical and electronic systems.

(R. N. NAGPURE, S. R. GAIGOWAL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Power Electronics

Course Code: 23EL503

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Power Electronics (23EL503)

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

CO	Statement	Blooms Level
CO-1	Describe the working, characteristics, and show the need of protection of power semiconductor	L2
CO-2	devices and select them for suitable application.	L4
CO-3	Analyze controlled single- and three-phase rectifiers, and cycloconverters.	L4
CO-4	Evaluate the performance of DC – DC converters (Choppers).	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	1	1							1	1	3
CO-2	3	2	2	2	1						1	2	3
CO-3	3	2	2	2	1						1	3	3
CO-4	3	2	2	2	1						1	3	3
Average	3.00	2.00	1.75	1.75	1.00						1.00	2.25	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strongly contributes by reinforcing fundamental electrical engineering knowledge.
CO-2		3	: Reinforces core engineering knowledge of AC systems..
CO-3		3	Strong relevance in understanding and analyzing AC machine operations.
CO-4		3	Strongly contributes by applying foundational knowledge in electrical engineering to AC machine systems

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Strong contribution by enabling analysis of simple DC circuits.
CO-2		2	Strong analytical involvement in evaluating circuit behavior.
CO-3		2	Strong relevance in understanding and analyzing AC machine operations
CO-4		2	Supports analytical and evaluative capabilities in understanding transformer and motor performance.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Supports preliminary design or estimation in DC circuits.
CO-2		2	Encourages understanding of phase relationships and power calculations
CO-3		2	Strong relevance in understanding and analyzing AC machine operations.
CO-4		2	Enables students to design and assess practical electrical systems involving AC machines.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Limited contribution through basic data interpretation..
CO-2		2	Basic interpretation of computed results.
CO-3		2	Basic contribution through explanation of performance data.
CO-4		2	Provides limited support through interpretation of technical data and experimental results.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5		
CO-2		1	Limited relevance; minor connection to ethics and environmental impact.
CO-3		1	General awareness encouraged regarding energy and environmental aspects.
CO-4		1	Reinforces use of basic tools and sustainable practices in electrical system evaluation.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Being a laboratory of Sustainable Energy, which are used extensively in academics and industries alike, graduates are expected to extend learning experience throughout their professional career. Hence moderate mapping.
CO-2		1	Enhances communication and reporting through assignments.
CO-3		1	Helps develop presentation and discussion skills.
CO-4		1	Basic involvement through reporting and documentation of experiments.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Introductory level exposure to discipline-specific concepts.
CO-2		2	Supports discipline knowledge in electrical measurements.

CO-3		3	Contributes to practical understanding of electrical machinery
CO-4		3	Strong alignment with discipline-specific skills in transformer and motor diagnostics.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Introductory level exposure to discipline-specific concepts..
CO-2		3	Supports discipline knowledge in electrical measurements.
CO-3		3	Contributes to practical understanding of electrical machinery
CO-4		3	Strong alignment with discipline-specific skills in transformer and motor diagnostics.

(Dr. P. M. Meshram) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Power Electronics Lab

Course Code: 22EL504

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Power Electronics Lab (22EL504)

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

CO	Statement	Blooms Level
CO-1	Trace the static and dynamic characteristics of power semiconductor devices	L2
CO-2	Examine the performance parameter of rectifier and cycloconverter	L3
CO-3	Calculate the performance parameter of buck/boost converter	L3
CO-4	Evaluate the performance parameter of DC/AC inverters	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	1	1							1	1	3
CO-2	3	2	2	2	1						1	2	3
CO-3	3	2	2	2	1						1	3	3
CO-4	3	2	2	2	1						1	3	3
Average	3.00	2.00	1.75	1.75	1.00						1.00	2.25	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies engineering knowledge of semiconductor device physics to trace their static and dynamic characteristics.
CO-2		3	Applies core engineering knowledge to analyze rectifier and cycloconverter performance.
CO-3		3	Applies mathematical and engineering concepts to calculate converter parameters.
CO-4		3	Applies in-depth engineering principles to evaluate DC/AC inverter performance.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Involves analyzing device behavior and interpreting specifications to support performance evaluation.
CO-2		2	Requires analytical skills to interpret output waveforms and assess conversion efficiency.
CO-3		2	Engages in performance analysis of buck/boost circuits for varying loads.
CO-4		2	Analyzes waveform quality, THD, and load performance using engineering knowledge.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Understanding device characteristics supports future design decisions in converter circuits.
CO-2		2	Assesses design parameters like firing angle and harmonics to understand solution suitability.
CO-3		2	Evaluates converter design elements to meet output specifications.
CO-4		2	Evaluates inverter designs against criteria like voltage, efficiency, and application need.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Basic investigation of device parameters is required but not the focus.
CO-2		2	Involves data interpretation and simulation to validate rectifier/cycloconverter performance.
CO-3		2	Uses practical data and models to analyze converter behavior.
CO-4		2	Requires interpretation of simulation/lab data to draw valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5		
CO-2		1	Uses simulation tools (e.g., MATLAB/PSIM) for waveform analysis.
CO-3		1	Employs modern tools for simulating buck/boost converter characteristics.
CO-4		1	Involves use of simulation software to model and study inverters.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Staying updated on types of DC Circuits alongwith types of connections and its applications is must for lifelong learning
CO-2		1	Understanding single phase AC Circuits alongwith types of connections and its applications is must for lifelong learning
CO-3		1	Staying updated on types of three phase AC Circuits alongwith types of connections and its applications is must for lifelong learning
CO-4		1	Understanding types of transformer Circuits alongwith types of connections and its applications is must for lifelong learning

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Directly targets power system elements like rectifiers and converters.
CO-2		2	Focuses on power system-related conversion equipment.
CO-3		3	Strongly aligned with power system inverter analysis.
CO-4		3	Directly targets power system elements like rectifiers and converters.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Strong relevance to electronic system evaluation and performance understanding.
CO-2			
CO-3		3	Engages in analysis of electronic converters, reinforcing PSO2.
CO-4		3	Engages deeply with the design and assessment of electronic systems.

(S.L.TIWARI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electronics Engineering Workshop Lab

Course Code: 22EL505

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Electronics Engineering Workshop Lab (22EL505)

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

CO	Statement	Blooms Level
CO-1	Explain the electrical characteristics and functions of Power Electronics components.	L2
CO-2	Apply PCB design principles to fabricate functional circuits.	L3
CO-3	Analyze and implement voltage regulators and timer circuits using Op-Amps, LEDs, and ICs.	L4
CO-4	Evaluate power diodes, transistors, and Op-Amps using systematic testing and measurement.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3		3	3								3
CO-2	3		3		3								3
CO-3	3	3		3	3						3		3
CO-4	3	3		3	3						3		3
Avera ge	3.00	3	3	3	3						3		3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strong mapping as explaining component characteristics requires applying fundamental electrical and electronics engineering knowledge.
CO-2		3	Strong mapping as PCB fabrication uses fundamental electronics and circuit theory knowledge.
CO-3		3	Strong mapping since implementation requires applying core electronics principles.
CO-4		3	Strong mapping as evaluation requires applying electrical and electronics engineering fundamentals.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Strong link because understanding characteristics involves analyzing specifications and interpreting technical data.
CO-2			
CO-3		3	Strong link as analyzing circuit behavior involves problem analysis and result interpretation.
CO-4		3	Strong link due to systematic analysis of test results for performance assessment.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3		
CO-2		3	Strong link since this CO involves creating functional hardware solutions through PCB design.
CO-3			
CO-4			

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Strong link since this CO requires practical investigation and observation of device behavior under different conditions.
CO-2			
CO-3		3	Strong link because this CO includes experimental investigation and performance verification.
CO-4		3	Strong link since evaluation involves experimental investigation, measurement, and interpretation.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	3	Strong mapping due to the requirement of using measuring instruments and simulation tools for studying characteristics.
CO-2		3	Strong mapping due to the use of PCB design software and fabrication tools.
CO-3		3	Strong mapping due to the use of laboratory instruments and simulation tools in circuit testing.
CO-4		3	Strong mapping due to the use of modern measuring equipment and test setups.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11		
CO-2			
CO-3		3	Strong link as understanding and implementing such circuits requires keeping up-to-date with evolving component technologies.
CO-4		3	Strong link as testing methods and component technologies require continuous learning and skill upgradation.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Strong mapping as knowledge of device characteristics directly supports understanding and working with electronic systems.
CO-2		3	Strong mapping as it develops the ability to work with and integrate various electronic system components.
CO-3		3	Strong mapping as it develops the ability to work with and integrate various electronic system components.
CO-4		3	Strong mapping because evaluation skills are directly relevant to maintaining and improving electronic systems.

(R. N. NAGPURE, S. R. GAIGOWAL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE I: Electric & Magentic Field

Course Code: 22EL511

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Fundamentals of PE I: Electric & Magentic Field (22EL511)

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

CO	Statement	Blooms Level
CO-1	Explain vector analysis in different coordinates for electromagnetic fields	L2
CO-2	Apply Coulomb's Law, Gauss's Law, and field equations to analyze electric fields and charge distributions	L3
CO-3	Analyze conductors, dielectrics, and magnetic materials under fields to compute capacitance, inductance, and forces.	L4
CO-4	Evaluate Maxwell’s equations and their applications in time-varying fields, and power flow.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	2	2	2					2	2	3
CO-2	3	3	2	3	2	2					2	2	3
CO-3	3	3	2	2	3	3					3	3	3
CO-4	3	3	2	3	3	2					3	2	3
Average	3.00	3.00	2.00	2.50	2.50	2.25					2.50	2.25	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Understanding vector analysis across coordinate systems is fundamental knowledge.
CO-2		3	Students apply fundamental electrostatics laws and field theory.
CO-3		3	Analyzing materials like dielectrics and inductors builds on core engineering principles.
CO-4		3	Maxwell's equations are a cornerstone of electromagnetics.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Vector-based field problems enhance analytical thinking.
CO-2		3	Coulomb's and Gauss's laws are used to solve complex field problems.
CO-3		3	Requires evaluating real-world materials under field interactions.
CO-4		3	Students analyze dynamic field systems using Maxwell's laws.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Students derive and interpret field equations, supporting theoretical design.
CO-2		2	Students derive and interpret field equations, supporting theoretical design.
CO-3		2	Students derive and interpret field equations, supporting theoretical design.
CO-4		2	Students derive and interpret field equations, supporting theoretical design.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Students derive vector operations in Cartesian, cylindrical, and spherical systems.
CO-2		3	Applying Gauss's Law in different symmetries mimics investigative work.
CO-3		2	Investigation of inductive/capacitive materials.
CO-4		3	Time-varying field problems require simulation and deeper investigation.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Use of simulation tools like MATLAB for field visualization.
CO-2		2	Tools used for electric field mapping and charge simulation.
CO-3		3	Tools help in computing inductance, capacitance, and force distributions.
CO-4		3	Tools required for solving Maxwell's equations in time-varying conditions.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Knowledge of electromagnetic safety and field exposure is important for societal applications.
CO-2		2	Knowledge of electromagnetic safety and field exposure is important for societal applications.
CO-3		3	Knowledge of electromagnetic safety and field exposure is important for societal applications.
CO-4		2	Knowledge of electromagnetic safety and field exposure is important for societal applications.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

CO	PO	Mapping	Remark
CO-1	PO-09	3	Lab tasks are performed in teams, enhancing team collaboration.
CO-2		3	Enhances collaboration and teamwork in experimental setups
CO-3		3	Strengthens ability to function in diverse lab teams
CO-4		3	Requires collaboration in executing transformer experiments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Coordination during lab-based vector analysis.
CO-2		2	Charge distribution experiments require planning.
CO-3		3	Managing multiple materials and tools.
CO-4		3	Power flow projects require higher-level planning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	All COs develop a foundation relevant to field theory in power system engineering.
CO-2		2	All COs develop a foundation relevant to field theory in power system engineering.
CO-3		3	All COs develop a foundation relevant to field theory in power system engineering.
CO-4		2	All COs develop a foundation relevant to field theory in power system engineering.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Strong mapping—electromagnetic fields are integral to all advanced electrical systems.
CO-2		3	Strong mapping—electromagnetic fields are integral to all advanced electrical systems.
CO-3		3	Strong mapping—electromagnetic fields are integral to all advanced electrical systems.
CO-4		3	Strong mapping—electromagnetic fields are integral to all advanced electrical systems.

(Dr. A. S. LILHARE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE I: Electrical Machine Design

Course Code: 22EL512

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Electrical Machine Design(22EL512)

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

CO	Statement	Blooms Level
CO-1	Identify various materials used in construction of electrical machines and find their rating and performance	L2
CO-2	Estimate the design parameters of transformer	L3
CO-3	Evaluate stator, rotor design dimensions of induction motor	L4
CO-4	Formulate the designed parameters of synchronous machine.	L6

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	2	2					2	3	2
CO-2	3	3	3	3	2	2					2	3	2
CO-3	3	3	3	3	2	2					2	3	2
CO-4	3	3	3	3	2	2					2	3	2
Average	3.00	3.00	3.00	3.00	2.00	2.00					2.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies EE fundamentals & materials science to relate properties (B–H, current density) to ratings/performance.
CO-2		3	Uses emf/core/winding relations to estimate transformer parameters.
CO-3		3	Applies machine equations to size stator/rotor, air-gap, slots.
CO-4		3	Integrates fundamentals to formulate synchronous machine parameters.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes datasheets/standards to justify material suitability.
CO-2		3	Evaluates regulation, efficiency, thermal limits for transformer design.
CO-3		3	Assesses torque, slip, losses, temperature rise for IM dimensions.
CO-4		3	Critically evaluates reactances, voltage regulation, SCR, stability.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Links material choices to safe/sustainable machine design.
CO-2		3	Develops feasible transformer design (core, winding, cooling).
CO-3		3	Refines IM dimensions/cooling to meet performance specs.
CO-4		3	Creates coherent synchronous machine design specification.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Validates selections via standards, calculations, literature.
CO-2		3	Iterative calculations/checks against IS/IEC for transformers.
CO-3		3	Uses equivalent-circuit/empirical charts/FEA judgment.
CO-4		3	Interprets leakage, loss, thermal investigations for sync machines.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Uses datasheets/spreadsheets; recognizes limits of rules of thumb.
CO-2		2	Employs design sheets/CAD; basic electromagnetic checks.
CO-3		2	Uses templates/FEA at preliminary depth.
CO-4		2	Applies structured tools for parameter formulation.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Considers lifecycle efficiency, recyclability, environmental impact.
CO-2		2	Accounts for efficiency classes, noise, oil vs. dry-type.
CO-3		2	Evaluates energy efficiency and materials usage.
CO-4		2	Considers sustainability, maintainability in designs.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Tracks advances in steels, insulation, standards.
CO-2		2	Adapts to evolving transformer efficiency/norms & materials.
CO-3		2	Keeps pace with new rotor/cooling/efficiency regulations.
CO-4		2	Updates on excitation, insulation, cooling technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Material choice affects losses, heating, reliability in operation.
CO-2		3	Transformer design central to system regulation/reliability.
CO-3		3	IM dimensions impact starting/PF/efficiency in power systems.
CO-4		3	Sync machines key for generation & reactive power control.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Supports winding/insulation coordination assessments.
CO-2		2	Evaluates layouts, clearances, thermal management.
CO-3		2	Links electrical, thermal, mechanical limits in IM design.
CO-4		2	Assesses excitation control and insulation choices.

(Dr. S.P.Adhau) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE I: Design of Photovoltaic System

Course Code: 22EL513

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE I: Design of Photovoltaic System(22EL513)

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

CO	Statement	Blooms Level
CO-1	Express the knowledge and apply key solar electric system concepts.	L2
CO-2	Select the Mounting, grounding, positioning and installing the photovoltaic system.	L2
CO-3	Examine the performance, operation and maintenance of solar photovoltaic system.	L3
CO-4	Design of solar PV Plant with inclusion of costing and safety parameters.	L6

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3				2	2					2	2	
CO-2	3	2	1	1	2	2					2	1	1
CO-3	3	3	3	2	1	1					1	2	
CO-4		3	3	2	2	2					2	2	
Average	3.00	2.67	2.33	1.67	1.75	1.75					1.75	1.75	1.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies basic solar energy and PV system principles such as solar irradiance, energy conversion, module characteristics, and electrical fundamentals.
CO-2		3	Requires understanding of structural and electrical standards to install PV systems correctly.
CO-3		3	Applies scientific principles to monitor, troubleshoot, and maintain solar installations effectively.
CO-4		-	-

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	-	-
CO-2		2	Analyzes installation environment (inclination, location, wiring, shading) to identify best configuration.
CO-3		3	Identifies performance issues and assesses system behavior under different conditions.
CO-4		3	Analyzes design options, fault risks, and cost/safety trade-offs for PV plant layout.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3		
CO-2		1	Students develop basic layout understanding during installation.
CO-3		3	Students evaluate PV system operation for maintenance/design improvements
CO-4		3	Students design the entire PV system, ensuring performance and safety.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4		
CO-2		1	Students carry out limited investigations during installation practices.
CO-3		2	Students measure and interpret data to assess PV system performance.
CO-4		2	Students validate the design parameters using data and calculations.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Students use software or basic tools for system understanding.
CO-2		2	Students use measuring tools during installation.
CO-3		1	Students use tools for performance testing and analysis.
CO-4		1	Students employ design software and calculation tools for complete system design.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Students relate PV adoption to environmental benefits and sustainability.
CO-2		2	Students communicate the societal benefits of system diagnostics and maintenance.
CO-3		1	Students communicate the societal benefits of system diagnostics and maintenance.
CO-4		2	Students consider environmental and safety standards when designing PV plants.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Students stay updated on PV technology and codes.
CO-2		2	Students adopt diagnostic procedures and updates in maintenance.
CO-3		1	Students adopt diagnostic procedures and updates in maintenance.
CO-4		2	Students adapt to new safety codes and tools in plant design.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Students understand PV system integration with power systems.
CO-2		1	Students integrate PV systems with wiring and protection schemes.
CO-3		2	Students connect performance assessment with operational reliability.
CO-4		2	Students design PV systems aligned with distributed power operation.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2		
CO-2		1	Students plan installations as per electrical safety standards.
CO-3			
CO-4			

(Dr. R.M.MOHARIL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE I: Electric Power Utilization

Course Code: 22EL514

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE I: Electric Power Utilization (22EL514)

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

CO	Statement	Blooms Level
CO-1	Describe various types of heating and welding methods.	L2
CO-2	Calculate number of lamps required for Illumination.	L3
CO-3	Explain different refrigeration and Air Conditioning systems for various application	L3
CO-4	Categorize various types of fans, pumps, compressor and DG sets along with their application and their performance	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3					1			3		3
CO-2	3	3	3					1			3		3
CO-3	3	3	3					1			3		3
CO-4	3	3	3					1			3		3
Average	3.00	3.00	3.00					1.00			3.00		3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Students apply basic EE fundamentals to describe types of heating and welding methods.
CO-2		3	Students use electrical and illumination fundamentals to calculate the number of lamps required.
CO-3		3	Students explain refrigeration and air-conditioning systems using thermodynamics and power system knowledge.
CO-4		3	Students categorize fans, pumps, compressors, and DG sets based on engineering principles and performance data.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Students analyze and differentiate different heating and welding methods for specific applications.
CO-2		3	Students analyze lighting layouts and illumination levels for proper system design.
CO-3		3	Students evaluate various refrigeration and air-conditioning options for suitability and energy efficiency.
CO-4		3	Students analyze and compare the performance of different utility equipment (fans, pumps, compressors, DG sets).

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Students relate the selection of appropriate heating/welding methods to practical industrial applications.
CO-2		3	Students develop illumination layouts by determining the number of lamps based on given constraints.
CO-3		3	Students apply energy-efficient strategies in refrigeration and air-conditioning applications.
CO-4		3	Students identify appropriate equipment (fans, pumps, compressors, DG sets) to design efficient utility systems.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

CO	PO	Mapping	Remark
CO-1	PO-8	1	Students work in teams and follow safety practices in heating/welding projects.
CO-2		1	Students collaborate effectively while working on lighting system design.
CO-3		1	Students work in teams for refrigeration and AC system analysis.
CO-4		1	Students function as team members when assessing or categorizing utility equipment.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Students stay updated on evolving heating/welding technologies and practices.
CO-2		3	Students adapt to new lighting technologies and standards.
CO-3		3	Students engage in continuous learning about new refrigeration and AC systems.
CO-4		3	Students update themselves on advancements in utility equipment performance and applications.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Students evaluate heating and welding equipment performance.
CO-2		3	Students design and assess lighting systems.
CO-3		3	Students evaluate energy efficiency in refrigeration and AC systems.
CO-4		3	Students assess the performance and application of utility equipment.

(S.B. REWATKAR) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE II: Illumination Engineering (MOOC)

Course Code: 22EL531

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE II: Illumination Engineering (MOOC) (22EL531)

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

CO	Statement	Blooms Level
CO-1	Identify the criteria for the selection of lamps and lighting systems for an indoor or outdoor space	L2
CO-2	Explain the different parameters in designing an illumination system for a particular application.	L3
CO-3	Apply different illumination systems for different applications.	L3
CO-4	Devise proper illumination model for a specific application.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	1	1	2					1	2	2
CO-2	3	3	3	1	1	2					1	2	2
CO-3	3	2	3	1	1	2					1	2	2
CO-4	3	3	3	1	1	2					1	2	2
Average	3.00	2.75	3.00	1.00	1.00	2.00					1	2.00	2.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamentals of lighting (luminous flux, efficacy, CRI/CCT, glare) to identify suitable lamps/systems.
CO-2		3	Uses photometry and basic EE concepts to explain design parameters (illuminance, utilization factor, maintenance factor).
CO-3		3	Applies core principles to select/implement appropriate illumination systems across applications.
CO-4		3	Employs foundational theory while devising an illumination model for a specific space/task.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes space/task requirements (visual acuity, glare control, uniformity) to identify selection criteria.
CO-2		3	Breaks down design variables (room index, reflectances, target lux, daylight contribution) to justify choices.
CO-3		2	Interprets site constraints and operational needs when applying systems (indoor/outdoor, industrial, roadway).
CO-4		3	Evaluates trade-offs (energy, comfort, safety) before finalizing a model.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Translates selection criteria into feasible lamp/luminaire choices meeting codes and user needs.
CO-2		3	Explains design parameters that directly inform layout and specification decisions.
CO-3		3	Applies system choices (lamp + luminaire + controls) to real contexts.
CO-4		3	Devises a complete illumination model addressing function, safety, and efficiency.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Limited investigation—primarily catalog/spec-based selection.
CO-2		1	Basic verification of design parameters using standard methods/charts.
CO-3		1	Elementary site checks and validation steps when applying systems.
CO-4		1	Simple confirmation calculations for the devised model.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Introductory use of datasheets or simple calculators.
CO-2		1	Basic spreadsheets/hand methods for illuminance calculation.
CO-3		1	Limited tool support for system application checks.
CO-4		1	Entry-level use of software (if any) to validate model output.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Considers safety, comfort, and energy implications in lamp/system selection.
CO-2		2	Integrates efficacy, lifetime, maintenance, and light pollution considerations.
CO-3		2	Applies systems that balance visibility, safety, and environmental impact.

CO-4		2	Models include sustainability aspects (controls, LPD limits, glare/light trespass).

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Encourages staying current with evolving lamp/LED tech and standards.
CO-2		1	Requires learning updated design guidelines and codes.
CO-3		1	Ongoing updates to best practices for diverse applications.
CO-4		1	Continuous improvement mindset for modeling/controls and safety norms.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Understands lighting loads and their effect on distribution circuits.
CO-2		2	Design parameters relate to connected load, PF, and demand management.
CO-3		2	System application considers controls (scheduling/occupancy/daylight) and grid impact.
CO-4		2	Devised model fits within power system constraints (LPD, demand, PF).

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark

CO-1	PSO-2	2	Reviews luminaire/driver characteristics and quality metrics (CCT/CRI/UGR).
CO-2		2	Uses parameters to assess luminaires and layouts for performance and safety.
CO-3		2	Applies systems with basic assessment of drivers, controls, and reliability.
CO-4		2	Builds models that can be evaluated for efficiency and visual performance.

(A.P.MUNSHI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE II: Energy Storage System

Course Code: 22EL532

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE II: Energy Storage System (22EL532)

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

CO	Statement	Blooms Level
CO-1	Describe the functions of energy storages, their sizing, and applications.	L2
CO-2	Discuss electrochemical and mechanical energy storage.	L3
CO-3	Analyse the function and use of flywheel, fuel cells and hydrogen storage.	L4
CO-4	Explain battery hybridization, recycling, battery management systems, chargers, testing and mobile storage.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	2	2	2					3	3	2
CO-2	3	3	3	3	2	2					3	3	2
CO-3	3	3	3	3	2	2					3	3	2
CO-4	3	3	3	3	3	2					3	3	2
Average	3.00	3.00	3.00	2.75	2.25	2.00					3.00	3.00	2.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamentals of electrochemistry, mechanics, and energy balance to describe storage functions, sizing basics, and use-cases.
CO-2		3	Uses EE/materials principles to discuss electrochemical (batteries, supercaps) and mechanical (pumped hydro, CAES) storage.
CO-3		3	Applies machine/drive and thermodynamic knowledge to analyze flywheels, fuel cells, and H_2 storage.
CO-4		3	Employs core theory for BMS, hybridization logic, charger/testing principles, and mobile storage concepts.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Identifies requirements (power/energy, duty cycle) and constraints for sizing and application fit.
CO-2		3	Compares chemistries/mechanical options via cycle life, C-rate, round-trip efficiency, safety, and environment.
CO-3		3	Analyzes operating envelopes, efficiency, and interface issues for flywheels, fuel cells, and H_2 storage.
CO-4		3	Evaluates hybrid topologies, BMS strategies, charging/test protocols, and recyclability impacts.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Translates use-case and sizing principles into preliminary storage selections.
CO-2		3	Develops solution options (electrochemical vs. mechanical) for application scenarios.
CO-3		3	Shapes integration choices (power electronics interface, DC bus, safety) from analysis insights.
CO-4		3	Formulates designs including hybridization (e.g., battery+supercap), BMS thresholds, charger specs, and test plans.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Performs basic sizing checks and literature/standards review to validate choices.
CO-2		3	Investigates performance data/aging models to substantiate technology selection.
CO-3		3	Interprets experimental/simulation results for flywheel dynamics, fuel-cell polarization, and H_2 safety margins.
CO-4		3	Plans/assesses testing (capacity, SOH, safety) and charger validation; interprets data for conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Uses spreadsheets/basic simulators for sizing (Wh/kW, DoD, autonomy).
CO-2		2	Employs modeling tools/datasheets to compare chemistries and mechanical stores.
CO-3		2	Uses simulation/measurement tools for flywheel losses, fuel-cell maps, H_2 balance-of-plant.
CO-4		3	Applies specialized tools for BMS tuning, charge profiles, test automation, and hybrid control.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Considers sustainability, safety, and policy drivers in storage adoption.
CO-2		2	Compares environmental/safety implications of chemistries and mechanical options.
CO-3		2	Addresses societal risks/benefits of H_2, fuel cells, and high-speed rotors (codes, siting).
CO-4		2	Discusses recycling, second-life, and compliance in BMS/charging/testing and mobile storage.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Encourages tracking evolving standards and sizing practices across applications.
CO-2		3	Requires staying current with new chemistries, separators, electrolytes, and mechanical advances.
CO-3		3	Fosters continued learning on fuel-cell catalysts, storage media, and safety advancements.
CO-4		3	Demands ongoing updates on BMS algorithms, recycling norms, fast-charging/testing protocols.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Links storage sizing/role to grid support (peak shaving, backup, demand response).
CO-2		3	Relates technology choice to system operation (efficiency, ramping, reliability).
CO-3		3	Connects flywheel/fuel-cell/H_2 systems to power-system stability and interfacing.
CO-4		3	Aligns hybridization/BMS/charging with grid codes, safety, and operational control.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Assesses storage modules/inverters at a basic level for application fit.
CO-2		2	Evaluates device characteristics and interfaces for electrochemical/mechanical stores.
CO-3		2	Analyzes system behavior and diagnostics (sensors, control loops, protection) for flywheel/fuel-cell/H_2.
CO-4		2	Designs/assesses BMS, charger topologies, testing procedures, and mobile storage integration.

(P.S.SHETE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE II: Electrical Wiring Estimation and Costing

Course Code: 22EL533

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE II: Electrical Wiring Estimation and Costing (22EL533)

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

CO	Statement	Blooms Level
CO-1	Illustrate Tendering, quotation processes and enabling the use of standardized electrical symbols, SI units.	L2
CO-2	Solve for different conductor size and estimation of H.T. & L.T. overhead lines and underground cables.	L3
CO-3	Estimate the costing of electrical installations material for residential & workshops buildings.	L4
CO-4	Analyze material requirements and prepare cost estimates for LT distributors and 11kV feeders and understand Indian Electricity Amendment Rules-1972	L4
CO-5	Design substations and connection schemes & choose different cable insulation and materials for earth resistance measurement.	L6

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	1	1	1	1	1					1	3	2
CO-2	3	3	3	2	2	1					1	3	2
CO-3	3	3	2	2	2	1					1	3	2
CO-4	3	3	2	2	2	1					1	3	2
CO-5	3	3	3	2	2	1					1	3	2
Average	3.00	2.60	2.20	1.80	1.80	1.00					1.00	3.00	2.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies core EE fundamentals and standards to interpret tendering terms, symbols, and SI units.
CO-2		3	Uses electrical principles (current density, voltage drop) to size conductors; applies line/cable fundamentals.
CO-3		3	Applies load assessment and circuiting principles for material take-off in residential/workshop installations.
CO-4		3	Uses distribution engineering basics for LT distributors and 11 kV feeders (voltage regulation, losses).
CO-5		3	Integrates power systems knowledge to design substations and connection schemes.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	1	Interprets tender/quotation specs—limited analytical depth.
CO-2		3	Analyzes route lengths, loading, and constraints for HT/LT lines and underground cables.
CO-3		3	Breaks down loads, circuits, and protection to quantify materials/costs.
CO-4		3	Analyzes feeder/distributor performance and compliance with rules for material requirements.
CO-5		3	Evaluates substation ratings, fault levels, and insulation/material choice trade-offs.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Selection of standard symbols/units supports design documentation.
CO-2		3	Develops conductor sizing and layout solutions meeting voltage-drop/thermal criteria.
CO-3		2	Prepares BoQ and layouts for building installations (design support).
CO-4		2	Develops material and layout plans for LT distributors/11 kV feeders.
CO-5		3	Designs substation single-line schemes and earthing/cable insulation choices.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Basic standards referencing for tendering; minimal investigation.
CO-2		2	Verifies sizing via calculations (V-drop, short-circuit thermal checks).
CO-3		2	Validates estimates through site parameters and code cross-checks.
CO-4		2	Uses feeder studies (voltage regulation/loss) to support estimates.
CO-5		2	Checks substation parameters (fault levels, clearances, earthing) against standards.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Uses standard schedules/templates for tendering/Bill of Quantities.
CO-2		2	Employs spreadsheets/design calculators for line and cable sizing.
CO-3		2	Uses estimation software/templates for material costing in buildings.
CO-4		2	Applies basic feeder calculation tools and mapping layouts.
CO-5		2	Uses CAD/sizing sheets for substation layouts, cable/earthing choices.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Awareness of statutory/contractual compliance in tendering and documentation.
CO-2		1	Considers safety clearances and statutory limits in line/cable works.
CO-3		1	Applies wiring rules and safe practices in residential/workshop contexts.
CO-4		1	References Indian Electricity Amendment Rules-1972 during estimation for feeders/distributors.
CO-5		1	Considers safety, legal, and environmental aspects in substation design and earthing.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Exposure to evolving tendering practices and standardization.
CO-2		1	Keeps current with new conductor materials/installation practices.
CO-3		1	Updates on codes and estimation norms for buildings.
CO-4		1	Keeps pace with revisions to rules/utility specifications.
CO-5		1	Learns new standards for substation design and earth resistance methods.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Standardized documentation underpins reliable system design/operation.
CO-2		3	Conductor/line/cable sizing directly affects system performance and reliability.
CO-3		3	Accurate installation estimates support safe and reliable system operation.
CO-4		3	Proper feeder/distributor estimation is central to distribution system design.
CO-5		3	Substation/cable/earthing design choices drive system safety and control.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Supports standardized symbols/units for clear system assessment.
CO-2		2	Assesses suitability of conductors/cables, insulation, and laying methods.
CO-3		2	Evaluates installation materials and cost effectiveness for buildings.
CO-4		2	Assesses distributor/feeder materials against performance/cost targets.
CO-5		2	Evaluates substation connections, cable insulation, and earth resistance measurement methods.

(R.S. KHONDE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE II: Distributed Generations in Power System

Course Code: 22EL534

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE II: Distributed Generations in Power System (22EL534)

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

CO	Statement	Blooms Level
CO-1	Classify the energy sources and its conversion for distributed energy generation	L2
CO-2	Distinguish Solar Photovoltaic, wind turbine systems and other renewable energy sources	L2
CO-3	Use of fundamental knowledge of energy storage devices in power system	L3
CO-4	Evaluate the Performance of power system with respect to power quality	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	2								3	3	3
CO-2	3	3	3	1	1						3	3	3
CO-3	3	3	3			2					3	3	3
CO-4	3	3	3	3	1						3	3	3
Average	3.00	2.75	2.75	2.00	1.00	2.00					3.00	3.00	3.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies engineering fundamentals to classify energy sources and conversion methods for distributed generation.
CO-2		3	Understands the working principles of Solar PV, wind, and other RES technologies.
CO-3		3	Uses core knowledge of energy storage devices (batteries, fuel cells, flywheels) for power systems.
CO-4		3	Requires deep engineering understanding of power quality metrics and system operation.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Analyzes feasibility and efficiency of different energy sources for distributed generation.
CO-2		3	Compares performance and environmental aspects of RES options.
CO-3		3	Determines appropriate storage solutions based on load and generation profiles.
CO-4		3	Troubleshoots and analyzes power quality issues in distributed systems.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Identifies energy source options as part of distributed system planning.
CO-2		3	Informs design and selection of RES for specific distributed generation applications.
CO-3		3	Supports integration of storage devices in distributed power system designs.
CO-4		3	Enhances system design to improve performance and power quality.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4		
CO-2		1	Performs basic investigative comparisons across renewable technologies.
CO-3			
CO-4		3	Conducts detailed investigations (measurements, modeling) for power quality assessment.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5		
CO-2		1	Uses simple tools or software to compare renewable energy systems.
CO-3			
CO-4		1	Employs basic PQ analyzers or simulation tools for assessment.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6		
CO-2			
CO-3		2	Considers sustainability, safety, and societal impacts of storage integration.
CO-4			

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Promotes awareness of evolving energy technologies and distributed generation practices.
CO-2		3	Encourages learning emerging RES standards and integration methods.
CO-3		3	Updates knowledge on new energy storage technologies and applications.
CO-4		3	Stays current with new power quality standards, devices, and control techniques.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Selects suitable energy sources to meet distributed system operational requirements.
CO-2		3	Integrates RES technologies considering grid and power system constraints.
CO-3		3	Ensures power balance and reliability using energy storage devices.
CO-4		3	Supports system performance improvement through power quality evaluation.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Understands energy source impact on electrical and control systems.
CO-2		3	Evaluates system compatibility of various renewable energy sources.
CO-3		3	Assesses storage system integration with electrical systems.
CO-4		3	Ensures reliable performance of electrical/electronic systems through PQ improvement.

(S.D.PATIL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Fundamentals of Power System

Course Code: EL2303

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Fundamentals of Power System (EL2303)

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

CO	Statement	Blooms Level
CO-1	Describe basic components of Power System and per unit values of system components	L2
CO-2	Determine the transmission line parameters.	L3
CO-3	Explain the types of insulators, underground cables and the performance of system.	L4
CO-4	Evaluate the performance of distribution and transmission system.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	2	3	1	1						3	1
CO-2	3	2	2	2	1	1						3	2
CO-3	3	3	2	2	1	1						3	2
CO-4	3	2	2	3	1	1						3	
Average	3.00	2.25	2.00	2.50	1.00	1.00						3.00	1.67

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies core EE fundamentals to describe power-system components and per-unit normalization.
CO-2		3	Uses transmission-line theory to determine R, L, C, G parameters.
CO-3		3	Applies insulation, cable, and system-performance fundamentals.
CO-4		3	Uses power-system theory to evaluate T&D performance measures.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Interprets component data and base conversions in per-unit computations.
CO-2		2	Analyzes conductor geometry/spacing and material properties to compute line parameters.
CO-3		3	Compares insulator types/cable constructions; analyzes their suitability and impact on performance.
CO-4		2	Reviews loading/voltage-drop/loss data to judge distribution & transmission performance.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Basic mapping of real components to per-unit models supports later design tasks.
CO-2		2	Parameter determination informs preliminary line design choices.
CO-3		2	Relates insulation/cable selection to system performance and reliability.
CO-4		2	Uses evaluation outcomes to suggest improvement options at concept level.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Performs per-unit conversions/checks and validates component representations.
CO-2		2	Carries out standard calculations/assumptions for long/medium/short lines.
CO-3		2	Interprets test data/standards for insulators and underground cables.
CO-4		3	Investigates T&D performance (voltage regulation, losses) and interprets results.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Uses basic spreadsheets/charts for per-unit and component data handling.
CO-2		1	Employs simple calculators/sheets for line-parameter evaluation.
CO-3		1	Uses datasheets/handbooks for insulation and cable parameters.
CO-4		1	Applies elementary tools for loss/voltage-profile calculations.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Recognizes safety/standards context of major system components.
CO-2		1	Notes right-of-way, environmental and safety aspects in line design.

CO-3		1	Considers insulation ratings, thermal limits, and safe installation practices.
CO-4		1	Appreciates reliability/quality implications for consumers and society.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Promotes awareness of evolving energy technologies and distributed generation practices.
CO-2		3	Encourages learning emerging RES standards and integration methods.
CO-3		3	Updates knowledge on new energy storage technologies and applications.
CO-4		3	Stays current with new power quality standards, devices, and control techniques.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Per-unit modeling is foundational for system studies and operation.
CO-2		3	Accurate line parameters are critical for planning, protection, and control.
CO-3		3	Insulation/cable knowledge underpins dependable system operation.
CO-4		3	T&D performance evaluation directly supports system design and optimization.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	Basic mapping of components aids assessment of interfacing equipment.
CO-2		2	Parameter estimation supports assessment of line behavior with connected equipment.
CO-3		2	Cable/insulator performance assessment impacts equipment reliability.
CO-4			

(S.P. ADHAU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: OEI: Renewable Energy Generation System

Course Code: 22EL551

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of OEI: Renewable Energy Generation System (22EL551)

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

CO	Statement	Blooms Level
CO-1	Discuss types of renewable energy sources, outline as per Global and Indian context	L2
CO-2	Describe various applications of Solar energy sources and describe types of wind turbine generator systems.	L2
CO-3	Explain geothermal and biomass energy resources.	L3
CO-4	Summarize energy from ocean, tide, wave and hydro for power generation, storage methods for renewable energy sources.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	1		3					1	2	1
CO-2	3	3	3	1		3					1	2	1
CO-3	3	3	3	1		3					1	2	1
CO-4	3	3	3	1		3					1	2	1
Average	3.00	3.00	3.00	1.00		3.00					1.00	2.00	1.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies core engineering knowledge to classify and describe renewable energy types.
CO-2		3	Uses solar and wind system theory to explain energy generation.
CO-3		3	Applies fundamental principles to geothermal and biomass systems.
CO-4		3	Utilizes engineering knowledge to understand ocean, hydro, and storage systems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes resource potential and deployment in global and Indian contexts.

CO-2		3	Evaluates energy output based on site-specific solar and wind data.
CO-3		3	Identifies performance challenges in biomass and geothermal systems.
CO-4		3	Compares technical feasibility of energy storage and ocean-based energy.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Selects suitable renewable options based on application and location.
CO-2		3	Demonstrates system selection and basic layout of RE systems.
CO-3		3	Estimates output and selects biomass/geothermal options.
CO-4		3	Proposes integrated RE and storage options conceptually.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Interprets RE policy data and implementation status.
CO-2		1	Uses basic performance data for solar/wind yield analysis.
CO-3		1	Assesses feasibility through performance curves and fuel data.
CO-4		1	Investigates suitability of ocean and hydro storage through real-world data.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	3	Promotes societal energy solutions via clean RE adoption.
CO-2		3	Highlights benefits of solar/wind in reducing emissions.
CO-3		3	Shows how biomass/geothermal contribute to sustainability.
CO-4		3	Connects storage solutions to societal energy access needs.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Encourages awareness of RE policies and global updates.
CO-2		1	Promotes continuous learning in evolving RE tech.
CO-3		1	Updates understanding of biomass/geothermal tech.
CO-4		1	Motivates learning in storage innovation (hydrogen, batteries).

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Understands RE source contribution to the power system.
CO-2		2	Estimates RE generation and grid impact.
CO-3		2	Evaluates integration potential in distribution systems.
CO-4		2	Relates storage with RE for grid support and load balancing.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	Covers evaluation of RE technologies.
CO-2		1	Involves performance assessment of PV and wind systems.
CO-3		1	Evaluates viability of biomass/geothermal systems.
CO-4		1	Assesses storage system roles in power generation.

(S.P. ADHAU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: OE III: Solar Power Plant Design and Installation

Course Code: 22EL653

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of OE III: Solar Power Plant Design and Installation (22EL653)

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

CO	Statement	Blooms Level
CO-1	Classify different types of solar power plant and system sizing based on load profiles	L2
CO-2	Compare different types of solar PV panels and inverters for solar power plant.	L2
CO-3	Select AC and DC cable, earthing and lightening arrestors.	L3
CO-4	Utilize government policies for solar power plant installation and select proper operation and maintenance procedures for a solar power plant.	L3

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	2	2					3	1	3
CO-2	3	3	3	3	2	2					3	1	3
CO-3	3	3	3	3	2	2					3	1	3
CO-4	3	3	3	3	2	2					3	1	3
Average	3.00	3.00	3.00	3.00	2.00	2.00					3.00	1.00	3.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamental knowledge to classify solar plant types and estimate load-based sizing.
CO-2		3	Uses basic electrical and materials engineering to compare PV panels and inverters.
CO-3		3	Applies core electrical knowledge in cable, earthing, and protection device selection.
CO-4		3	Applies electrical and policy-related engineering knowledge to system operation and maintenance.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes load profile requirements to select system configuration.
CO-2		3	Compares performance and suitability of various solar PV technologies.
CO-3		3	Identifies cable sizing and safety components based on system parameters.
CO-4		3	Analyzes operation and maintenance strategies based on system design.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Designs suitable solar system types as per user loads.
CO-2		3	Supports design decisions regarding inverter and module selection.
CO-3		3	Selects safety and protection components as per electrical codes.
CO-4		3	Selects appropriate maintenance procedures and policy-based design practices.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Investigates sizing parameters and constraints for solar plants.
CO-2		3	Evaluates inverter-module performance data.
CO-3		3	Assesses current carrying capacity and fault tolerance in cables and protection.
CO-4		3	Investigates government schemes and maintenance logs for performance optimization.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	May involve use of software tools for sizing and layout.
CO-2		2	Uses selection tools and datasheet comparisons for inverter/panel evaluation.
CO-3		2	Applies standards and tools for cable sizing and safety component configuration.
CO-4		2	Uses maintenance planning tools or documentation standards.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Promotes societal sustainability through clean solar energy systems.
CO-2		2	Encourages use of eco-friendly PV technologies and system components.
CO-3		2	Addresses electrical safety, improving public and system safety.
CO-4		2	Informs about policy benefits and promotes solar deployment in society.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Encourages continuous learning in solar technologies and grid integration.
CO-2		3	Promotes keeping updated with the latest PV/inverter models and standards.
CO-3		3	Encourages lifelong learning in electrical standards and protection systems.
CO-4		3	Engages with current government policies and emerging O&M practices.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Supports system planning and control related to solar integration.
CO-2		1	Helps assess PV system characteristics relevant to distribution networks.
CO-3		1	Provides understanding of cabling and protection within the power system.
CO-4		1	Relates to operational performance and compliance in solar installations.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Enables evaluation and development of solar power system configurations.
CO-2		3	Assists in technology selection for efficient system design.
CO-3		3	Supports component-level assessment for system safety.
CO-4		3	Enables assessment of policy-compliant and maintainable solar systems.

(N.T. SAHU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: OE II: Electrical Energy Audit and Safety

Course Code: 22EL571

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of OE II: Electrical Energy Audit and Safety (22EL571)

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

CO	Statement	Blooms Level
CO-1	Classify the consumption pattern, conservation of electrical energy and Electricity Act 2001.	L2
CO-2	Demonstrate different forms of energy to optimize the use for maximizing the efficiency of system.	L2
CO-3	Examine the proper utilization of energy by energy management and audit.	L4
CO-4	Analyze the various Global Environmental Concerns and Electrical safety procedures.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	2	2					3	1	3
CO-2	3	3	3	3	2	2					3	1	3
CO-3	3	3	3	3	2	2					3	1	3
CO-4	3	3	3	3	2	3					3	1	3
Average	3.00	3.00	3.00	3.00	2.00	2.25					3.00	1.00	3.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies foundational electrical engineering knowledge to understand consumption patterns and policies.
CO-2		3	Uses engineering principles to identify energy optimization methods.
CO-3		3	Applies core engineering knowledge for conducting audits and improving energy efficiency.
CO-4		3	Applies technical knowledge to evaluate safety standards and environmental concerns.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes energy usage data and conservation practices.
CO-2		3	Evaluates forms of energy and system efficiency improvements.
CO-3		3	Identifies issues in energy usage and proposes audit-based solutions.
CO-4		3	Analyzes hazards and formulates preventive electrical safety measures.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Supports designing energy conservation solutions based on policy and usage.
CO-2		3	Helps develop energy-optimized systems for real-life scenarios.
CO-3		3	Assists in designing audit-based energy management strategies.
CO-4		3	Encourages designing safety solutions and environmental mitigation strategies.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Investigates electricity consumption trends and legal frameworks.
CO-2		3	Explores optimization techniques to reduce losses and improve efficiency.
CO-3		3	Involves detailed investigation during energy audits.
CO-4		3	Analyzes complex safety systems and environmental impacts.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Uses basic tools for energy data collection, safety analysis, and reporting.
CO-2		2	Uses basic tools for energy data collection, safety analysis, and reporting.
CO-3		2	Uses basic tools for energy data collection, safety analysis, and reporting.
CO-4		2	Uses basic tools for energy data collection, safety analysis, and reporting.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Addresses societal impact through efficient energy use.
CO-2		2	Addresses societal impact through efficient energy use.
CO-3		2	Addresses societal impact through efficient energy use.
CO-4		3	Focuses on safety protocols and environmental responsibility.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Promotes lifelong learning in energy laws, conservation, and safety standards.
CO-2		3	Promotes lifelong learning in energy laws, conservation, and safety standards.
CO-3		3	Promotes lifelong learning in energy laws, conservation, and safety standards.
CO-4		3	Promotes lifelong learning in energy laws, conservation, and safety standards.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Supports understanding of system performance from an energy audit and safety viewpoint.
CO-2		1	Supports understanding of system performance from an energy audit and safety viewpoint.
CO-3		1	Supports understanding of system performance from an energy audit and safety viewpoint.
CO-4		1	Supports understanding of system performance from an energy audit and safety viewpoint.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Enables assessment and development of safe and energy-efficient electrical systems.
CO-2		3	Enables assessment and development of safe and energy-efficient electrical systems.
CO-3		3	Enables assessment and development of safe and energy-efficient electrical systems.
CO-4		3	Enables assessment and development of safe and energy-efficient electrical systems.

(S.L. TIWARI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: OE II: Power System Engineering

Course Code: 22EL573

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of OE II: Power System Engineering (22EL573)

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

CO	Statement	Blooms Level
CO-1	Articulate types of load and power system components and its behaviour.	L3
CO-2	Develop and examine the transmission lines to improve the parameters and safety of the power system.	L3
CO-3	Compare A.C and D.C distribution networks performance.	L4
CO-4	Select proper switchgear and protection system and analysis for distribution network.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	1			1					1	2	1
CO-2	3	2	1	1	1	1					1	2	1
CO-3	3	2	1	1	1	1					1	2	1
CO-4	3	2	1			1					1	2	1
Average	3.00	2.00	1.00	1.00	1.00	1.00					1.00	2.00	1.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies foundational electrical engineering knowledge to understand various types of loads and components in a power system.
CO-2		3	Uses engineering concepts to develop and analyze transmission lines for improved performance and safety.
CO-3		3	Applies theoretical understanding to compare A.C and D.C distribution networks.
CO-4		3	Demonstrates technical knowledge in selecting appropriate switchgear and protective systems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Analyzes the behavior of load and components under different conditions.
CO-2		2	Evaluates transmission systems to enhance system efficiency and safety.
CO-3		2	Analyzes performance of various distribution networks under operational constraints.
CO-4		2	Assesses distribution networks and fault scenarios for protection design.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Introduces component identification and sizing as a step toward power system design.
CO-2		1	Involves basic design elements in transmission line performance enhancement.
CO-3		1	Compares configurations to aid in optimal distribution system design.
CO-4		1	Assists in selecting protection systems as part of basic network design.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4		
CO-2		1	Analyzes transmission systems with multiple parameters for efficiency.
CO-3		1	Investigates comparative performance of AC/DC systems under practical constraints.
CO-4			

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5		
CO-2		1	May involve basic simulation tools for line performance or fault analysis.
CO-3		1	Introduces tools/software to study system behavior under various loadings.
CO-4			

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Awareness of societal impact of load growth and system efficiency.
CO-2		1	Considers societal impact of improved transmission reliability and safety.

CO-3		1	Considers implications of power distribution methods on end-users.
CO-4		1	Ensures protection systems safeguard human and societal infrastructure.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Encourages continuous learning of evolving load types and system behaviors in modern power systems.
CO-2		1	Motivates learners to keep up with advances in transmission technologies and safety practices.
CO-3		1	Inspires learners to compare and evaluate distribution networks as technologies evolve.
CO-4		1	Promotes awareness of new switchgear, protection techniques, and distribution advancements requiring ongoing learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Discusses load behavior and system component roles in operations.
CO-2		2	Engages in design/evaluation of transmission systems.
CO-3		2	Evaluates performance characteristics relevant to power system control.
CO-4		2	Focuses on protection—essential for system stability and control.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	Introduces system understanding, a base for system assessment.
CO-2		1	Studies transmission lines for performance improvements.
CO-3		1	Applies distribution evaluation as part of system development.
CO-4		1	Involves assessment of protection mechanisms in electrical systems.

(S.P. ADHAU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Power System Analysis

Course Code: 22EL601

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Power System Analysis(22EL601)

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

CO	Statement	Blooms Level
CO-1	Apply symmetrical components concepts in fault analysis	L3
CO-2	Analyze different faults in power system	L4
CO-3	Evaluate stability and economic operation of power system	L4
CO-4	Differentiate different neutral grounding and compensation systems	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3		2	2	2		1			3	3	2
CO-2	3	3		2	2	2		1			3	3	2
CO-3	3	3		2	2	2		1			3	3	2
CO-4	3	2		1	1						3	3	2
Average	3.00	2.75		1.75	1.75	2.00		1.00			3.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Symmetrical-component theory requires solid grounding in complex algebra and network fundamentals.
CO-2		3	Applies deep understanding of network theory and machine behavior under faults.
CO-3		3	Uses advanced system-stability theory and economic-dispatch algorithms.
CO-4		3	Requires thorough knowledge of grounding theory and network design.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Fault analysis demands formulation of unbalanced system equations and critical problem-solving.
CO-2		3	Requires critical analysis of fault types, causes, and effects.
CO-3		3	Requires evaluation of dynamic behavior and cost-benefit tradeoffs.
CO-4		2	Involves comparison of grounding methods and their merits/demerits.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Involves investigation of fault cases via simulation or analytical case studies.
CO-2		2	Uses simulation studies or lab fault simulators for data interpretation.
CO-3		2	Involves simulation/experimental validation of stability margins or dispatch results.
CO-4		1	Minimal investigation; largely theoretical differentiation.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Uses tools like MATLAB/Simulink or ETAP to compute sequence networks.
CO-2		2	Employs software tools to model and analyze fault scenarios.
CO-3		2	Uses power-system analysis software (PSCAD, PSS®E) for modeling.
CO-4		1	Limited tool usage, mostly schematic study.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Considers system reliability and safety implications under faulted conditions.
CO-2		2	Assesses environmental/safety impact of fault currents and clearances.
CO-3		2	Considers environmental impact of dispatch decisions and stability controls.
CO-4		-	-

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

CO	PO	Mapping	Remark
CO-1	PO-08	1	Typically individual analysis; minimal teamwork requirement.
CO-2		1	Mostly performed individually; minor collaboration.
CO-3		1	Individual/team analysis is minimal.
CO-4		-	-

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Students must engage with evolving analysis techniques, simulation tools (e.g., ETAP, PSCAD), and modern protection strategies, which fosters the habit of continuous, self-directed learning.
CO-2		3	Fault types and protection schemes continue to evolve with smart grids and digital relaying systems. Students are encouraged to learn and adapt to new methods and technologies throughout their careers.
CO-3		3	As economic dispatch algorithms and stability control systems evolve (e.g., AI-based methods), students must be prepared for continuous upskilling to handle future challenges.
CO-4		3	Exposure to diverse grounding practices—including modern compensation and active grounding techniques—develops a mindset open to emerging approaches, encouraging lifelong learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Directly tied to power-system fault operations and protection design.
CO-2		3	Core to power system operation and protective design analysis.
CO-3		3	Stability and economics are central to power-system operation and control.
CO-4		3	Grounding is fundamental to safe system operation and protection schemes.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Relies on electronic relaying and system modeling skills.
CO-2		3	Involves relay coordination and electronic protection systems.
CO-3		3	Involves control-system modeling and assessment in electronic platforms.
CO-4		3	Relates to electronic compensation devices and protective relaying.

(B. Y. BAGDE, S.R.GAIGOWAL) (Dr. S. P.GAWANDE)

Course Coordinator HOD

Course Name: Electric Vehicles

Course Code: 22EL602

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Electric Vehicles (22EL602)

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

CO	Statement	Blooms Level
CO-1	Explain the EV structure, its dynamics and details about the power train and propulsion system.	L2
CO-2	Discuss and identify the appropriate battery and its characteristics with various alternating energy sources	L2
CO-3	Illustrate and analyze different motors for EV and HEVs with their modelling	L3
CO-4	Analyze and formulate various power electronics converter for AC and DC drives and their controls.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	1	2					2	2	2
CO-2	3	3	3	2	1	2					2	3	2
CO-3	3	3	3	2	1	2					2	3	2
CO-4	3	3	3	2							2	3	3
Average	3	3	3	2.25	1	2					2	2.75	2.25

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires fundamental engineering knowledge in electrical machines, vehicle mechanics, and dynamics.
CO-2		3	Applies core knowledge of batteries, electrochemistry, and energy systems.
CO-3		3	Requires knowledge of electrical machines (BLDC, PMSM, IM, SRM).
CO-4		3	Requires knowledge of power electronics converters.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves analysis of EV motion dynamics and system behavior under various conditions.
CO-2		3	Analyzes charge/discharge cycles, battery sizing, and lifespan.
CO-3		3	Analysis of performance curves, losses, and torque characteristics
CO-4		3	Analysis of various power converters.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Enables students to conceptually design an EV propulsion system.
CO-2		3	Designs hybrid energy systems combining batteries and alternate sources.
CO-3		3	Enables drive cycle-based motor selection and system integration.
CO-4		3	Enables students to conceptually design a power electronics converters for EV.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Promotes investigation into component efficiencies, losses, and system interaction.
CO-2		2	Conducts experimental analysis of battery performance under varied loads.
CO-3		2	Applies simulation tools to test motor responses under varying conditions.
CO-4		2	Conduct modelling and analysis of power converters.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Uses modern tools (MATLAB/Simulink, ANSYS) to model EV structure and powertrain.
CO-2		1	Involves battery management and simulation tools like BMS simulators.
CO-3		1	Involves use of modeling tools (e.g., MATLAB, PSIM) for validation.
CO-4		-	-

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Encourages consideration of environmental impact of EV vs. ICE vehicles.
CO-2		2	Highlights eco-friendly aspects of battery-based transport.
CO-3		2	Improves technical communication when justifying motor selection.
CO-4		-	-

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Encourages awareness of modern EV technologies and systems.
CO-2		2	Encourages learning of emerging battery technologies..
CO-3		2	Motivates learning of motor control advancements.
CO-4		2	Emerging EV technology motivates life-long learning..

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Connects with powertrain understanding in power system design context.
CO-2		3	Deeply relates to energy storage, which is integral to power system design.
CO-3		3	Strongly connected to motor control and integration in power systems.
CO-4		3	Directly involved in power system converter application.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Applies to knowledge of electrical systems used in propulsion.

CO-2		2	Involves electronic control of battery charging/discharging.
CO-3		2	Focuses on motor control circuits and electronics.
CO-4		3	Focuses on converter control and assessment in electronic systems.

(P. S. SHETE, Dr. S. P. GAWANDE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Electric Vehicles Lab

Course Code: 22EL603

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Electric Vehicles Lab (22EL603)

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

CO	Statement	Blooms Level
CO-1	Interpret the configuration and operation of BLDC motor.	L2
CO-2	Explain the operation of PMDC motor.	L2
CO-3	Illustrate the operation of Plug-in Electric Vehicle Charging System.	L2
CO-4	Develop the simulation model of bidirectional dc to dc converter.	L3

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	3	1					2	2	3
CO-2	3	3	3	2	3	1					2	2	3
CO-3	3	3	3	2	3	1					2	2	3
CO-4	3	3	3	2	3	1					2	2	3
Average	3.00	3.00	3.00	2.25	3.00	1.00					2.00	2.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires application of engineering knowledge in understanding the structure and operation of BLDC motors.
CO-2		3	Uses fundamental concepts of electrical machines.
CO-3		3	Involves concepts of charging systems, voltage levels, and protocols.
CO-4		3	Applies power electronics knowledge to create practical models.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves identifying and analyzing system components and vehicle behavior.
CO-2		3	Involves comparative analysis of batteries and alternate energy sources.
CO-3		3	Demands analysis of motor performance and suitability for EVs.
CO-4		3	Involves critical analysis of converters and control strategies.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Supports development of conceptual designs based on propulsion types.
CO-2		3	Helps design suitable energy storage configurations for EVs.
CO-3		3	Enables modeling and selection of motors for different drive conditions.
CO-4		3	Supports formulation of drive solutions using converters.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Enables investigation of performance through simulation or literature review.
CO-2		2	Includes some investigation and interpretation of battery performance.
CO-3		2	Investigative learning through simulations and modeling tools.
CO-4		2	Encourages design analysis through modeling and experimentation.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	3	Includes usage of simulation/lab tools (e.g., controllers, oscilloscopes).
CO-2		3	Uses motor kits, measuring instruments and lab tools.
CO-3		3	Use of actual hardware kits or simulation tools.
CO-4		3	Include usage of Includes usage of simulation/lab tools for power electronics converters.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Slight relevance in understanding energy-efficient motor operation.
CO-2		1	Encourages energy conservation thinking.
CO-3		1	Considers environmental and societal need for clean energy.
CO-4		1	Understanding energy flow and conservation.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Introduces current motor control technology, encouraging ongoing learning.
CO-2		2	Promotes curiosity about motor technologies and their evolution.
CO-3		2	Connects students with evolving EV infrastructure technology.
CO-4		2	Helps students explore modern DC–DC converter control strategies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Involves control and design within power systems context.
CO-2		2	Applies to basic motor control in power systems.
CO-3		2	Related to grid interface and power transfer logic.
CO-4		2	Connected to bidirectional energy flow in smart power systems.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Closely relates to electrical system development and motor behavior assessment.
CO-2		3	Directly connected to development and operation of motor-driven electronic systems.
CO-3		3	Involves energy systems operation and control.
CO-4		3	Strong link to control and design of advanced converter systems.

(P. S. SHETE, Dr. S. P. GAWANDE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Simulation in Power Electronics & Power System Lab

Course Code: 22EL604

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Simulation in Power Electronics & Power System Lab (22EL604)

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

CO	Statement	Blooms Level
CO-1	Demonstrate the fundamentals of the simulation environment of MATLAB/SIMULINK software	L2
CO-2	Describe MATLAB/SIMULINK as a tool to solve power system and power electronics problems	L2
CO-3	Develop simulation models in the power system and analyse the performance	L3
CO-4	Make use of SIMULINK to build and analyse models of power electronics	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	1	1	1	1	3						2	3	2
CO-2	2	2	2	2	3						2	3	2
CO-3	3	3	2	2	3						2	3	2
CO-4	3	3	2	2	3						2	3	2
Average	2.25	2.25	1.75	1.75	3						2	3	2

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	1	While understanding simulation environment, specific toolboxes of power system only are explored. Hence weak mapping
CO-2		2	Simulation environment SIMULINK explored in terms of developing models in power electronics and power system. Hence moderate mapping
CO-3		3	To develop models in power system and analyse its performance, knowledge of mathematics, computing and, engineering fundamentals are required. Hence strong mapping
CO-4		3	To develop models in power electronics and analyse its performance, knowledge of mathematics, computing and, engineering fundamentals are required. Hence strong mapping

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	1	Review of MATLAB Central portal, demo models as a literature survey to understand how the models are developed. Hence weak mapping
CO-2		2	SIMULINK explored in terms of parameters setting, default settings of the blocks. Hence moderate mapping
CO-3		3	System parameters are identified, methodology is formulated, analysing the model developed and critically assess the results or waveforms obtained for power system is carried out. Hence strong mapping.
CO-4		3	System parameters are identified, methodology is formulated, analysing the model developed and critically assess the results or waveforms obtained for power electronics is carried out. Hence strong mapping.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	While understanding simulation environment, specific toolboxes of power system only are explored. Hence weak mapping.
CO-2		2	Solutions for engineering problems in power systems and power electronics are obtained for developed systems to meet identified needs for society in terms of economy, and in consideration of the environment. Hence moderate mapping.
CO-3		2	Solutions for engineering problems in power systems are obtained for developed systems to meet identified needs for society in terms of economy, and in consideration of the environment. Hence moderate mapping.

CO-4		2	Solutions for engineering problems in power electronics are obtained for developed systems to meet identified needs for society in terms of economy, and in consideration of the environment. Hence moderate mapping.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	While exploring SIMULINK simulation environment, specific toolboxes of power system only are explored. Hence weak mapping
CO-2		2	Experiments are designed for power systems, power electronics systems, along with analysis and investigations of the results obtained to arrive at valid conclusions. Hence, moderate mapping.
CO-3		2	Experiments are designed for power systems, along with analysis and investigations of the results obtained to arrive at valid conclusions. Hence, moderate mapping.
CO-4		2	Experiments are designed for power electronics systems, along with analysis and investigations of the results obtained to arrive at valid conclusions. Hence, moderate mapping.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	3	MATLAB as an IT tool, has been used extensively to model and analyse electrical systems. Hence, strong mapping.
CO-2		3	MATLAB as an IT tool, has been used extensively to model and analyse power systems, power electronics systems. Hence, strong mapping.
CO-3		3	MATLAB as an IT tool, has been used extensively to model and analyse power systems. Hence, strong mapping.
CO-4		3	MATLAB as an IT tool, has been used extensively to model and analyse power electronics systems. Hence, strong mapping.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Being a laboratory of modern IT tools which are used extensively in academics and industries alike, graduates are expected to extend learning experience throughout their professional career. Hence moderate mapping.
CO-2		2	Being a laboratory of modern IT tools which are used extensively in academics and industries alike, graduates are expected to extend learning experience throughout their professional career. Hence moderate mapping.
CO-3		2	Being a laboratory of modern IT tools which are used extensively in academics and industries alike, graduates are expected to extend learning experience throughout their professional career. Hence moderate mapping.
CO-4		2	Being a laboratory of modern IT tools which are used extensively in academics and industries alike, graduates are expected to extend learning experience throughout their professional career. Hence moderate mapping.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	The electrical systems are modelled and analysed for operation and control. Hence, strong mapping.
CO-2		3	The power systems, power electronics systems are modelled and analysed for operation and control. Hence, strong mapping.
CO-3		3	The power systems are modelled and analysed for operation and control. Hence, strong mapping.
CO-4		3	The power electronics systems are modelled and analysed for operation and control. Hence, strong mapping.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	The knowledge is acquired to develop, control, and assess electrical systems only. Hence, moderate mapping.
CO-2		2	The knowledge is acquired to develop, control, and assess power systems and power electronics systems . Hence, moderate mapping.
CO-3		2	The knowledge is acquired to develop, control, and assess power systems . Hence, moderate mapping.
CO-4		2	The knowledge is acquired to develop, control, and assess power electronics systems only. Hence, moderate mapping.

(Dr. P. M. Meshram) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Substation Design Lab

Course Code: 223EL605

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Substation Design Lab (22EL605)

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

CO	Statement	Blooms Level
CO-1	Explain single line diagram of substation with rating of different equipments, types of relays required and their settings.	L2
CO-2	Construct plan of equipment's and panels mounted in a substation	L3
CO-3	Analyze earthing system of substation.	L4
CO-4	Design of substation complete in regards to selection of equipments, sizes, protective schemes and earthing system.	L6

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	3	1				1		2	2	3	2
CO-2	3	2	2	1				1		2	2	3	2
CO-3	3	3	3	2				1		2	2	3	2
CO-4	3	3	3	2				1		2	2	3	2
Average	3.00	2.50	2.75	1.50				1.00		2.00	2.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires fundamental electrical engineering knowledge of substation layout and protection components.
CO-2		3	Applies engineering knowledge to physical layout planning.
CO-3		3	Earthing involves strong knowledge of electrical safety, standards, and system behavior.
CO-4		3	Requires comprehensive knowledge of power systems and components.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Involves interpreting and reviewing technical data and system requirements.
CO-2		2	Requires analysis of substation components for logical arrangement.
CO-3		3	Requires analysis of soil resistivity, fault currents, and safe grounding practices.
CO-4		3	Analyzing load flow, protection, and safety for substation design.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Understanding equipment ratings and relay types contributes to design consideration.
CO-2		2	Encourages design development at the layout level.
CO-3		3	Includes development of grounding solutions.
CO-4		3	Involves full design process for equipment sizing and selection.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Minimal investigative work, more focused on conceptual explanation.
CO-2		1	Minimal investigation; primarily a constructive task.
CO-3		2	Involves investigation through case studies or field data.
CO-4		2	Research-based investigation in planning and selecting protection and earthing.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

CO	PO	Mapping	Remark
CO-1	PO-08	1	Encourages participation in lab teamwork and report preparation.
CO-2		1	Tasks require basic collaboration in lab setting.
CO-3		1	Group-based lab experiments and analysis tasks.
CO-4		1	Coordination needed in final design projects.

PO10: Project Management: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments..

CO	PO	Mapping	Remark
CO-1	PO-10	2	Understanding of relay setting and system planning ties to project execution.
CO-2		2	Planning of layout involves time, space, and resource consideration.
CO-3		2	Realistic grounding design must consider project aspects like cost and implementation.
CO-4		2	Full substation design includes budgeting, resource planning, and management aspects.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Exposure to evolving substation standards and lifelong learning.
CO-2		2	Develops practical understanding aligned with industry norms.
CO-3		2	Encourages learning updated grounding norms.
CO-4		2	Demands keeping up with design codes and industry practices.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Closely related to substation operation.
CO-2		3	Substation design expertise.
CO-3		3	Essential to safe and stable substation operation.
CO-4		3	Closely tied to system-wide substation planning.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Involves awareness of electronic protection components.
CO-2		2	Technical arrangement and assessment of panel systems.
CO-3		2	Linked to electronic and power system interface.
CO-4		2	Incorporates protection, control, and electronic interface aspects.

(B. S. SUDAME) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Electrical Installation Design

Course Code: 22EL611

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE III: Electrical Installation Design (22EL611)

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

CO	Statement	Blooms Level
CO-1	Classify the techniques used to identify the load pattern.	L2
CO-2	Explain various types of wires, cables used in distribution systems and their tests.	L2
CO-3	Identify different types of luminaries and develop calculation skills.	L3
CO-4	Analyze various components involved in substation and their functions.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3							3	3	2
CO-4	3	3	3								3	3	2
CO-3	3	3	3	3							3	3	2
CO-4	3	3	3	3							3	3	2
Average	3.00	3.00	3.00	3.00							3.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strong use of engineering knowledge is essential to understand and apply NEC and other standards..
CO-2		3	Strong mapping due to application of theoretical, analytical, and design skills.
CO-3		3	Strong requirement of knowledge, analysis, and design of earthing systems.
CO-4		3	Requires strong analytical and investigative knowledge.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Interpreting standards involves problem analysis for compliance and safe design.
CO-2		3	Strong mapping due to application of theoretical, analytical, and design skills.
CO-3		3	Strong requirement of knowledge, analysis, and design of earthing systems.
CO-4		3	Requires strong analytical and investigative knowledge.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Standards guide the design of compliant and safe systems..
CO-2		3	Strong mapping due to application of theoretical, analytical, and design skills.
CO-3		3	Strong requirement of knowledge, analysis, and design of earthing systems.
CO-4		3	Requires strong analytical and investigative knowledge.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Involves investigative skills in understanding and evaluating standards.
CO-2		-	-
CO-3		3	Strong requirement of knowledge, analysis, and design of earthing systems.
CO-4		3	Requires strong analytical and investigative knowledge.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Strong need for continuous learning as codes and regulations are regularly updated.
CO-2		3	Strong need for lifelong learning due to evolving tools and standards.
CO-3		3	Lifelong learning needed for updates in IS codes.
CO-4		3	New substation technologies demand continuous learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Direct application to power system design and operation under regulatory standards.
CO-2		3	Key skill for analyzing and designing power distribution in buildings.
CO-3		3	Essential in safe operation and control of electrical systems.
CO-4		3	Central to power system design and performance evaluation.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Applies in designing systems compliant with national codes.
CO-2		2	Key skill for analyzing and designing power distribution in buildings.
CO-3		2	Essential in safe operation and control of electrical systems.
CO-4		2	Central to power system design and performance evaluation.

(N. T. SAHU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Electrical Installation Design Lab

Course Code: 22EL612

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Introduction to PE III: Electrical Installation Design Lab (22EL612)

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

CO	Statement	Blooms Level
CO-1	Interpret the salient features of National Electrical Code and other relevant national standards applicable for electrical installations in India.	L2
CO-2	Develop detailed wiring diagram for house building electrification.	L3
CO-3	Prepare the system and equipment earthing as per IS3043	L3
CO-4	Categorize various types of substations, their ratings and equipments used.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	2						3	3	3
CO-2	3	3	3	3	2						3	3	3
CO-3	3	3	3	3	2						3	3	3
CO-4	3	3	3	3	2						3	3	3
Average	3.00	3.00	3.00	3.00	2.00						3.00	3.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires fundamental knowledge of engineering standards and electrical design codes
CO-2		3	Involves fundamental knowledge of electrical circuits, loads, and protection devices.
CO-3		3	Requires in-depth understanding of engineering principles and standards in grounding systems.
CO-4		3	In-depth engineering knowledge is needed to classify and understand substations.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves analyzing and interpreting legal and technical literature to solve real-world electrical installation problems.
CO-2		3	Requires problem analysis to plan and allocate loads and protection appropriately.
CO-3		3	Involves analyzing system requirements and selecting appropriate earthing methods.
CO-4		3	Analysis of substation specifications aligns with complex problem analysis.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Enables development of code-compliant design solutions ensuring safety and efficiency.
CO-2		3	Strongly aligned with designing solutions (electrical layout) for safe and efficient installations.
CO-3		3	Supports development of safe electrical systems in accordance with IS 3043.
CO-4		3	Engages students in investigating real-life electrical scenarios using standard codes.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Engages students in investigating real-life electrical scenarios using standard codes.
CO-2		3	Encourages data collection (e.g., load calculation) and diagrammatic representation as a valid conclusion.
CO-3		3	Investigative tasks include testing and verification of earth resistance and layout design.
CO-4		3	Investigation includes evaluating parameters and functions of equipment.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Moderate use of tools like AutoCAD, software simulators, or code compliance checkers.
CO-2		2	Use of modern design tools like AutoCAD or EPLAN for wiring diagrams.
CO-3		2	Involves moderate use of instruments or software tools for earth fault analysis.
CO-4		2	Moderate tool usage to simulate or visualize substation layouts.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Standards evolve; requires lifelong learning to stay updated.
CO-2		3	Wiring practices evolve with new tech (smart metering, IoT), demanding continual learning.
CO-3		3	Constant updates in IS standards necessitate lifelong learning
CO-4		3	Lifelong learning is crucial to adapt to smart substations and advanced grid technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Strong link to understanding power system design implications.
CO-2		3	Closely tied to power system operation at the distribution level.
CO-3		3	Direct relevance to control and operation of grounded power systems.
CO-4		3	Directly supports understanding of power system control and operation

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Direct application to assessment and control of electrical systems per standards.
CO-2		3	Key for assessing and ensuring performance of electrical systems.
CO-3		3	Key for assessing and ensuring performance of equipment earthing systems.
CO-4		3	Key for selecting and evaluating substation electrical systems.

(N. T. SAHU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Electrical Energy Audit and Safety Analysis

Course Code: 22EL613

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE III: Electrical Energy Audit and Safety Analysis

(22EL613)

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

CO	Statement	Blooms Level
CO-1	Explain, the energy sources, methods of energy conservation and its pattern, electricity act 2003	L2
CO-2	Interpret different forms of electrical and thermal energy	L2
CO-3	Examine the Energy Management, Energy Audit, Energy Monitoring and Targeting	L3
CO-4	Estimate the performance evaluation of Electric motors and drives and testing procedure, and Electrical safety procedures.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3						3	3	3	3
CO-2	3	3	3	3						3	3	3	3
CO-3	3	3	3	3						3	3	3	3
CO-4	3	3	3	3						3	3	3	3
Average	3.00	3.00	3.00	3.00						3.00	3.00	3.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Students apply core math/science/EE fundamentals to classify energy sources, interpret consumption patterns, and understand conservation principles and tariff concepts in the Act.
CO-2		3	Applies thermodynamics and electrical fundamentals to end-use systems and conversions (kWh ↔ kcal, COP, efficiency).
CO-3		3	Uses core EE knowledge to understand facility processes, loads, and energy flows.
CO-4		3	Applies machines/drives theory to evaluate performance (loss segregation, efficiency, PF, harmonics).

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	They analyze demand profiles and conservation opportunities, drawing substantiated conclusions from standards/policies.
CO-2		3	Interprets Sankey diagrams/end-use breakdowns; evaluates where and how energy is used/lost.
CO-3		3	Analyzes baselines, KPIs (SEC, kWh/ton), and deviations; justifies audit findings with evidence.
CO-4		3	Performs analytical estimation and compares measured vs. nameplate/specified performance to reach justified conclusions.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	They translate understanding into conceptual solution ideas (e.g., choosing suitable ECMs, DSM options) with attention to safety and sustainability.
CO-2		3	Identifies appropriate conservation options (e.g., heat recovery, insulation, VFDs) as solution concepts.
CO-3		3	Develops feasible solution pathways (ECMs/EMOs), addressing safety, cost, and sustainability constraints.
CO-4		3	Formulates improvement solutions (proper sizing, VFD application, PF correction, harmonics mitigation) considering safety and reliability.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	They investigate literature/benchmark data (BEE, ECBC, utility schedules), organize findings, and infer valid conclusions.
CO-2		3	Examines measurement data/logs and literature to support interpretations with evidence.
CO-3		3	Conducts investigations: data acquisition, instrumentation, sampling plans, uncertainty considerations; interprets results to conclude.
CO-4		3	Investigates via standardized testing procedures, interprets datasets, and validates conclusions.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	3	Conservation planning ties directly to cost/tariff impacts, budgeting, and prioritization of measures—introducing practical project/economic decisions.
CO-2		3	Relates energy forms to costs (fuel substitution, tariff blocks), enabling economic decision-making.
CO-3		3	Prioritizes measures via payback/NPV/IRR; schedules implementation and resources—classic project/finance skills.
CO-4		3	Associates performance improvements with cost savings and implementation planning (retrofit scope, scheduling).

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Policies, codes, and technologies evolve (e.g., updates to efficiency standards), requiring independent, continuous learning.
CO-2		3	Requires learning current benchmarks, best practices, and evolving technologies/materials.
CO-3		3	Embeds continuous improvement (PDCA) and keeps pace with evolving audit norms, tools, and standards.
CO-4		3	Requires staying current with testing standards/protocols and emerging drive technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Conservation strategies influence power-system operation (load shapes, PF, losses), linking directly to system control/operation.
CO-2		3	Connects interpretations to system-level operations (demand management, losses).
CO-3		3	Strong alignment to operational optimization, DSM, and system control.
CO-4		3	Performance improvements directly impact system operation (demand reduction, stability of supply).

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Understanding end-use systems (lighting, motors, HVAC) connects to developing/assessing electrical and electronic solutions for efficiency.
CO-2		3	Involves instrumentation and control perspectives when assessing electrical/thermal systems.
CO-3		3	Requires knowledge of meters, loggers, BMS/SCADA interfaces, and control strategies.
CO-4		3	Deep involvement with electrical/electronic systems development, control tuning, and assessment.

(B. S. SUDAME) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Electrical Energy Audit and Safety Analysis Lab

Course Code: 22EL614

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE III: Electrical Energy Audit and Safety Analysis Lab (22EL614)

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

CO	Statement	Blooms Level
CO-1	Explain Electrical Shock, Fire Safety, and the efficiency evaluation of solar panels.	L2
CO-2	Identify the lux level and power consumption using an energy meter.	L2
CO-3	Examine phase sequence, characteristics of a synchronous generator, and types of earthing.	L3
CO-4	Measure energy consumption and analyze the measurement of harmonics.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	2					3	3	3	3
CO-2	3	3	3	3	2					3	3	3	3
CO-3	3	3	3	3	3					3	3	3	3
CO-4	3	3	3	3	2					3	3	3	3
Average	3.00	3.00	3.00	3.00	2.25					3.00	3.00	3.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Students apply fundamental electrical and physics knowledge to understand electrical shock effects, fire safety norms, and solar energy concepts.
CO-2		3	Applies basic EE concepts (power, energy, lighting) to perform relevant measurements.
CO-3		3	Requires sound engineering knowledge of electrical machines, power systems, and grounding theory.
CO-4		3	Students apply advanced electrical knowledge to understand harmonics, THD, and energy analysis.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzing safety issues and interpreting test conditions of solar panels or electric shocks requires structured analytical thought.
CO-2		3	Students interpret data from instruments (lux meter, energy meter) and assess efficiency or abnormal consumption.
CO-3		3	Students analyze measured values and system behavior to validate phase sequence, generator output, and earthing resistance.
CO-4		3	They analyze and interpret non-sinusoidal waveforms, energy usage trends, and filter responses.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Students link theoretical safety principles and efficiency standards to propose safety and operational guidelines.
CO-2		3	Enables students to suggest improvement areas (e.g., lighting layout modifications, load reduction) based on data.
CO-3		3	Promotes solution-oriented thinking: appropriate earthing selection, fault avoidance strategies, synchronization requirements.
CO-4		3	Evaluates multiple improvement solutions (e.g., filter design, load balancing) based on harmonic data.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Involves investigation of real systems (shock scenarios, fire drills, solar panel testing) to reach practical conclusions.
CO-2		3	Investigation involves instrument handling, data collection, tabulation, and analysis to reach conclusions.
CO-3		3	Investigative tasks such as megger testing, simulation/model verification, and experimental validation are key.
CO-4		3	Involves thorough investigation through energy analyzers, harmonic meters, and waveform analysis.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Moderate use of tools—e.g., multimeters, pyranometers, thermal sensors, or fire extinguishers—demonstrating equipment proficiency.
CO-2		2	Moderate-level use of measuring tools and meters—key for real-world application and audits.
CO-3		3	Hands-on engagement with test kits, sequence indicators, and generators—significant tool application.
CO-4		2	Use of power quality analyzers and data logging tools reflects moderate but essential tool application.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one’s own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	3	Ensures understanding of safety protocols in workplace/lab settings and their role in project planning and management.
CO-2		3	Measurement informs decision-making on load planning and lighting energy optimization.
CO-3		3	Ties directly to practical management of machine connections, safe operation, and audit coordination.
CO-4		3	Students link harmonics to equipment performance, cost increase, and corrective planning.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Emphasizes lifelong learning of evolving safety codes, solar technologies, and emergency protocols.
CO-2		3	Introduces standards for illumination (lux levels) and metering practices that evolve with technology.
CO-3		3	Reinforces continuous learning—machine behavior under load, new generator control techniques, and earthing updates.
CO-4		3	Constant need to update knowledge of harmonic mitigation techniques, standards (IEEE 519), and measurement instruments.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Connects to grid-side safety, protection practices, and solar integration impacts.
CO-2		3	Closely relates to power system loading, demand side audit, and operational optimization.
CO-3		3	Highly relevant for operation/control of power systems with earthing and generator integration.
CO-4		3	Strongly tied to power quality, system performance, and reliability metrics.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Involves development/assessment of electrical systems (solar panels, grounding, protection devices).
CO-2		3	Supports system-level understanding of power distribution and metering.
CO-3		3	Central to electrical system configuration and fault control measures.
CO-4		3	Supports electrical system diagnostics, protection strategies, and efficient operation.

(B. S. SUDAME) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Computer Methods in Power System

Course Code: 22EL615

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE III: Computer Methods in Power System (22EL615)

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

CO	Statement	Blooms Level
CO-1	Compute different Matrices using graph theory	L3
CO-2	Illustrate different methods for Load Flow studies	L3
CO-3	Analyze the system for different types of faults	L4
CO-4	Deduce different methods for Transient Stability Studies.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	1	2	2	1						1	3	
CO-2	3	1	2	1	1						1	3	
CO-3	3	1	2	1	1						1	3	
CO-4	3	1	1	1	1						1	3	
Average	3.00	1.00	1.75	1.25	1.00						1.00	3.00	

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires solid application of EE/math fundamentals (graph theory, linear algebra, circuit/network theory) to derive system matrices.
CO-2		3	Applies power-flow equations, complex power/current relations, Jacobians—core EE fundamentals.
CO-3		3	Uses sequence networks, Thevenin equivalents, and machine models—advanced EE fundamentals.
CO-4		3	Involves machine dynamics, system modelling, and differential equations—core EE knowledge.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	1	Limited problem analysis beyond forming matrices; deeper research/interpretation is minimal at this step.
CO-2		1	Limited literature review; emphasis is demonstration/illustration rather than deep comparative research.
CO-3		1	While conclusions are drawn, the matrix maps analysis depth at a basic level of literature use.
CO-4		1	Limited scope for extensive literature analysis within this CO’s framing.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Matrix formulation underpins later solution development (LF, SC, stability); some design/development thinking to choose efficient formulations.
CO-2		2	Method selection/tuning (tolerances, acceleration) reflects design/development considerations.
CO-3		2	Building/connecting sequence networks and selecting solution pathways shows moderate design/development of the analytical model.
CO-4		1	Design/development is minimal—focus is on deducing/applying established methods rather than designing new control schemes.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Investigation/modelling to validate matrix properties (sparsity, symmetry) and confirm correctness on test systems.
CO-2		1	Minimal investigative rigour; primarily runs standard cases to illustrate convergence.
CO-3		1	Limited experimental/validation studies; focus is computational analysis.
CO-4		1	Basic investigation via test cases; not research-heavy in the given scope.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Introductory use of computational tools (e.g., MATLAB/NumPy) to assemble matrices; tool depth limited here.
CO-2		1	Basic use of computing tools to implement/execute LF algorithms.
CO-3		1	Basic application of software to compute fault currents and bus voltages.
CO-4		1	Introductory use of numerical tools/solvers (e.g., RK methods) to simulate rotor angle dynamics.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Students are introduced to graph-theoretic matrix computation techniques that require adapting to new software tools or algorithms as power-system modelling evolves.
CO-2		1	Load flow algorithms and software are continually updated; students develop basic self-learning skills to explore new techniques beyond the syllabus.
CO-3		1	Fault analysis methods and standards are periodically revised. Students cultivate the ability to upgrade their knowledge for new protection schemes.
CO-4		1	Stability studies increasingly integrate modern control strategies and renewable energy models. Students gain awareness of the need for lifelong learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Matrix foundations are critical to power-system operation/control analyses (LF, fault, stability).
CO-2		3	Load flow is a cornerstone of power-system operation, planning, and control.
CO-3		3	Fault studies directly support system protection, operation, and control.
CO-4		3	Transient stability is central to secure power-system operation and control.

(P. S. PATIL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Computer Methods in Power System Lab

Course Code: 22EL616

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE III: Computer Methods in Power System Lab (22EL616)

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

CO	Statement	Blooms Level
CO-1	Explain the main features and importance of the MATLAB/ SCI LAB mathematical programming environment.	L2
CO-2	Interpret and visualize simple mathematical functions and operations thereon using plots/display.	L2
CO-3	Apply programing knowledge to edit compile, debug, correct, recompile and run.	L3
CO-4	Analyze, and plot simulation results using MATLAB/SCI LAB tools.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	2		2		3		1	2			1	2	
CO-2	2	1	2		3		1	2	2		1	2	
CO-3	2	1	2		3		1	2	2		1	2	
CO-4	2	1	2		3		1	2	2		1	2	
Average	2.00	1.00	2.00		3.00		1.00	2.00	2.00		1.00	2.00	

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	2	Students use fundamental electrical engineering knowledge to understand MATLAB/SCI LAB environment and its importance.
CO-2		2	Requires applying mathematics and EE fundamentals to interpret results.
CO-3		2	Requires knowledge of EE fundamentals to ensure correctness of computations.
CO-4		2	Requires applying EE fundamentals to interpret simulation results.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	-	-
CO-2		1	Students analyze and troubleshoot simple computational errors; analysis is basic.
CO-3		1	Involves basic analysis and debugging of logical errors.
CO-4		1	Students perform basic troubleshooting and validation of simulation outputs.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Students understand how these environments aid in the development of solutions for mathematical and engineering problems.
CO-2		2	Students structure code to create correct outputs and visualizations.
CO-3		2	Students design solutions by modifying programs and ensuring correct functionality.
CO-4		2	Students use results for refining and improving programs or system models.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	3	The CO focuses on learning advanced computational tools (MATLAB/SCI LAB), making this mapping at the highest level.
CO-2		3	Heavy use of MATLAB/SCI LAB plotting and display functions to visualize data.
CO-3		3	Strong tool usage focus as debugging and compilation are core lab activities.
CO-4		3	Extensive use of tools for simulation, result analysis, and plotting data.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7	1	Students are sensitized to software ethics (e.g., licensed use, avoiding plagiarism) at a basic level.
CO-2		1	Students follow software and lab ethics during simulations.
CO-3		1	Students maintain ethical coding practices (properly documenting and using code).
CO-4		1	Ethics maintained in reporting and presenting simulation results.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams

CO	PO	Mapping	Remark
CO-1	PO-8	2	Lab work promotes teamwork when exploring software environments together.
CO-2		2	Students work in teams to interpret and visualize data.
CO-3		2	Collaboration is encouraged when debugging and correcting code in lab teams.
CO-4		2	Students collaborate in interpreting and analyzing simulation outputs.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

CO	PO	Mapping	Remark
CO-1	PO-9	-	-
CO-2		2	Students add basic titles/labels/units to plots and give 1–2 line captions—only essential result communication.
CO-3		2	Students write brief code comments/change-logs and a short note of debugging outcome—minimal reporting for verification.
CO-4		2	Students submit plots with a concise observation paragraph (expected vs. obtained)—basic, confirmatory communication only.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Students gain basic awareness that MATLAB/SCI LAB tools evolve and may explore help/docs to understand features. Independent learning is introductory only.
CO-2		1	While plotting/visualizing, learners consult built-in help/examples to use simple functions—minimal self-directed learning.
CO-3		1	During edit/compile/debug, students look up error messages or basic commands to fix issues—entry-level lifelong-learning behavior.
CO-4		1	For analyzing/plotting results, students may read brief references to apply a new plotting/analysis command—scope is limited, not sustained self-study.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Students understand the MATLAB/SCI LAB environment, which provides the computational foundation for modeling and simulating power system components.
CO-2		2	Visualization of functions and operations strengthens skills to interpret power system data, useful for load flow, stability, and other analyses.
CO-3		2	Applying programming knowledge to debug and run simulations develops the ability to build accurate models for power system studies.
CO-4		2	Analyzing and plotting results helps students interpret system behavior, supporting operation and control applications.

(P. S. PATIL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Project Planning and Management

Course Code: 22EL617

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE III: Project Planning and Management (22EL617)

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

CO	Statement	Blooms Level
CO-1	Describe the methodologies involved in project planning and various project planning tools.	L2
CO-2	Analyze the project cost and the risk involved in project execution.	L4
CO-3	Survey the material handling and earth moving equipment.	L4
CO-4	Summarize the documents and formats involved in project execution and its control.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	1						2	2	1	2
CO-2	3	3	3	2						2	2	1	2
CO-3	3	3	3	2						2	2	1	2
CO-4	3	3	3	2						2	2	1	2
Average	3.00	3.00	3.00	1.75						2.00	2.00	1.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamentals of engineering economics, WBS, and scheduling logic to understand planning methodologies and tools.
CO-2		3	Uses cost engineering (time–cost trade-off, cash flow, depreciation) and risk basics to analyze projects.
CO-3		3	Applies technical knowledge to evaluate capabilities/limits of material handling & earth-moving equipment.
CO-4		3	Uses standards and procedures to comprehend technical documentation and control formats in projects.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Identifies planning problems; selects appropriate tool (Gantt/PERT/CPM) after reviewing alternatives.
CO-2		3	Formulates and analyzes project cost/risk problems; draws substantiated conclusions from data.
CO-3		3	Analyzes site conditions vs. equipment selection/throughput, safety and utilization constraints

CO-4		3	Reviews and interprets control documents (RFI logs, submittals, change orders) to ensure compliance.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Develops baseline schedules, WBS, and network diagrams tailored to project needs.
CO-2		3	Designs cost breakdown structures, risk registers, and response plans integrated with schedule/cost.
CO-3		3	Lays out equipment deployment plans (fleet mix, cycle times) aligned to productivity targets.
CO-4		3	Prepares/control formats (S-curves, progress reports, earned value sheets) for execution control.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Limited investigation—primarily literature/tool study to select planning methods.
CO-2		2	Investigates cost/risk data (sensitivities, Monte-Carlo/what-if in spreadsheets) to support decisions.
CO-3		2	Gathers/analyses equipment specs, site constraints, and productivity data to validate choices.

CO-4		2	Interprets progress/variance data from reports to conclude on corrective actions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Moderate use of tools—e.g., multimeters, pyranometers, thermal sensors, or fire extinguishers—demonstrating equipment proficiency.
CO-2		2	Moderate-level use of measuring tools and meters—key for real-world application and audits.
CO-3		3	Hands-on engagement with test kits, sequence indicators, and generators—significant tool application.
CO-4		2	Use of power quality analyzers and data logging tools reflects moderate but essential tool application.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	2	Applies PM frameworks (scope, time, cost, quality) and planning tools to organize work.
CO-2		2	Uses budgeting, cost control, cash-flow, and risk–cost impacts for decision-making.
CO-3		2	Plans equipment utilization, productivity, and resource leveling within time–cost constraints.

CO-4		2	Uses control documents (EVM metrics, progress/S-curve) for tracking and reporting.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Exposure to evolving planning tools/standards (e.g., PMBOK updates, software) fosters continuous learning.
CO-2		2	Cost/risk techniques and norms evolve; students learn to update methods and reference benchmarks.
CO-3		2	Equipment technologies/safety regulations change—necessitates ongoing upskilling.
CO-4		2	Documentation practices and digital control systems evolve, requiring adaptive learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Connects to grid-side safety, protection practices, and solar integration impacts.
CO-2		1	Cost/risk analysis supports decision-making in substation/line/plant execution.

CO-3		1	Equipment selection/logistics planning align with site execution of power projects.
CO-4		1	Control documentation aids monitoring and controlling power system project execution.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Tools and methods structure development workflows for electrical project deliverables.
CO-2		2	Financial and risk assessments inform feasibility of electrical systems deployment.
CO-3		2	Selection and utilization plans address installation/commissioning of electrical equipment.
CO-4		2	Standardized formats enable assessment and control of electrical works during execution.

(P. B. JOSHI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Project Planning and Management Lab

Course Code: 22EL618

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Introduction to PE III: Project Planning and Management (22EL618)

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

CO	Statement	Blooms Level
CO-1	Contrast the main features and importance of the MS Project environment.	L2
CO-2	Develop Bar chart, Gantt chart, Milestone chart.	L3
CO-3	Prepare Project Report of Project Planning.	L3
CO-4	Establish CPM and PERT Project Planning Tools.	L3

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	1						2	2	1	2
CO-2	3	3	3	2						2	2	1	2
CO-3	3	3	3	2						2	2	1	2
CO-4	3	3	3	2						2	2	1	2
Average	3.00	3.00	3.00	1.75						2.00	2.00	1.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Students use fundamental engineering knowledge to understand MS Project software functions, scheduling logic, and project management terminology.
CO-2		3	Developing charts (Bar, Gantt, Milestone) requires understanding timelines, dependencies, and resource allocations based on engineering project context.
CO-3		3	Project report writing applies technical understanding of project elements like scope, schedule, and resources.
CO-4		3	Creating CPM and PERT networks requires strong grasp of engineering scheduling methods and logic flow.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Students analyze scheduling and resource-related problems using MS Project environment tools.
CO-2		3	Students identify scheduling bottlenecks and resolve sequencing issues in charts.
CO-3		3	Analyze components of a project (cost, schedule, risks) to construct a valid project report.

CO-4		3	Students identify critical paths, slack, and dependencies using CPM and PERT — key tools in problem-solving project time issues.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Students design scheduling frameworks using MS Project's features to suit project needs.
CO-2		2	Charts are developed to visually represent timelines and dependencies tailored to project requirements.
CO-3		2	Students design and compile professional project documentation and structure reports.
CO-4		2	Students create well-structured project networks using CPM and PERT, designing models for time optimization.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Limited investigation; basic feature exploration of MS Project software.
CO-2		2	Analyzing time–activity relationships and resource conflicts through chart development.
CO-3		2	Investigating project data and progress to prepare comprehensive reports.
CO-4		2	Studying time dependencies and simulating scenarios using CPM/PERT models.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	2	Introduces project control concepts through MS Project; students learn basics of scheduling and resource control.
CO-2		2	Students understand how to manage and visualize project timelines for better time management.
CO-3		2	Exposure to budget and reporting formats indirectly helps in understanding finance aspects.
CO-4		2	Use of project planning tools helps understand time–cost trade-offs and project monitoring.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Students are introduced to MS Project; develop basic awareness of PM software and tools, encouraging self-learning.
CO-2		2	Students explore practical scheduling tools that evolve with industry trends—initiating lifelong learning habits.
CO-3		2	Writing project reports encourages learning structured communication formats used in industry.
CO-4		2	Students gain exposure to widely used planning tools (CPM, PERT), initiating continued professional skill development.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Using MS Project environment gives students skills to plan and schedule tasks for power system projects (like substation or line installations).
CO-2		1	Developing Gantt, Bar, and Milestone charts strengthens scheduling and sequencing skills directly applicable to power system operations and maintenance projects.
CO-3		1	Preparing project reports helps in planning resource utilization, timelines, and monitoring progress for system design and implementation.
CO-4		1	Establishing CPM and PERT networks provides the ability to identify critical paths and potential delays in power system construction or upgrade projects.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Exposure to MS Project helps students plan tasks related to development and assessment of electrical/electronic systems.
CO-2		2	Creating scheduling charts enables better coordination of design, procurement, testing, and commissioning activities for electrical systems.
CO-3		2	Project report preparation develops documentation skills essential for electrical system assessment and compliance.
CO-4		2	CPM and PERT allow students to evaluate resource constraints and timelines during development and testing of electrical/electronic projects.

(P. B. JOSHI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE IV: Advanced Power Electronics

Course Code: 22EL631

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE IV: Advanced Power Electronics (22EL631)

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

CO	Statement	Blooms Level
CO-1	Describe the performance of power semiconductor devices and to use these devices in power electronic converters.	L2
CO-2	Analyze the performance of DC/DC and DC/AC converters/Inverters and have an in-depth understanding of the methodologies for designing them.	L4
CO-3	Classify modulation schemes for the DC/AC two level and multilevel inverters.	L4
CO-4	Illustrate the knowledge of the causes, and effects of harmonics and apply suitable mitigation techniques such as passive and active power filters.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3										1	1	1
CO-2	3	2		1							1	2	1
CO-3	3	2		1							1	2	1
CO-4	3	2		1							1	2	1
Average	3.00	2.00		1.00							1.00	1.75	1.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Understanding working, characteristics of the different power semiconductor devices need strong engineering fundamental knowledge. (High contribution).
CO-2		3	Students understand the principle working of the Buck, boost, and the buck – boost DC/DC converters and NPC, FC, and CHB multilevel inverters. And the derivation of the output voltage, inductor current ripple, and output voltage ripple is carried out by strong engineering knowledge and fundamental concepts. (High contribution).
CO-3		3	Students shall learn and understand the implementation of various modulation techniques which need strong fundamentals and engineering knowledge. (High contribution).
CO-4		3	Students shall learn and understand through the strong fundamental and engineering knowledge, the causes, effects of harmonics and solutions to the mitigation of the harmonics. (High contribution).

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	-	-
CO-2		2	Number of numerical are solved to calculate the various parameters such output voltage, inductor current ripple, and output voltage ripple may require for designing the Buck, boost, and the buck – boost DC/DC converters are calculated. Various parameters are also found for the NPC, FC and CHB multilevel inverters (Moderate contribution).
CO-3		2	Performance analysis is done in terms of the calculation of the total harmonic distortion, and fundamental voltage in the square wave modulation, single pulse width modulation, sinusoidal pulse width modulation and multicarrier modulation techniques applied to the half, full bridge inverter. (Moderate contribution).
CO-4		2	Evaluating the effects of the harmonics by solving the different numerical. Design of the different (Moderate contribution).

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	-	-
CO-2		1	The interpretation is made based on the valid results obtained by calculating the different parameters in simple as well as complex numerical on DC/DC converters. (Low contribution)
CO-3		1	By interpretation, it is to find suitable modulation method of the inverter for the specific application. (Low contribution).

CO-4		1	Analysis of the different passive power filters and the active power filters is done, which may help to come to valid conclusions of the right choice of the filters. (Low contribution).

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Students must update themselves about upcoming new devices and the use of new materials in devices. This may be acquired by lifelong learning. (Low contribution).
CO-2		1	Students must update themselves about upcoming new DC/DC and DC/AC converters. This may be acquired by lifelong learning. (Low contribution).
CO-3		1	Students must update themselves about any modification or new modulation methods associated with the DC/AC inverters. This may be acquired by lifelong learning. (Low contribution).
CO-4		1	Students must update themselves about any modification in passive as well as active power filters. This may be acquired by lifelong learning. (Low contribution).

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Identifying the suitable power semiconductor device may help in proper electric power system design. (Low contribution)
CO-2		1	The analysis and performance evaluation are carried out after evaluating the various parameters associated with the buck, boost, and the buck – boost DC/DC converters and different multilevel inverters. (Moderate contribution)

CO-3		1	The analysis and performance evaluation are carried out after evaluating the various parameters associated with the square wave modulation, single pulse width modulation, sinusoidal pulse width modulation and multicarrier modulation techniques applied to the half, full bridge inverter (Moderate contribution)
CO-4		1	Evaluating the various parameters associated with passive power filters and hence aligns with the power system operation (Moderate contribution)

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Students should understand the functioning of the semiconductor devices which may help in developing the electrical or electrical and electronics system. (Low contribution)
CO-2		2	The continuous and discontinuous mode of the operation of different DC/DC converters is analyzed which may be part of the developing suitable DC/DC converter for the specific applications. (Low contribution)
CO-3		2	Different modulations methods are the fundamental part of any control of the inverter used in electrical or electronics applications. (Low contribution)
CO-4		2	Understanding and the analysis of passive and the active power filters help to develop the system of eliminating or mitigating the harmonics in the power system. (Low contribution)

(Dr. P. M. MESHRAM) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE IV: Advanced Electrical drives

Course Code: 22EL632

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE IV: Advanced Electrical Drives (22EL632)

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

CO	Statement	Blooms Level
CO-1	Explain the dynamics, control schemes, four-quadrant operation of electric drives and energy conservation.	L2
CO-2	Analyze controlled rectifier-fed and chopper-controlled D.C. drives and battery-powered drives.	L4
CO-3	Classify the control for asynchronous and synchronous motors, stepper motor.	L4
CO-4	Evaluate semiconductor-controlled DC and AC traction systems.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	2	1	2					2	2	3
CO-2	3	3	3	3	2	2					2	2	3
CO-3	3	3	3	3	3	2					2	2	3
CO-4	3	3	3	3	2	3					3	2	3
Average	3.00	3.00	2.75	2.75	2.00	2.25					2.25	2.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Involves understanding dynamics, energy conservation, and motor-drive principles.
CO-2		3	Applies power electronics and control principles for DC drives and battery systems.
CO-3		3	Builds on machine theory and converter technology for motor control.
CO-4		3	Requires knowledge of semiconductors and electrical systems for traction applications.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves identifying control-related issues in energy-efficient drive operations.
CO-2		3	Encourages analysis of converter-driven drive performance.
CO-3		3	Requires evaluation of motor control types under different industrial needs.
CO-4		3	Includes performance analysis and comparison of traction systems.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Helps design energy-saving schemes using four-quadrant control.
CO-2		3	Involves developing converter configurations for specific applications.
CO-3		3	Enables selection/design of control strategies for multiple motor types.
CO-4		3	Assists in evaluating and recommending suitable control for traction systems.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Includes basic investigation into system performance and energy usage.
CO-2		3	Students explore relationships between converter type and drive behavior.
CO-3		3	Involves simulation and analysis of motor responses to control variations.
CO-4		3	Evaluation of traction systems through analysis and testing.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Involves basic use of semiconductor devices and drive control interfaces.
CO-2		2	Requires simulation and analysis of chopper and rectifier-based drives.
CO-3		3	Relies on software tools for motor control simulations.
CO-4		2	Engages in the practical application of advanced tools for AC/DC traction systems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Reflects the importance of energy-efficient designs.
CO-2		2	Focuses on reducing energy consumption and promoting sustainable transport.
CO-3		2	Applications in automation and environmentally responsible systems.
CO-4		3	Emphasizes clean, sustainable traction technologies for society.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Encourages awareness of energy conservation advancements.
CO-2		2	Promotes continuous learning in battery and drive technology.
CO-3		2	Motivates learning of evolving motor control schemes.
CO-4		3	Develops an understanding of emerging semiconductor traction technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Focus on drive integration and control within power systems.
CO-2		2	Applies to drive systems as a part of broader power system control.
CO-3		2	Enhances ability to configure motor control in power grids.
CO-4		2	Strongly linked to control of electric traction in distributed systems.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Control schemes are designed using electronics and evaluated for performance.
CO-2		3	Relates to analyzing drive electronics like choppers and converters.
CO-3		3	Students assess control logic and system effectiveness.
CO-4		3	Emphasizes development and testing of AC/DC drive systems using semiconductors.

(Dr. S. G. KADWANE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE IV: Grid Integration in Renewable Energy Systems

Course Code: 22EL633

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE IV: Grid Integration in Renewable Energy Systems

(22EL633)

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

CO	Statement	Blooms Level
CO-1	Explain the need of integrating large renewable energy sources in the existing power system.	L2
CO-2	Identify components required for grid connected Solar and Wind Energy Conversion System.	L2
CO-3	Select appropriate renewable energy policies for solar PV installation.	L4
CO-4	Analyze the impacts of renewable energy integration on grid and environment.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	1	1					3	3	2
CO-2	3	3	3	3	1	1					3	3	2
CO-3	3	3	3	3	1	1					3	3	2
CO-4	3	3	3	3	1	2					3	3	2
Average	3.00	3.00	3.00	3.00	1.00	1.25					3.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamental knowledge of power systems and renewable energy integration
CO-2		3	Involves application of engineering knowledge to identify RE system components
CO-3		3	Knowledge of policies and regulations requires engineering fundamentals
CO-4		3	Requires advanced understanding of energy systems and integration

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Requires analysis of integrating renewables into complex power systems with sustainability in mind.
CO-2		3	Analyzing components for compatibility with grid systems.
CO-3		3	Policy selection and comparison require research and analysis.
CO-4		3	Analysis of grid and environmental impacts involves complex evaluation.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Understanding integration enables conceptual design of improved systems
CO-2		3	Component selection supports system design for integration
CO-3		3	Policy understanding influences design decisions for PV projects
CO-4		3	Proposes sustainable solutions based on impact analysis

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Involves analyzing real-world problems using data and research
CO-2		3	Analysis of performance and suitability involves data interpretation
CO-3		3	Analyzing policy impact uses data and logical reasoning.
CO-4		3	Utilizes modeling and data interpretation for impact studies

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Basic exposure to engineering tools for modeling or evaluating systems
CO-2		1	Minimal use of modern tools or simulation.
CO-3		1	Indirect relevance; may involve software for policy analysis.
CO-4		1	Basic level use of tools for evaluating integration impacts.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Involves awareness of environmental and societal impacts of large-scale RE integration
CO-2		1	Environmental considerations in selecting RE components.
CO-3		1	Covers socio-environmental and legal aspects of RE policy
CO-4		2	Strong focus on sustainability, health, and environmental consequences

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Promotes lifelong learning and adaptability to future energy system changes.
CO-2		3	Continuous learning required for new component technologies.
CO-3		3	Promotes updating knowledge in changing regulatory landscape.
CO-4		3	Prepares for emerging trends and future learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Directly relevant to identifying and analyzing power system challenges..
CO-2		3	Strong link to power system operation and equipment analysis.
CO-3		3	Important for understanding grid operation within policy framework.
CO-4		3	Highly relevant to evaluating operational impact of renewables on the grid.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Addresses understanding and assessment of electronic systems in integration.
CO-2		2	Involves understanding electronic integration in RE systems.
CO-3		2	Affects design and evaluation of control/electronic systems in compliance.
CO-4		2	Involves impact assessment of electronic control systems in integration.

(S. B. REWATKAR) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: OEI: Renewable Energy Generation System

Course Code: 22EL651

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of OEI: Renewable Energy Generation System (22EL651)

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

CO	Statement	Blooms Level
CO-1	Discuss types of renewable energy sources, outline as per Global and Indian context	L2
CO-2	Describe various applications of Solar energy sources and describe types of wind turbine generator systems.	L2
CO-3	Explain geothermal and biomass energy resources.	L3
CO-4	Summarize energy from ocean, tide, wave and hydro for power generation, storage methods for renewable energy sources.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	1		3					1	2	1
CO-2	3	3	3	1		3					1	2	1
CO-3	3	3	3	1		3					1	2	1
CO-4	3	3	3	1		3					1	2	1
Average	3.00	3.00	3.00	1.00		3.00					1.00	2.00	1.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies core engineering knowledge to classify and describe renewable energy types.
CO-2		3	Uses solar and wind system theory to explain energy generation.
CO-3		3	Applies fundamental principles to geothermal and biomass systems.
CO-4		3	Utilizes engineering knowledge to understand ocean, hydro, and storage systems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes resource potential and deployment in global and Indian contexts.
CO-2		3	Evaluates energy output based on site-specific solar and wind data.
CO-3		3	Identifies performance challenges in biomass and geothermal systems.
CO-4		3	Compares technical feasibility of energy storage and ocean-based energy.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Selects suitable renewable options based on application and location.
CO-2		3	Demonstrates system selection and basic layout of RE systems.
CO-3		3	Estimates output and selects biomass/geothermal options.
CO-4		3	Proposes integrated RE and storage options conceptually.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Interprets RE policy data and implementation status.
CO-2		1	Uses basic performance data for solar/wind yield analysis.
CO-3		1	Assesses feasibility through performance curves and fuel data.
CO-4		1	Investigates suitability of ocean and hydro storage through real-world data.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	3	Promotes societal energy solutions via clean RE adoption.
CO-2		3	Highlights benefits of solar/wind in reducing emissions.
CO-3		3	Shows how biomass/geothermal contribute to sustainability.
CO-4		3	Connects storage solutions to societal energy access needs.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Encourages awareness of RE policies and global updates.
CO-2		1	Promotes continuous learning in evolving RE tech.
CO-3		1	Updates understanding of biomass/geothermal tech.
CO-4		1	Motivates learning in storage innovation (hydrogen, batteries).

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Understands RE source contribution to the power system.
CO-2		2	Estimates RE generation and grid impact.
CO-3		2	Evaluates integration potential in distribution systems.
CO-4		2	Relates storage with RE for grid support and load balancing.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	Covers evaluation of RE technologies.
CO-2		1	Involves performance assessment of PV and wind systems.
CO-3		1	Evaluates viability of biomass/geothermal systems.
CO-4		1	Assesses storage system roles in power generation.

(S.P. ADHAU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: OE III: Solar Power Plant Design and Installation

Course Code: 22EL653

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of OE III: Solar Power Plant Design and Installation (22EL653)

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

CO	Statement	Blooms Level
CO-1	**Classify** different types of solar power plant and system sizing based on load profiles	**L2**
CO-2	**Compare** different types of solar PV panels and inverters for solar power plant.	**L2**
CO-3	**Select** AC and DC cable, earthing and lightening arrestors.	**L3**
CO-4	**Utilize** government policies for solar power plant installation and **select** proper operation and maintenance procedures for a solar power plant.	**L3**

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	2	2					3	1	3
CO-2	3	3	3	3	2	2					3	1	3
CO-3	3	3	3	3	2	2					3	1	3
CO-4	3	3	3	3	2	2					3	1	3
Average	3.00	3.00	3.00	3.00	2.00	2.00					3.00	1.00	3.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamental knowledge to classify solar plant types and estimate load-based sizing.
CO-2		3	Uses basic electrical and materials engineering to compare PV panels and inverters.
CO-3		3	Applies core electrical knowledge in cable, earthing, and protection device selection.
CO-4		3	Applies electrical and policy-related engineering knowledge to system operation and maintenance.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes load profile requirements to select system configuration.
CO-2		3	Compares performance and suitability of various solar PV technologies.
CO-3		3	Identifies cable sizing and safety components based on system parameters.
CO-4		3	Analyzes operation and maintenance strategies based on system design.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Designs suitable solar system types as per user loads.
CO-2		3	Supports design decisions regarding inverter and module selection.
CO-3		3	Selects safety and protection components as per electrical codes.
CO-4		3	Selects appropriate maintenance procedures and policy-based design practices.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Investigates sizing parameters and constraints for solar plants.
CO-2		3	Evaluates inverter-module performance data.
CO-3		3	Assesses current carrying capacity and fault tolerance in cables and protection.
CO-4		3	Investigates government schemes and maintenance logs for performance optimization.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	May involve use of software tools for sizing and layout.
CO-2		2	Uses selection tools and datasheet comparisons for inverter/panel evaluation.
CO-3		2	Applies standards and tools for cable sizing and safety component configuration.
CO-4		2	Uses maintenance planning tools or documentation standards.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Promotes societal sustainability through clean solar energy systems.
CO-2		2	Encourages use of eco-friendly PV technologies and system components.
CO-3		2	Addresses electrical safety, improving public and system safety.
CO-4		2	Informs about policy benefits and promotes solar deployment in society.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Encourages continuous learning in solar technologies and grid integration.
CO-2		3	Promotes keeping updated with the latest PV/inverter models and standards.
CO-3		3	Encourages lifelong learning in electrical standards and protection systems.
CO-4		3	Engages with current government policies and emerging O&M practices.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Supports system planning and control related to solar integration.
CO-2		1	Helps assess PV system characteristics relevant to distribution networks.
CO-3		1	Provides understanding of cabling and protection within the power system.
CO-4		1	Relates to operational performance and compliance in solar installations.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Enables evaluation and development of solar power system configurations.
CO-2		3	Assists in technology selection for efficient system design.
CO-3		3	Supports component-level assessment for system safety.
CO-4		3	Enables assessment of policy-compliant and maintainable solar systems.

(S.D. PATIL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: OE IV: Electrical Energy Audit and Safety

Course Code: 22EL671

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of OE IV: Electrical Energy Audit and Safety (22EL671)

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

CO	Statement	Blooms Level
CO-1	Classify the consumption pattern, conservation of electrical energy and Electricity Act 2001.	L2
CO-2	Demonstrate different forms of energy to optimize the use for maximizing the efficiency of system.	L2
CO-3	Examine the proper utilization of energy by energy management and audit.	L4
CO-4	Analyze the various Global Environmental Concerns and Electrical safety procedures.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	2	2					3	1	3
CO-2	3	3	3	3	2	2					3	1	3
CO-3	3	3	3	3	2	2					3	1	3
CO-4	3	3	3	3	2	3					3	1	3
Average	3.00	3.00	3.00	3.00	2.00	2.25					3.00	1.00	3.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies foundational electrical engineering knowledge to understand consumption patterns and policies.
CO-2		3	Uses engineering principles to identify energy optimization methods.
CO-3		3	Applies core engineering knowledge for conducting audits and improving energy efficiency.
CO-4		3	Applies technical knowledge to evaluate safety standards and environmental concerns.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes energy usage data and conservation practices.
CO-2		3	Evaluates forms of energy and system efficiency improvements.
CO-3		3	Identifies issues in energy usage and proposes audit-based solutions.
CO-4		3	Analyzes hazards and formulates preventive electrical safety measures.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Supports designing energy conservation solutions based on policy and usage.
CO-2		3	Helps develop energy-optimized systems for real-life scenarios.
CO-3		3	Assists in designing audit-based energy management strategies.
CO-4		3	Encourages designing safety solutions and environmental mitigation strategies.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Investigates electricity consumption trends and legal frameworks.
CO-2		3	Explores optimization techniques to reduce losses and improve efficiency.
CO-3		3	Involves detailed investigation during energy audits.
CO-4		3	Analyzes complex safety systems and environmental impacts.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Uses basic tools for energy data collection, safety analysis, and reporting.
CO-2		2	Uses basic tools for energy data collection, safety analysis, and reporting.
CO-3		2	Uses basic tools for energy data collection, safety analysis, and reporting.
CO-4		2	Uses basic tools for energy data collection, safety analysis, and reporting.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Addresses societal impact through efficient energy use.
CO-2		2	Addresses societal impact through efficient energy use.
CO-3		2	Addresses societal impact through efficient energy use.
CO-4		3	Focuses on safety protocols and environmental responsibility.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Promotes lifelong learning in energy laws, conservation, and safety standards.
CO-2		3	Promotes lifelong learning in energy laws, conservation, and safety standards.
CO-3		3	Promotes lifelong learning in energy laws, conservation, and safety standards.
CO-4		3	Promotes lifelong learning in energy laws, conservation, and safety standards.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Supports understanding of system performance from an energy audit and safety viewpoint.
CO-2		1	Supports understanding of system performance from an energy audit and safety viewpoint.
CO-3		1	Supports understanding of system performance from an energy audit and safety viewpoint.
CO-4		1	Supports understanding of system performance from an energy audit and safety viewpoint.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Enables assessment and development of safe and energy-efficient electrical systems.
CO-2		3	Enables assessment and development of safe and energy-efficient electrical systems.
CO-3		3	Enables assessment and development of safe and energy-efficient electrical systems.
CO-4		3	Enables assessment and development of safe and energy-efficient electrical systems.

(S.L. TIWARI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: OE IV: Power System Engineering

Course Code: 22EL673

Semester: Fifth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of OE II: Power System Engineering (22EL673)

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

CO	Statement	Blooms Level
CO-1	**Articulate** types of load and power system components and its behaviour.	**L3**
CO-2	**Develop** and **examine** the transmission lines to improve the parameters and safety of the power system.	**L3**
CO-3	**Compare** A.C and D.C distribution networks performance.	**L4**
CO-4	**Select** proper switchgear and protection system and analysis for distribution network.	**L4**

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	2	1			1					1	2	1
CO-2	3	2	1	1	1	1					1	2	1
CO-3	3	2	1	1	1	1					1	2	1
CO-4	3	2	1			1					1	2	1
Average	3.00	2.00	1.00	1.00	1.00	1.00					1.00	2.00	1.00

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies foundational electrical engineering knowledge to understand various types of loads and components in a power system.
CO-2		3	Uses engineering concepts to develop and analyze transmission lines for improved performance and safety.
CO-3		3	Applies theoretical understanding to compare A.C and D.C distribution networks.
CO-4		3	Demonstrates technical knowledge in selecting appropriate switchgear and protective systems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Analyzes the behavior of load and components under different conditions.
CO-2		2	Evaluates transmission systems to enhance system efficiency and safety.
CO-3		2	Analyzes performance of various distribution networks under operational constraints.
CO-4		2	Assesses distribution networks and fault scenarios for protection design.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Introduces component identification and sizing as a step toward power system design.
CO-2		1	Involves basic design elements in transmission line performance enhancement.
CO-3		1	Compares configurations to aid in optimal distribution system design.
CO-4		1	Assists in selecting protection systems as part of basic network design.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4		
CO-2		1	Analyzes transmission systems with multiple parameters for efficiency.
CO-3		1	Investigates comparative performance of AC/DC systems under practical constraints.
CO-4			

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5		
CO-2		1	May involve basic simulation tools for line performance or fault analysis.
CO-3		1	Introduces tools/software to study system behavior under various loadings.
CO-4			

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Awareness of societal impact of load growth and system efficiency.
CO-2		1	Considers societal impact of improved transmission reliability and safety.
CO-3		1	Considers implications of power distribution methods on end-users.
CO-4		1	Ensures protection systems safeguard human and societal infrastructure.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Encourages continuous learning of evolving load types and system behaviors in modern power systems.
CO-2		1	Motivates learners to keep up with advances in transmission technologies and safety practices.
CO-3		1	Inspires learners to compare and evaluate distribution networks as technologies evolve.
CO-4		1	Promotes awareness of new switchgear, protection techniques, and distribution advancements requiring ongoing learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Discusses load behavior and system component roles in operations.
CO-2		2	Engages in design/evaluation of transmission systems.
CO-3		2	Evaluates performance characteristics relevant to power system control.
CO-4		2	Focuses on protection—essential for system stability and control.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	Introduces system understanding, a base for system assessment.
CO-2		1	Studies transmission lines for performance improvements.
CO-3		1	Applies distribution evaluation as part of system development.
CO-4		1	Involves assessment of protection mechanisms in electrical systems.

(S.P. ADHAU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Switchgear and Protection

Course Code: EL2401

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Switchgear and Protection (EL2401)

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

CO	Statement	Blooms Level
CO-1	Explain the various basic principles of the protection system.	L3
CO-2	Illustrate overcurrent and distance protection schemes.	L4
CO-3	Classify different types of circuit breakers.	L4
CO-4	Select various protection schemes used for Electrical Equipment.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	1	1			1					1	3	1
CO-2	3	3	3	3		2					1	3	2
CO-3	3	3	3	1		2					1	3	2
CO-4	3	3	2	3		1					1	3	2
Average	3.00	2.50	2.25	2.33		1.50					1.00	3.00	1.75

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Understanding protection system principles requires strong foundational knowledge.
CO-2		3	Overcurrent/distance protection concepts are based on core electrical engineering.
CO-3		3	Circuit breaker classification relies on engineering fundamentals.
CO-4		3	Scheme selection for equipment protection needs solid electrical understanding.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	1	Basic identification of protective principles.
CO-2		3	Analyzing fault scenarios to choose protection schemes.
CO-3		3	Determining appropriate breakers involves analysis of fault conditions.
CO-4		3	Selecting equipment-specific protection needs analytical thinking.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Limited involvement in design from a theoretical perspective.
CO-2		3	Designing protection schemes based on system configuration.
CO-3		3	Design considerations in choosing breakers.
CO-4		2	Scheme selection implies partial design-based thinking.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	-	-
CO-2		3	Investigation of protection performance under different faults.
CO-3		1	Basic investigative role during breaker selection.
CO-4		3	Investigating scheme suitability for equipment protection.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	System protection ensures human and asset safety.
CO-2		2	Critical systems like relays impact public safety.
CO-3		2	Breakers protect infrastructure and personnel.
CO-4		1	Equipment-specific protection supports reliability and safety.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Basic relevance in cost-effective scheme selection.
CO-2		1	Basic relevance in cost-effective scheme selection.
CO-3		1	Basic relevance in cost-effective scheme selection.
CO-4		1	Basic relevance in cost-effective scheme selection.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark

CO-1	PSO-1	3	Strong alignment with PSO1 as all COs are related to protection systems.
CO-2		3	Strong alignment with PSO1 as all COs are related to protection systems.
CO-3		3	Strong alignment with PSO1 as all COs are related to protection systems.
CO-4		3	Strong alignment with PSO1 as all COs are related to protection systems.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	1	Introductory connection.
CO-2		2	Applicable to system design aspects of protection schemes.
CO-3		2	Applicable to system design aspects of protection schemes.
CO-4		2	Applicable to system design aspects of protection schemes.

(P. S. PATIL) (Dr. S. P.GAWANDE)

Course Coordinator HOD

Course Name: Switchgear and Protection Lab

Course Code: EL2402

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Switchgear and Protection (EL2402)

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

CO	Statement	Blooms Level
CO-1	Experiment on electromechanical overcurrent relay.	L3
CO-2	Classify various distance protection scheme and draw its opearing characteristics.	L4
CO-3	Evaluate protection scheme for transformer.	L4
CO-4	Illustrate the performance of digital protection relays.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	1	2	1	2	1	2					2	2	2
CO-2	3	2	1	2	1	2					2	2	2
CO-3	2	2	1	2	2	2					2	2	2
CO-4	3	2	1	2	2	2					2	2	2
Average	2.25	2.00	1.00	2.00	1.50	2.00					2.00	2.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	1	Understanding the working of relays requires foundational electrical concepts.
CO-2		3	Strong theoretical grounding is needed to comprehend and apply distance protection.
CO-3		2	Transformer protection builds on prior engineering knowledge.
CO-4		3	Analyzing digital relays involves advanced theoretical understanding.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	2	Fault scenario analysis, coordination, and selecting schemes involve problem-solving.
CO-2		2	Fault scenario analysis, coordination, and selecting schemes involve problem-solving.
CO-3		2	Fault scenario analysis, coordination, and selecting schemes involve problem-solving.
CO-4		2	Fault scenario analysis, coordination, and selecting schemes involve problem-solving.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	1	Minor design element in choosing proper test setups or drawing relay characteristics.
CO-2		1	Minor design element in choosing proper test setups or drawing relay characteristics.
CO-3		1	Minor design element in choosing proper test setups or drawing relay characteristics.
CO-4		1	Minor design element in choosing proper test setups or drawing relay characteristics.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Each CO involves experimental analysis and observation to reach conclusions.
CO-2		2	Each CO involves experimental analysis and observation to reach conclusions.
CO-3		2	Each CO involves experimental analysis and observation to reach conclusions.
CO-4		2	Each CO involves experimental analysis and observation to reach conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Use of relay test kits and simulation tools at a basic level.
CO-2		1	Use of relay test kits and simulation tools at a basic level.
CO-3		2	Involves advanced equipment and digital relay software tools.
CO-4		2	Involves advanced equipment and digital relay software tools.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Protection schemes impact public safety and grid reliability.
CO-2		2	Protection schemes impact public safety and grid reliability.
CO-3		2	Protection schemes impact public safety and grid reliability.
CO-4		2	Protection schemes impact public safety and grid reliability.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark

CO-1	PO-11	2	Equipment selection and lab execution involve project planning and management elements.
CO-2		2	Equipment selection and lab execution involve project planning and management elements.
CO-3		2	Equipment selection and lab execution involve project planning and management elements.
CO-4		2	Equipment selection and lab execution involve project planning and management elements.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Strong connection to PSO1 as all COs are directly aligned with protection systems.
CO-2		2	Strong connection to PSO1 as all COs are directly aligned with protection systems.
CO-3		2	Strong connection to PSO1 as all COs are directly aligned with protection systems.
CO-4		2	Strong connection to PSO1 as all COs are directly aligned with protection systems.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Relays and schemes contribute to the design and evaluation of protective electrical systems.

CO-2		2	Relays and schemes contribute to the design and evaluation of protective electrical systems.
CO-3		2	Relays and schemes contribute to the design and evaluation of protective electrical systems.
CO-4		2	Relays and schemes contribute to the design and evaluation of protective electrical systems.

(P. S. PATIL) (Dr. S. P.GAWANDE)

Course Coordinator HOD

Course Name: High Voltage Engineering

Course Code: EL2403

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of High Voltage Engineering (EL2403)

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

CO	Statement	Blooms Level
CO-1	Explain various breakdown mechanism and over voltages.	L3
CO-2	Illustrate propagation of travelling waves along with insulation coordination.	L4
CO-3	Analyze generation and measurement of high voltage and current.	L4
CO-4	Evaluate Non-destructive and high voltage testing of electrical apparatus.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	2	2	1					2	3	2
CO-2	3	3	2	2	2	1					2	3	2
CO-3	3	3	3	2	2	2					2	3	2
CO-4	3	3	3	2	3	2					2	3	2
Average	3.00	3.00	2.50	2.00	2.25	1.50					2.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Understanding breakdown mechanisms and over voltages requires strong engineering fundamentals.
CO-2		3	Understanding wave propagation requires fundamental EE knowledge.
CO-3		3	Requires fundamental understanding of voltage generation and measurement systems.
CO-4		3	Strong theoretical base needed for evaluating test methods.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Formulating explanations of over voltages and breakdown types demands problem analysis.
CO-2		3	Identification and analysis of travelling waves rely on analytical skills.
CO-3		3	Involves analysis and troubleshooting of measurement systems.
CO-4		3	Requires in-depth problem analysis of HV testing scenarios.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Moderate use of design thinking in interpreting insulation behaviour under high voltage.
CO-2		2	Limited design aspect, mainly selection of coordination levels.
CO-3		3	Design of HV generation circuits and test arrangements.
CO-4		3	Involves developing test plans and interpreting outcomes.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	CO1 indirectly involves investigation through understanding different breakdown tests.
CO-2		2	Basic investigation skills to understand waveforms and surge propagation.
CO-3		2	Analysis of experimental results requires investigative thinking.
CO-4		2	Involves analytical thinking during interpretation of non-destructive tests.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark

CO-1	PO-5	2	Application of modern tools may be required in analysing overvoltage protection schemes.
CO-2		2	Utilizes simulation tools or software to analyse wave behaviours.
CO-3		2	Uses specialized tools (e.g., CROs, sphere gaps) for testing.
CO-4		3	Uses high-end testing tools and software in HV diagnostics.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Awareness of societal safety is slightly touched through overvoltage consequences.
CO-2		1	Indirect consideration of societal impact through system safety.
CO-3		2	Measurement and safety procedures align with societal considerations.
CO-4		2	Addresses societal safety by ensuring equipment reliability.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Application of standard practices during analysis of high voltage breakdown.
CO-2		2	Follows standards in surge protection and insulation coordination.
CO-3		2	Involves application of national/international standards in HV labs.
CO-4		2	Involves standard procedures and regulatory practices.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Strong application of program-specific knowledge in power systems and insulation.
CO-2		3	Deeply related to power system protection – program-specific skill.
CO-3		3	Aligned with core domain expertise in HV equipment and testing.
CO-4		3	Strongly aligned with electrical apparatus testing, a key program skill.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Able to relate the concepts of breakdown and over voltages with practical power applications.
CO-2		2	Applicable in practical scenarios of surge handling in power systems.
CO-3		2	Applied in industrial setups involving HV testing and measurement
CO-4		2	Practical exposure to non-destructive techniques in power systems.

(T. D. TEMBHEKAR, B. S. SUDAME) (Dr. S. P.GAWANDE)

Course Coordinator HOD

Course Name: High Voltage Engineering Lab

Course Code: EL2404

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of High Voltage Engineering Lab (EL2404)

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

CO	Statement	Blooms Level
CO-1	Explain High voltage equipment and its rating in laboratory.	L2
CO-2	Test for breakdown voltage, resistivity, dielectric constant and tan delta of Transformer oil.	L4
CO-3	Measure breakdown voltage of dielectric medium.	L5
CO-4	Evaluate high voltage AC, DC or Impulse Voltage.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	1	1					2	3	2
CO-2	3	3	3	3	3	1					2	3	2
CO-3	3	3	3	3	3	2					2	3	2
CO-4	3	3	3	3	3	1					2	3	2
Average	3.00	3.00	3.00	3.00	2.50	1.25					2.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strong foundational knowledge is needed to understand the rating and function of HV equipment.
CO-2		3	Requires deep theoretical knowledge of dielectric properties and material behavior.
CO-3		3	Understanding the behavior of various dielectric materials is foundational.
CO-4		3	In-depth theoretical knowledge needed to differentiate between AC, DC, and impulse voltages.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves identifying and understanding various high-voltage components analytically.
CO-2		3	Involves analysis and interpretation of test results like tan delta and resistivity.
CO-3		3	Analysis of dielectric breakdown involves critical problem analysis.
CO-4		3	Measurement of complex waveforms requires strong analytical skills.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Requires basic design understanding and system-level application in lab scenarios.
CO-2		3	Lab work involves designing test setups and measurement systems.
CO-3		3	Requires application of experimental design principles in test setups.
CO-4		3	Design and configuration of impulse generator circuits used in labs.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Involves conducting laboratory investigation of equipment characteristics.
CO-2		3	In-depth experimental investigation of oil breakdown and dielectric performance.
CO-3		3	Accurate measurement and observation skills used in lab investigation.
CO-4		3	Experimental measurement and waveform capture demand investigative approach.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Minor use of tools/instruments (e.g., meters, probes) during demonstrations.
CO-2		3	Significant use of lab tools and modern testing kits.
CO-3		3	Uses modern diagnostic tools like BDV testers and HV probes.
CO-4		3	Use of specialized HV tools, e.g., impulse generators, CROs, dividers.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Slight link to societal safety via equipment handling protocols.
CO-2		1	Slight impact via safety in handling HV oils and testing procedures.
CO-3		2	Handling HV breakdown experiments safely is crucial for societal concern.
CO-4		1	Emphasizes lab safety in HV impulse experiments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Aligns with technical standards in identifying and documenting equipment ratings.
CO-2		2	Must comply with IS/IEC standards for dielectric testing.
CO-3		2	Requires following recognized testing standards.

CO-4		2	Measurements must align with international standards.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Strong correlation to core high-voltage apparatus operation in the power sector.
CO-2		3	Direct link to power system component testing and evaluation.
CO-3		3	Builds core competency in dielectric testing in power equipment.
CO-4		3	Strengthens domain expertise in HV AC, DC, and impulse measurement.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Practical skill in using and recognizing equipment for real-world electrical labs.
CO-2		2	Skill applicable in transformer maintenance and utility testing labs.
CO-3		2	Useful in-service industries testing insulators, cables, etc.
CO-4		2	Practical relevance to testing of equipment like surge arresters and insulators.

(T. D. TEMBHEKAR, B. S. SUDAME)	(Dr. S. P.GAWANDE)
Course Coordinator	HOD

Course Name: PE II: Fundamentals of Power Quality

Course Code: EL2411

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE II : Fundamentals of Power Quality (EL2411)

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

CO	Statement	Blooms Level
CO-1	Classify different various power quality problems and identify their causes, effects, and solutions.	L2
CO-2	Evaluate the voltage sag in power system with different conditions such as LG, LLG, and LLLG faults	L4
CO-3	Explain the fundamentals of harmonics and choose suitable passive and active power filter for harmonics mitigation.	L4
CO-4	Illustrate the need, and use of custom power and network configuring devices to address the power quality issues.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3						1	1	1		2	2	2
CO-2	3	2					1	1	1		2	2	2
CO-3	3	2					1	1	1		2	2	2
CO-4	3	2					1	1	1		2	2	2
Average	3.00	2.00					1.00	1.00	1.00		2.00	2.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	This course outcome involves knowing the various power quality issues, their causes, effects and the solutions. Hence mapped with PO-1 with high level, i.e., 3.
CO-2		3	This course outcome involves the evaluation of the voltage sag in the power system for different faults such as LG, LL, LLG and LLLG faults. Comprehensive knowledge of power systems may be used. Attainment will be done completely through problems Hence mapped with PO-1 with high level, i.e., 3.
CO-3		3	This course outcome involves the electric quantities under non-sinusoidal situations. Harmonics mitigation techniques specially focus on passive and active power filters. Strong understanding of the fundamentals and the ability to solve the numerical will be required. Hence mapped with PO-1 with high level, i.e., 3.
CO-4		3	This course outcome involves the need and the use of the custom power and network reconfiguring devices. Students will learn working and some basic problems of exchanging active and reactive power by devices to the power systems. Strong engineering knowledge is required. Hence mapped with PO-1 with high level, i.e., 3.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	-	-
CO-2		2	Through the material presented in this course, students will learn to identify, formulate and analyze problems in voltage sag, harmonic mitigation, and custom power devices . It will inculcate habit of logical thinking and will improve their numerical ability. These two important qualities will make the students more successful in the field of engineering research. Hence all CO’s are mapped with PO-2 with moderate level, i.e., 2.
CO-3		2	
CO-4		2	

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7	1	As a part of professional ethics and responsibilities, it is mandatory for all the students to maintain academic honesty. They will not involve in any unfair means, ragging etc. The attainment is carried out indirectly through course completion report. Hence all CO’s are mapped with PO-7 with low level, i.e., 1.
CO-2		1	
CO-3		1	
CO-4		1	

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

CO	PO	Mapping	Remark
CO-1	PO-08	1	During TA activity, group level assignment will be allotted to students. Student will learn to work individually and also as a member/group leader of the group. They will understand the importance of collaborative work. Hence all CO’s are mapped with PO-8 with low level, i.e., 1.
CO-2		1	
CO-3		1	
CO-4		1	

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

CO	PO	Mapping	Remark
CO-1	PO-09	1	Student will learn communication skills both in oral and written form, through class room discussions, presentations during TA activity. They are expected to submit course work in a more systematic way. Hence all CO's are mapped with PO-9 with low level, i.e., 1.
CO-2		1	
CO-3		1	
CO-4		1	

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	"The education of a man is never completed until he dies." Being one of the interesting courses of Electrical engineering, the students will be motivated for lifelong learning. Hence all CO's are mapped with PO-12 with moderate level, i.e., 2.
CO-2		2	
CO-3		2	
CO-4		2	

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Power quality is one of the important phenomenon in the power system. Therefore power system operation, control and design, need basics from the course of power quality. Hence all CO's are mapped with with PSO-1 with moderate level, i.e., 2.
CO-2		2	
CO-3		2	
CO-4		2	

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Students learn various power quality issues, their causes and solutions such as passive, active power filters, custom power devices etc. They also learn analysis of voltage sag in the power system for various faults. Students will demonstrate their knowledge regarding electrical and electronic systems through all five course outcomes. Hence CO's are mapped with PSO-2 with moderate level, i.e., 2.
CO-2		2	
CO-3		2	
CO-4		2	

(Dr. P. M. MESHRAM) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE II: Electrical Installation Design

Course Code: EL2412

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE III: Electrical Installation Design (EL2412)

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

CO	Statement	Blooms Level
CO-1	Classify the techniques used to identify the load pattern.	L2
CO-2	Explain various types of wires, cables used in distribution systems and their tests.	L2
CO-3	Identify different types of luminaries and develop calculation skills.	L3
CO-4	Analyze various components involved in substation and their functions.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3							3	3	2
CO-4	3	3	3								3	3	2
CO-3	3	3	3	3							3	3	2
CO-4	3	3	3	3							3	3	2
Average	3.00	3.00	3.00	3.00							3.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Strong use of engineering knowledge is essential to understand and apply NEC and other standards..
CO-2		3	Strong mapping due to application of theoretical, analytical, and design skills.
CO-3		3	Strong requirement of knowledge, analysis, and design of earthing systems.
CO-4		3	Requires strong analytical and investigative knowledge.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Interpreting standards involves problem analysis for compliance and safe design.
CO-2		3	Strong mapping due to application of theoretical, analytical, and design skills.
CO-3		3	Strong requirement of knowledge, analysis, and design of earthing systems.
CO-4		3	Requires strong analytical and investigative knowledge.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Standards guide the design of compliant and safe systems..
CO-2		3	Strong mapping due to application of theoretical, analytical, and design skills.
CO-3		3	Strong requirement of knowledge, analysis, and design of earthing systems.
CO-4		3	Requires strong analytical and investigative knowledge.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Involves investigative skills in understanding and evaluating standards.
CO-2		-	-
CO-3		3	Strong requirement of knowledge, analysis, and design of earthing systems.
CO-4		3	Requires strong analytical and investigative knowledge.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Strong need for continuous learning as codes and regulations are regularly updated.
CO-2		3	Strong need for lifelong learning due to evolving tools and standards.
CO-3		3	Lifelong learning needed for updates in IS codes.
CO-4		3	New substation technologies demand continuous learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Direct application to power system design and operation under regulatory standards.
CO-2		3	Key skill for analyzing and designing power distribution in buildings.
CO-3		3	Essential in safe operation and control of electrical systems.
CO-4		3	Central to power system design and performance evaluation.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Applies in designing systems compliant with national codes.
CO-2		2	Key skill for analyzing and designing power distribution in buildings.
CO-3		2	Essential in safe operation and control of electrical systems.
CO-4		2	Central to power system design and performance evaluation.

(N. T. SAHU) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE II: Power System Operation and Control

Course Code: EL2421

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Introduction to PE II: Power System Operation and Control (EL2421)

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

CO	Statement	Blooms Level
CO-1	Identify various factors & reserve requirement for economic aspects of power system.	L2
CO-2	Evaluate optimal unit commitment , load forecasting problem & optimal scheduling of generating unit	L4
CO-3	Explain the concept of Single area load frequency control.	L5
CO-4	Write various methods of voltage control, reactive power compensation.	L6

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3							3	3	3
CO-2	3	3	3	3							3	3	3
CO-3	3	3	3	3							3	3	3
CO-4	3	3	3	3							3	3	3
Average	3.00	3.00	3.00	3.00							3.00	3.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies engineering knowledge to calculate economic factors like reserves in power systems.
CO-2		3	Uses core engineering and mathematical knowledge for unit commitment and scheduling.
CO-3		3	Applies engineering principles to understand load frequency control concepts.
CO-4		3	Applies concepts of electrical machines and power systems to voltage/reactive power control.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Analyzes technical data to determine reserve margins and economic efficiency.
CO-2		3	Analyzes operational problems in load forecasting and unit scheduling.
CO-3		3	Analyzes the behavior of single-area systems under frequency deviations.
CO-4		3	Evaluates methods to manage voltage stability and reactive compensation.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Designs basic strategies for power system economics using reserve and reliability factors.
CO-2		3	Designs optimal power dispatch and commitment schedules.
CO-3		3	Explains and helps design basic frequency control mechanisms.
CO-4		3	Describes the design and application of control devices for voltage regulation.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Uses data-driven investigation to evaluate economic planning in power operations.
CO-2		3	Investigates forecasting and scheduling outcomes using simulation/modeling.
CO-3		3	Uses modeling to investigate system response to frequency fluctuations.
CO-4		3	Investigates different control strategies using system data and modeling tools. |

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Encourages ongoing learning due to evolving economic models and tools in power systems.
CO-2		3	Promotes adaptability to new forecasting tools and optimization algorithms.
CO-3		3	Supports life-long learning due to continuous advancements in control strategies.
CO-4		3	Supports continual learning of emerging voltage regulation technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Focuses on evaluating power system operation requirements.
CO-2		3	Applies system operation techniques to optimize resource utilization.
CO-3		3	Focuses on control aspects in power system frequency management.
CO-4		3	Directly supports understanding of power system control and operation

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Links economic aspects with control strategies for electrical systems.
CO-2		3	Integrates forecasting and control for efficient power system management.
CO-3		3	Links system response analysis to control implementation in electrical networks.
CO-4		3	Evaluates reactive power control methods in electronic and electrical systems.

(S. B. REWATKAR) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE III: Electrical Energy Management and Audit

Course Code: EL2423

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE III: Electrical Energy Management and Audit (EL2423)

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

CO	Statement	Blooms Level
CO-1	Explain, the energy sources, methods of energy conservation and its pattern, electricity act 2003	L2
CO-2	Interpret different forms of electrical and thermal energy	L2
CO-3	Examine the Energy Management, Energy Audit, Energy Monitoring and Targeting	L3
CO-4	Estimate the performance evaluation of Electric motors and drives and testing procedure, and Electrical safety procedures.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3						3	3	3	3
CO-2	3	3	3	3						3	3	3	3
CO-3	3	3	3	3						3	3	3	3
CO-4	3	3	3	3						3	3	3	3
Average	3.00	3.00	3.00	3.00						3.00	3.00	3.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Students apply core math/science/EE fundamentals to classify energy sources, interpret consumption patterns, and understand conservation principles and tariff concepts in the Act.
CO-2		3	Applies thermodynamics and electrical fundamentals to end-use systems and conversions (kWh ↔ kcal, COP, efficiency).
CO-3		3	Uses core EE knowledge to understand facility processes, loads, and energy flows.
CO-4		3	Applies machines/drives theory to evaluate performance (loss segregation, efficiency, PF, harmonics).

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	They analyze demand profiles and conservation opportunities, drawing substantiated conclusions from standards/policies.
CO-2		3	Interprets Sankey diagrams/end-use breakdowns; evaluates where and how energy is used/lost.
CO-3		3	Analyzes baselines, KPIs (SEC, kWh/ton), and deviations; justifies audit findings with evidence.

CO-4		3	Performs analytical estimation and compares measured vs. nameplate/specified performance to reach justified conclusions.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	They translate understanding into conceptual solution ideas (e.g., choosing suitable ECMs, DSM options) with attention to safety and sustainability.
CO-2		3	Identifies appropriate conservation options (e.g., heat recovery, insulation, VFDs) as solution concepts.
CO-3		3	Develops feasible solution pathways (ECMs/EMOs), addressing safety, cost, and sustainability constraints.
CO-4		3	Formulates improvement solutions (proper sizing, VFD application, PF correction, harmonics mitigation) considering safety and reliability.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	They investigate literature/benchmark data (BEE, ECBC, utility schedules), organize findings, and infer valid conclusions.
CO-2		3	Examines measurement data/logs and literature to support interpretations with evidence.
CO-3		3	Conducts investigations: data acquisition, instrumentation, sampling plans, uncertainty considerations; interprets results to conclude.

CO-4		3	Investigates via standardized testing procedures, interprets datasets, and validates conclusions.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	3	Conservation planning ties directly to cost/tariff impacts, budgeting, and prioritization of measures—introducing practical project/economic decisions.
CO-2		3	Relates energy forms to costs (fuel substitution, tariff blocks), enabling economic decision-making.
CO-3		3	Prioritizes measures via payback/NPV/IRR; schedules implementation and resources—classic project/finance skills.
CO-4		3	Associates performance improvements with cost savings and implementation planning (retrofit scope, scheduling).

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Policies, codes, and technologies evolve (e.g., updates to efficiency standards), requiring independent, continuous learning.
CO-2		3	Requires learning current benchmarks, best practices, and evolving technologies/materials.

CO-3		3	Embeds continuous improvement (PDCA) and keeps pace with evolving audit norms, tools, and standards.
CO-4		3	Requires staying current with testing standards/protocols and emerging drive technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Conservation strategies influence power-system operation (load shapes, PF, losses), linking directly to system control/operation.
CO-2		3	Connects interpretations to system-level operations (demand management, losses).
CO-3		3	Strong alignment to operational optimization, DSM, and system control.
CO-4		3	Performance improvements directly impact system operation (demand reduction, stability of supply).

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Understanding end-use systems (lighting, motors, HVAC) connects to developing/assessing electrical and electronic solutions for efficiency.
CO-2		3	Involves instrumentation and control perspectives when assessing electrical/thermal systems.
CO-3		3	Requires knowledge of meters, loggers, BMS/SCADA interfaces, and control strategies.
CO-4		3	Deep involvement with electrical/electronic systems development, control tuning, and assessment.

(B. S. SUDAME) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE IV: Computer Methods in Power System

Course Code: EL2433

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of PE IV: Computer Methods in Power System (EL2433)

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

CO	Statement	Blooms Level
CO-1	Compute different Matrices using graph theory	L3
CO-2	Illustrate different methods for Load Flow studies	L3
CO-3	Analyze the system for different types of faults	L4
CO-4	Deduce different methods for Transient Stability Studies.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	1	2	2	1						1	3	
CO-2	3	1	2	1	1						1	3	
CO-3	3	1	2	1	1						1	3	
CO-4	3	1	1	1	1						1	3	
Average	3.00	1.00	1.75	1.25	1.00						1.00	3.00	

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires solid application of EE/math fundamentals (graph theory, linear algebra, circuit/network theory) to derive system matrices.
CO-2		3	Applies power-flow equations, complex power/current relations, Jacobians—core EE fundamentals.
CO-3		3	Uses sequence networks, Thevenin equivalents, and machine models—advanced EE fundamentals.
CO-4		3	Involves machine dynamics, system modelling, and differential equations—core EE knowledge.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	1	Limited problem analysis beyond forming matrices; deeper research/interpretation is minimal at this step.
CO-2		1	Limited literature review; emphasis is demonstration/illustration rather than deep comparative research.
CO-3		1	While conclusions are drawn, the matrix maps analysis depth at a basic level of literature use.

CO-4		1	Limited scope for extensive literature analysis within this CO's framing.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Matrix formulation underpins later solution development (LF, SC, stability); some design/development thinking to choose efficient formulations.
CO-2		2	Method selection/tuning (tolerances, acceleration) reflects design/development considerations.
CO-3		2	Building/connecting sequence networks and selecting solution pathways shows moderate design/development of the analytical model.
CO-4		1	Design/development is minimal—focus is on deducing/applying established methods rather than designing new control schemes.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Investigation/modelling to validate matrix properties (sparsity, symmetry) and confirm correctness on test systems.
CO-2		1	Minimal investigative rigour; primarily runs standard cases to illustrate convergence.
CO-3		1	Limited experimental/validation studies; focus is computational analysis.
CO-4		1	Basic investigation via test cases; not research-heavy in the given scope.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Introductory use of computational tools (e.g., MATLAB/NumPy) to assemble matrices; tool depth limited here.
CO-2		1	Basic use of computing tools to implement/execute LF algorithms.
CO-3		1	Basic application of software to compute fault currents and bus voltages.
CO-4		1	Introductory use of numerical tools/solvers (e.g., RK methods) to simulate rotor angle dynamics.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Students are introduced to graph-theoretic matrix computation techniques that require adapting to new software tools or algorithms as power-system modelling evolves.
CO-2		1	Load flow algorithms and software are continually updated; students develop basic self-learning skills to explore new techniques beyond the syllabus.
CO-3		1	Fault analysis methods and standards are periodically revised. Students cultivate the ability to upgrade their knowledge for new protection schemes.

CO-4		1	Stability studies increasingly integrate modern control strategies and renewable energy models. Students gain awareness of the need for lifelong learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Matrix foundations are critical to power-system operation/control analyses (LF, fault, stability).
CO-2		3	Load flow is a cornerstone of power-system operation, planning, and control.
CO-3		3	Fault studies directly support system protection, operation, and control.
CO-4		3	Transient stability is central to secure power-system operation and control.

(P. S. PATIL) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE IV: Project Planning

Course Code: EL2436

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE III: Project Planning and Management (EL2436)

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

CO	Statement	Blooms Level
CO-1	Describe the methodologies involved in project planning and various project planning tools.	L2
CO-2	Analyze the project cost and the risk involved in project execution.	L4
CO-3	Survey the material handling and earth moving equipment.	L4
CO-4	Summarize the documents and formats involved in project execution and its control.	L5

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	1						2	2	1	2
CO-2	3	3	3	2						2	2	1	2
CO-3	3	3	3	2						2	2	1	2
CO-4	3	3	3	2						2	2	1	2
Average	3.00	3.00	3.00	1.75						2.00	2.00	1.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamentals of engineering economics, WBS, and scheduling logic to understand planning methodologies and tools.
CO-2		3	Uses cost engineering (time–cost trade-off, cash flow, depreciation) and risk basics to analyze projects.
CO-3		3	Applies technical knowledge to evaluate capabilities/limits of material handling & earth-moving equipment.
CO-4		3	Uses standards and procedures to comprehend technical documentation and control formats in projects.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Identifies planning problems; selects appropriate tool (Gantt/PERT/CPM) after reviewing alternatives.
CO-2		3	Formulates and analyzes project cost/risk problems; draws substantiated conclusions from data.
CO-3		3	Analyzes site conditions vs. equipment selection/throughput, safety and utilization constraints

CO-4		3	Reviews and interprets control documents (RFI logs, submittals, change orders) to ensure compliance.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Develops baseline schedules, WBS, and network diagrams tailored to project needs.
CO-2		3	Designs cost breakdown structures, risk registers, and response plans integrated with schedule/cost.
CO-3		3	Lays out equipment deployment plans (fleet mix, cycle times) aligned to productivity targets.
CO-4		3	Prepares/control formats (S-curves, progress reports, earned value sheets) for execution control.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	1	Limited investigation—primarily literature/tool study to select planning methods.
CO-2		2	Investigates cost/risk data (sensitivities, Monte-Carlo/what-if in spreadsheets) to support decisions.
CO-3		2	Gathers/analyses equipment specs, site constraints, and productivity data to validate choices.

CO-4		2	Interprets progress/variance data from reports to conclude on corrective actions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	2	Moderate use of tools—e.g., multimeters, pyranometers, thermal sensors, or fire extinguishers—demonstrating equipment proficiency.
CO-2		2	Moderate-level use of measuring tools and meters—key for real-world application and audits.
CO-3		3	Hands-on engagement with test kits, sequence indicators, and generators—significant tool application.
CO-4		2	Use of power quality analyzers and data logging tools reflects moderate but essential tool application.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	2	Applies PM frameworks (scope, time, cost, quality) and planning tools to organize work.
CO-2		2	Uses budgeting, cost control, cash-flow, and risk–cost impacts for decision-making.
CO-3		2	Plans equipment utilization, productivity, and resource leveling within time–cost constraints.

CO-4		2	Uses control documents (EVM metrics, progress/S-curve) for tracking and reporting.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Exposure to evolving planning tools/standards (e.g., PMBOK updates, software) fosters continuous learning.
CO-2		2	Cost/risk techniques and norms evolve; students learn to update methods and reference benchmarks.
CO-3		2	Equipment technologies/safety regulations change—necessitates ongoing upskilling.
CO-4		2	Documentation practices and digital control systems evolve, requiring adaptive learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Connects to grid-side safety, protection practices, and solar integration impacts.
CO-2		1	Cost/risk analysis supports decision-making in substation/line/plant execution.

CO-3		1	Equipment selection/logistics planning align with site execution of power projects.
CO-4		1	Control documentation aids monitoring and controlling power system project execution.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Tools and methods structure development workflows for electrical project deliverables.
CO-2		2	Financial and risk assessments inform feasibility of electrical systems deployment.
CO-3		2	Selection and utilization plans address installation/commissioning of electrical equipment.
CO-4		2	Standardized formats enable assessment and control of electrical works during execution.

(P. B. JOSHI) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE IV: Advanced Power Electronics

Course Code: 22EL631

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE IV: Advanced Power Electronics (22EL631)

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

CO	Statement	Blooms Level
CO-1	Describe the performance of power semiconductor devices and to use these devices in power electronic converters.	L2
CO-2	Analyze the performance of DC/DC and DC/AC converters/Inverters and have an in-depth understanding of the methodologies for designing them.	L4
CO-3	Classify modulation schemes for the DC/AC two level and multilevel inverters.	L4
CO-4	Illustrate the knowledge of the causes, and effects of harmonics and apply suitable mitigation techniques such as passive and active power filters.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3										1	1	1
CO-2	3	2		1							1	2	1
CO-3	3	2		1							1	2	1
CO-4	3	2		1							1	2	1
Average	3.00	2.00		1.00							1.00	1.75	1.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Understanding working, characteristics of the different power semiconductor devices need strong engineering fundamental knowledge. (High contribution).
CO-2		3	Students understand the principle working of the Buck, boost, and the buck – boost DC/DC converters and NPC, FC, and CHB multilevel inverters. And the derivation of the output voltage, inductor current ripple, and output voltage ripple is carried out by strong engineering knowledge and fundamental concepts. (High contribution).
CO-3		3	Students shall learn and understand the implementation of various modulation techniques which need strong fundamentals and engineering knowledge. (High contribution).
CO-4		3	Students shall learn and understand through the strong fundamental and engineering knowledge, the causes, effects of harmonics and solutions to the mitigation of the harmonics. (High contribution).

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	-	-

CO-2		2	Number of numerical are solved to calculate the various parameters such output voltage, inductor current ripple, and output voltage ripple may require for designing the Buck, boost, and the buck – boost DC/DC converters are calculated. Various parameters are also found for the NPC, FC and CHB multilevel inverters (Moderate contribution).
CO-3		2	Performance analysis is done in terms of the calculation of the total harmonic distortion, and fundamental voltage in the square wave modulation, single pulse width modulation, sinusoidal pulse width modulation and multicarrier modulation techniques applied to the half, full bridge inverter. (Moderate contribution).
CO-4		2	Evaluating the effects of the harmonics by solving the different numerical. Design of the different (Moderate contribution).

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	-	-
CO-2		1	The interpretation is made based on the valid results obtained by calculating the different parameters in simple as well as complex numerical on DC/DC converters. (Low contribution)
CO-3		1	By interpretation, it is to find suitable modulation method of the inverter for the specific application. (Low contribution).
CO-4		1	Analysis of the different passive power filters and the active power filters is done, which may help to come to valid conclusions of the right choice of the filters. (Low contribution).

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Students must update themselves about upcoming new devices and the use of new materials in devices. This may be acquired by lifelong learning. (Low contribution).
CO-2		1	Students must update themselves about upcoming new DC/DC and DC/AC converters. This may be acquired by lifelong learning. (Low contribution).
CO-3		1	Students must update themselves about any modification or new modulation methods associated with the DC/AC inverters. This may be acquired by lifelong learning. (Low contribution).
CO-4		1	Students must update themselves about any modification in passive as well as active power filters. This may be acquired by lifelong learning. (Low contribution).

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	1	Identifying the suitable power semiconductor device may help in proper electric power system design. (Low contribution)
CO-2		1	The analysis and performance evaluation are carried out after evaluating the various parameters associated with the buck, boost, and the buck – boost DC/DC converters and different multilevel inverters. (Moderate contribution)

CO-3		1	The analysis and performance evaluation are carried out after evaluating the various parameters associated with the square wave modulation, single pulse width modulation, sinusoidal pulse width modulation and multicarrier modulation techniques applied to the half, full bridge inverter (Moderate contribution)
CO-4		1	Evaluating the various parameters associated with passive power filters and hence aligns with the power system operation (Moderate contribution)

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Students should understand the functioning of the semiconductor devices which may help in developing the electrical or electrical and electronics system. (Low contribution)
CO-2		2	The continuous and discontinuous mode of the operation of different DC/DC converters is analyzed which may be part of the developing suitable DC/DC converter for the specific applications. (Low contribution)
CO-3		2	Different modulations methods are the fundamental part of any control of the inverter used in electrical or electronics applications. (Low contribution)
CO-4		2	Understanding and the analysis of passive and the active power filters help to develop the system of eliminating or mitigating the harmonics in the power system. (Low contribution)

(Dr. P. M. MESHRAM) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE IV: Advanced Electrical drives

Course Code: EL2431

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE IV: Advanced Electrical Drives (EL2431)

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

CO	Statement	Blooms Level
CO-1	Explain the dynamics, control schemes, four-quadrant operation of electric drives and energy conservation.	L2
CO-2	Analyze controlled rectifier-fed and chopper-controlled D.C. drives and battery-powered drives.	L4
CO-3	Classify the control for asynchronous and synchronous motors, stepper motor.	L4
CO-4	Evaluate semiconductor-controlled DC and AC traction systems.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	2	2	1	2					2	2	3
CO-2	3	3	3	3	2	2					2	2	3
CO-3	3	3	3	3	3	2					2	2	3
CO-4	3	3	3	3	2	3					3	2	3
Average	3.00	3.00	2.75	2.75	2.00	2.25					2.25	2.00	3.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Involves understanding dynamics, energy conservation, and motor-drive principles.
CO-2		3	Applies power electronics and control principles for DC drives and battery systems.
CO-3		3	Builds on machine theory and converter technology for motor control.
CO-4		3	Requires knowledge of semiconductors and electrical systems for traction applications.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves identifying control-related issues in energy-efficient drive operations.
CO-2		3	Encourages analysis of converter-driven drive performance.
CO-3		3	Requires evaluation of motor control types under different industrial needs.
CO-4		3	Includes performance analysis and comparison of traction systems.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	2	Helps design energy-saving schemes using four-quadrant control.
CO-2		3	Involves developing converter configurations for specific applications.
CO-3		3	Enables selection/design of control strategies for multiple motor types.
CO-4		3	Assists in evaluating and recommending suitable control for traction systems.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Includes basic investigation into system performance and energy usage.
CO-2		3	Students explore relationships between converter type and drive behavior.
CO-3		3	Involves simulation and analysis of motor responses to control variations.
CO-4		3	Evaluation of traction systems through analysis and testing.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	1	Involves basic use of semiconductor devices and drive control interfaces.
CO-2		2	Requires simulation and analysis of chopper and rectifier-based drives.
CO-3		3	Relies on software tools for motor control simulations.
CO-4		2	Engages in the practical application of advanced tools for AC/DC traction systems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	2	Reflects the importance of energy-efficient designs.
CO-2		2	Focuses on reducing energy consumption and promoting sustainable transport.
CO-3		2	Applications in automation and environmentally responsible systems.
CO-4		3	Emphasizes clean, sustainable traction technologies for society.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	2	Encourages awareness of energy conservation advancements.
CO-2		2	Promotes continuous learning in battery and drive technology.

CO-3		2	Motivates learning of evolving motor control schemes.
CO-4		3	Develops an understanding of emerging semiconductor traction technologies.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	2	Focus on drive integration and control within power systems.
CO-2		2	Applies to drive systems as a part of broader power system control.
CO-3		2	Enhances ability to configure motor control in power grids.
CO-4		2	Strongly linked to control of electric traction in distributed systems.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Control schemes are designed using electronics and evaluated for performance.
CO-2		3	Relates to analyzing drive electronics like choppers and converters.
CO-3		3	Students assess control logic and system effectiveness.
CO-4		3	Emphasizes development and testing of AC/DC drive systems using semiconductors.

(Dr. S. G. KADWANE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: PE IV: Grid Integration in Renewable Energy Systems

Course Code: 22EL633

Semester: Sixth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Introduction to PE IV: Grid Integration in Renewable Energy Systems

(22EL633)

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

CO	Statement	Blooms Level
CO-1	Explain the need of integrating large renewable energy sources in the existing power system.	L2
CO-2	Identify components required for grid connected Solar and Wind Energy Conversion System.	L2
CO-3	Select appropriate renewable energy policies for solar PV installation.	L4
CO-4	Analyze the impacts of renewable energy integration on grid and environment.	L4

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3	3	3	1	1					3	3	2
CO-2	3	3	3	3	1	1					3	3	2
CO-3	3	3	3	3	1	1					3	3	2
CO-4	3	3	3	3	1	2					3	3	2
Average	3.00	3.00	3.00	3.00	1.00	1.25					3.00	3.00	2.00

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Applies fundamental knowledge of power systems and renewable energy integration
CO-2		3	Involves application of engineering knowledge to identify RE system components
CO-3		3	Knowledge of policies and regulations requires engineering fundamentals
CO-4		3	Requires advanced understanding of energy systems and integration

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Requires analysis of integrating renewables into complex power systems with sustainability in mind.
CO-2		3	Analyzing components for compatibility with grid systems.
CO-3		3	Policy selection and comparison require research and analysis.
CO-4		3	Analysis of grid and environmental impacts involves complex evaluation.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	3	Understanding integration enables conceptual design of improved systems
CO-2		3	Component selection supports system design for integration
CO-3		3	Policy understanding influences design decisions for PV projects
CO-4		3	Proposes sustainable solutions based on impact analysis

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Involves analyzing real-world problems using data and research
CO-2		3	Analysis of performance and suitability involves data interpretation
CO-3		3	Analyzing policy impact uses data and logical reasoning.
CO-4		3	Utilizes modeling and data interpretation for impact studies

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark

CO-1	PO-5	1	Basic exposure to engineering tools for modeling or evaluating systems
CO-2		1	Minimal use of modern tools or simulation.
CO-3		1	Indirect relevance; may involve software for policy analysis.
CO-4		1	Basic level use of tools for evaluating integration impacts.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

CO	PO	Mapping	Remark
CO-1	PO-6	1	Involves awareness of environmental and societal impacts of large-scale RE integration
CO-2		1	Environmental considerations in selecting RE components.
CO-3		1	Covers socio-environmental and legal aspects of RE policy
CO-4		2	Strong focus on sustainability, health, and environmental consequences

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Promotes lifelong learning and adaptability to future energy system changes.
CO-2		3	Continuous learning required for new component technologies.
CO-3		3	Promotes updating knowledge in changing regulatory landscape.
CO-4		3	Prepares for emerging trends and future learning.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Directly relevant to identifying and analyzing power system challenges..
CO-2		3	Strong link to power system operation and equipment analysis.
CO-3		3	Important for understanding grid operation within policy framework.
CO-4		3	Highly relevant to evaluating operational impact of renewables on the grid.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	Addresses understanding and assessment of electronic systems in integration.
CO-2		2	Involves understanding electronic integration in RE systems.
CO-3		2	Affects design and evaluation of control/electronic systems in compliance.
CO-4		2	Involves impact assessment of electronic control systems in integration.

(S. B. REWATKAR) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Mini Project

Course Code: EL2409

Semester: Seventh

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Mini Project (EL2409)

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

CO	Statement	Blooms Level
CO-1	Identify a relevant research problem in Electrical Engineering through critical analysis of current issues.	L2
CO-2	Review and interpret existing literature to define objectives and scope of the proposed project work.	L3
CO-3	Develop a solution using appropriate hardware/software tools with proper specifications.	L3
CO-4	Analyze, test, and validate the developed system to ensure it meets the defined objectives.	L4
CO-5	Prepare a comprehensive project report and present findings effectively in both written and oral formats.	L6

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3		2							1	3	2
CO-2		3		3				2			2	2	3
CO-3			3		3			2		2		2	3
CO-4	3			2	2				2			2	3
CO-5							2		3	2	2	2	2
Average	3	3	3	2.33	2.50		2	2	2	2	1.67	2.20	2.60

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires applying engineering knowledge to identify relevant research problems.
CO-2		-	-
CO-3		-	-
CO-4		3	Understanding of underlying engineering concepts is necessary for analysis.
CO-5		-	

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves deep problem analysis, identifying key issues, and determining research relevance.
CO-2		3	In-depth literature review and analysis require strong analytical thinking.
CO-3		-	-
CO-4		-	-
CO-5		--	-

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	-	As a first step towards designing creative solutions for complex engineering problems, students will learn designing electric circuits for specified voltage, current, power, for maximum power transfer to load, and for specified transfer function through poles and zeros.. Hence all CO's are mapped with PO-3 with low level, i.e., 1.
CO-2		-	-
CO-3		3	Core to designing and implementing an engineering solution.
CO-4		-	-
CO-5		-	-

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Involves initial investigation and background understanding of the identified problem.
CO-2		3	Literature review is a core component of conducting research-based investigations.
CO-3		-	-
CO-4		2	Validation and result analysis are fundamental parts of engineering investigations.
CO-5		-	-

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	-	-
CO-2		-	-
CO-3		3	Involves applying modern engineering tools for development.
CO-4		2	Analysis may involve software tools, simulations, or measurement equipment.
CO-5		-	-

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7	-	-
CO-2		-	-
CO-3		-	-
CO-4		-	-
CO-5		2	Adherence to ethical standards in writing, originality, and citations is expected.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

CO	PO	Mapping	Remark
CO-1	PO-08	-	-
CO-2		2	May involve collaboration in evaluating literature if project is team-based.
CO-3		2	Teamwork is critical in large-scale design and development projects.
CO-4		-	-
CO-5		-	-

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

CO	PO	Mapping	Remark
CO-1	PO-09	-	-
CO-2		-	-
CO-3		-	-
CO-4		2	Results are interpreted and shared using appropriate communication formats.
CO-5		3	Effective communication through reports and presentations is essential.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	-	-
CO-2		-	-
CO-3		2	Requires basic project planning, resource management, and timeline tracking.
CO-4		-	-
CO-5		2	Report structuring and time/resource management reflect project management principles.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Encourages research orientation and continuous knowledge updating.
CO-2		2	Promotes self-learning and staying updated with current research trends.
CO-3		-	-
CO-4		-	-
CO-5		2	Encourages learning technical writing and presentation skills as lifelong skills.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Students identify and formulate relevant research problems in power systems or electrical domains.
CO-2		2	Literature review helps in analyzing trends and gaps in power system.
CO-3		2	Prototype may involve power system modeling, hardware control, or operation.
CO-4		2	Result validation may relate to performance of power systems.
CO-5		2	Report may include a minor portion on power system insights or observations.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	May involve initial problem formulation in electrical/electronic system applications.
CO-2		3	Evaluation of electronics/system design methods strengthens application of PSO2.
CO-3		3	Focused on development and implementation of electrical/electronic systems.
CO-4		3	Uses simulation/data/testing to assess system behavior and performance.
CO-5		2	Communication includes documentation of electrical/electronic system outcomes.

(A. S. LILHARE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Major Project

Course Code: EL2451

Semester: Eighth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 3

COURSE OUTCOMES

Course Outcomes Of Major Project (EL2451)

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

CO	Statement	Blooms Level
CO-1	Identify a relevant research problem in Electrical Engineering through critical analysis of current issues.	L2
CO-2	Review and interpret existing literature to define objectives and scope of the proposed project work.	L3
CO-3	Develop a solution using appropriate hardware/software tools with proper specifications.	L3
CO-4	Analyze, test, and validate the developed system to ensure it meets the defined objectives.	L4
CO-5	Prepare a comprehensive project report and present findings effectively in both written and oral formats.	L6

COURSE ARTICULATION MATRIX

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PSO-1	PSO-2
CO-1	3	3		2							1	3	2
CO-2		3		3				2			2	2	3
CO-3			3		3			2		2		2	3
CO-4	3			2	2				2			2	3
CO-5							2		3	2	2	2	2
Average	3	3	3	2.33	2.50		2	2	2	2	1.67	2.20	2.60

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Requires applying engineering knowledge to identify relevant research problems.
CO-2		-	-
CO-3		-	-
CO-4		3	Understanding of underlying engineering concepts is necessary for analysis.
CO-5		-	

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Involves deep problem analysis, identifying key issues, and determining research relevance.
CO-2		3	In-depth literature review and analysis require strong analytical thinking.
CO-3		-	-
CO-4		-	-
CO-5		--	-

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	-	As a first step towards designing creative solutions for complex engineering problems, students will learn designing electric circuits for specified voltage, current, power, for maximum power transfer to load, and for specified transfer function through poles and zeros.. Hence all CO’s are mapped with PO-3 with low level, i.e., 1.
CO-2		-	-
CO-3		3	Core to designing and implementing an engineering solution.
CO-4		-	-
CO-5		-	-

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	2	Involves initial investigation and background understanding of the identified problem.
CO-2		3	Literature review is a core component of conducting research-based investigations.
CO-3		-	-
CO-4		2	Validation and result analysis are fundamental parts of engineering investigations.
CO-5		-	-

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

CO	PO	Mapping	Remark
CO-1	PO-5	-	-
CO-2		-	-
CO-3		3	Involves applying modern engineering tools for development.
CO-4		2	Analysis may involve software tools, simulations, or measurement equipment.
CO-5		-	-

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

CO	PO	Mapping	Remark
CO-1	PO-7	-	-
CO-2		-	-
CO-3		-	-
CO-4		-	-
CO-5		2	Adherence to ethical standards in writing, originality, and citations is expected.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

CO	PO	Mapping	Remark
CO-1	PO-08	-	-
CO-2		2	May involve collaboration in evaluating literature if project is team-based.
CO-3		2	Teamwork is critical in large-scale design and development projects.
CO-4		-	-
CO-5		-	-

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

CO	PO	Mapping	Remark
CO-1	PO-09	-	-
CO-2		-	-
CO-3		-	-
CO-4		2	Results are interpreted and shared using appropriate communication formats.
CO-5		3	Effective communication through reports and presentations is essential.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	-	-
CO-2		-	-
CO-3		2	Requires basic project planning, resource management, and timeline tracking.
CO-4		-	-
CO-5		2	Report structuring and time/resource management reflect project management principles.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	1	Encourages research orientation and continuous knowledge updating.
CO-2		2	Promotes self-learning and staying updated with current research trends.
CO-3		-	-
CO-4		-	-
CO-5		2	Encourages learning technical writing and presentation skills as lifelong skills.

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Students identify and formulate relevant research problems in power systems or electrical domains.
CO-2		2	Literature review helps in analyzing trends and gaps in power system.
CO-3		2	Prototype may involve power system modeling, hardware control, or operation.
CO-4		2	Result validation may relate to performance of power systems.
CO-5		2	Report may include a minor portion on power system insights or observations.

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	2	May involve initial problem formulation in electrical/electronic system applications.
CO-2		3	Evaluation of electronics/system design methods strengthens application of PSO2.
CO-3		3	Focused on development and implementation of electrical/electronic systems.
CO-4		3	Uses simulation/data/testing to assess system behavior and performance.
CO-5		2	Communication includes documentation of electrical/electronic system outcomes.

(A. S. LILHARE) (Dr. S. P. GAWANDE)

Course Coordinator HOD

Course Name: Extra curricular Activity Evaluation

Course Code: EL2452

Semester: Eighth

Programme: B. Tech.

Branch: Electrical Engineering

Credits: 2

COURSE OUTCOMES

Course Outcomes Of Extra curricular Activity Evaluation(EL2452)

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

CO	Statement	Blooms Level
CO-1	Demonstrate actively in extracurricular activities to develop a sense of responsibility and discipline.	L2
CO-2	Apply time management and organizational skills during involvement in events and student-led activities.	L3
CO-3	Analyze the impact of extracurricular activities on personal and professional development.	L4
CO-4	Design and execute innovative technical or social events to address current societal or academic needs	L6

COURSE ARTICULATION MATRIX

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

1 – Low level

2 – Moderate level

3 – High level

JUSTIFICATION OF CO – PO MAPPING

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

CO	PO	Mapping	Remark
CO-1	PO-1	3	Evaluates experiences using engineering knowledge for personal growth.
CO-2		3	
CO-3		-	
CO-4		3	

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

CO	PO	Mapping	Remark
CO-1	PO-2	3	Encourages critical thinking in analyzing team roles and personal contribution.
CO-2		3	
CO-3		3	
CO-4		-	

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

CO	PO	Mapping	Remark
CO-1	PO-3	-	Analyzes the effectiveness of event planning and design,Apply design skills in planning technical/cultural events.-
CO-2		3	
CO-3		-	
CO-4		3	

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

CO	PO	Mapping	Remark
CO-1	PO-4	3	Demonstrates decision-making in real-time event coordination.Evaluates problem-solving strategies used during activities.
CO-2		3	
CO-3		3	
CO-4		3	

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

CO	PO	Mapping	Remark
CO-1	PO-09	3	Identifies the need for team participation and collaboration,Understands importance of teamwork in event success, Leads and functions effectively within diverse teams,Evaluate team dynamics and personal evaluation.
CO-2		3	
CO-3		3	
CO-4		3	

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

CO	PO	Mapping	Remark
CO-1	PO-10	3	Recognizes basic communication requirements in group settings,Explains effective communication in collaborative activities,Communicates clearly in event coordination and reporting.Reflects on effectiveness of communication strategies.
CO-2		3	
CO-3		3	
CO-4		3	

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies.

CO	PO	Mapping	Remark
CO-1	PO-11	3	Understands basics of organizing and managing events.Demonstrates project management and leadership in activities.Assesses success of project execution and leadership skills.
CO-2		3	
CO-3		3	
CO-4		3	

PSO1: Interpret, identify, analyse and evaluate problems in power system operation, control and design.

CO	PO	Mapping	Remark
CO-1	PSO-1	3	Applies domain-specific knowledge in technical events.Evaluates how technical activities enhance EE understanding.
CO-2		3	
CO-3		3	
CO-4		3	

PSO2: Demonstrate knowledge to develop, control and assess electrical and electronic systems.

CO	PO	Mapping	Remark
CO-1	PSO-2	3	Identifies role of extracurriculars in developing soft skills,Understands importance of communication and ethics,Demonstrates leadership and organizational ability,Assesses growth in leadership, time management, and professionalism.
CO-2		3	
CO-3		3	
CO-4		3	

(B. S. SUDAME) (Dr. S. P. GAWANDE)

Course Coordinator HOD