Shree Warana Vibhag Shikshan Mandal's

Tatyasaheb Kore Institute of Engineering And Technology, Waranangar

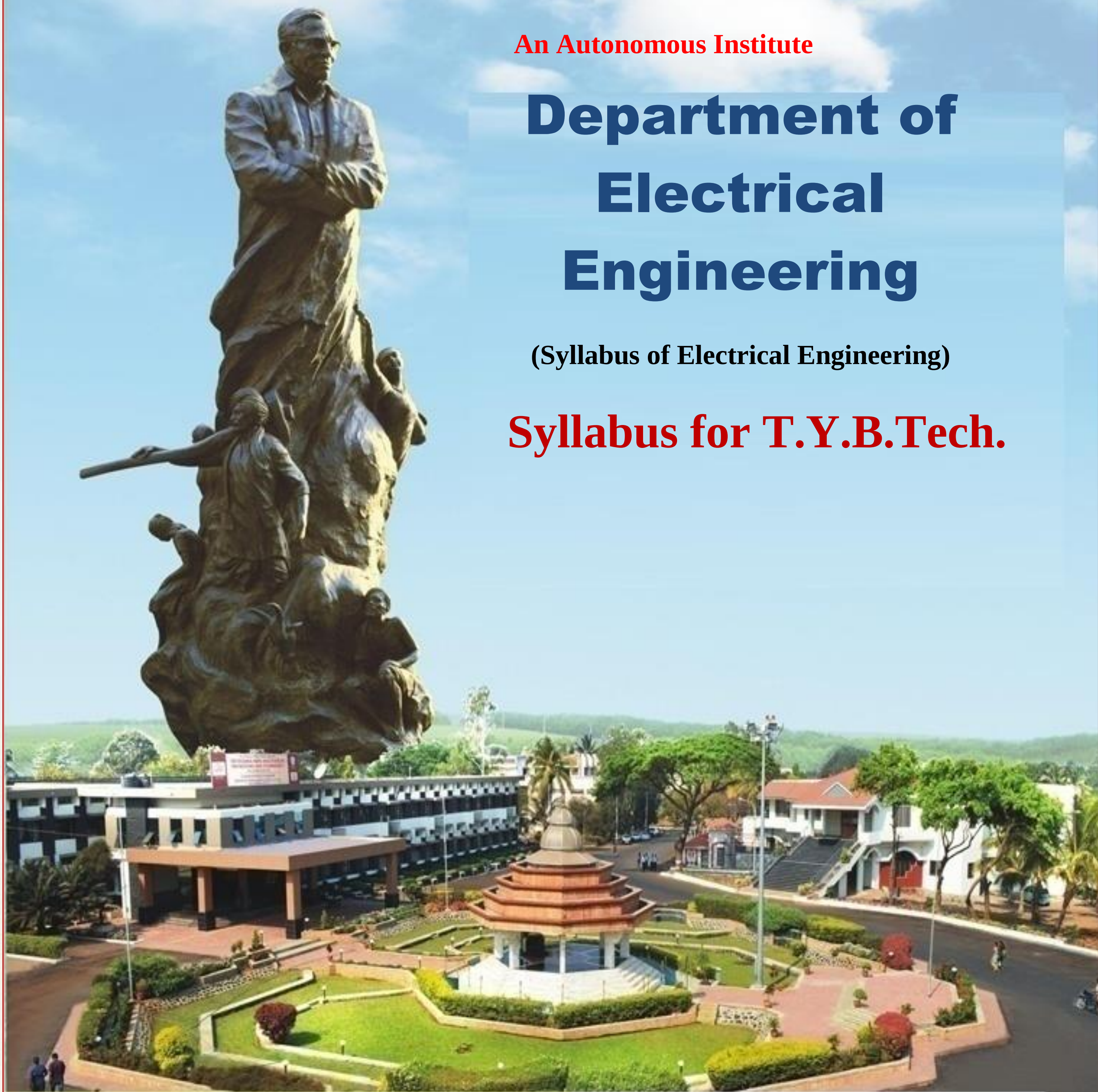
NBA Accredited Institute

An Autonomous Institute

Department of Electrical Engineering

(Syllabus of Electrical Engineering)

Syllabus for T.Y.B.Tech.



B.Tech.in Electrical Engineering

Proposed Structure and Syllabus under Autonomy as per
The NEP Policy 2020

Vision

To be a recognized Department of Electrical Engineering by fostering a dynamic learning ecosystem that develops competent professionals and serves societal needs through innovation and sustainable engineering practices.

Mission

1).To impart quality education by providing a strong foundation in Electrical Engineering through outcome-based education, experiential learning, and modern pedagogical practices.
2).To encourage a dynamic learning ecosystem through innovation, research, industry collaboration and the adoption of emerging technologies.
3).To develop competent, ethical and socially responsible engineers with leadership qualities, a commitment to lifelong learning, and sustainable engineering practices.

4).To strengthens industry institute interaction and encourages entrepreneurship, consultancy, and collaborative activities for addressing real world engineering challenges.

Quality Policy

To promote excellence in academic and training activities by inspiring students for becoming competent professionals to cater industrial and social needs.

Program Objectives

1. **Engineering Knowledge** Graduates will possess a strong foundation in engineering fundamentals and apply this knowledge to identify, analyze, and solve complex engineering problems. They will be able to understand and apply principles of mathematics, science, and engineering to a variety of real-world situations.
2. **Problem Analysis and Solution Design** Graduates will be able to critically analyze engineering problems and design effective solutions. Using their skills in problem-solving and analytical thinking, they will develop innovative solutions while considering factors such as feasibility, sustainability, and societal impact.
3. **Design and Development of Solutions** Graduates will be able to design and develop solutions for complex engineering problems by selecting and applying appropriate engineering design principles, tools, and techniques. They will also consider ethical, cultural, and environmental aspects in their designs, contributing to sustainable solutions.
4. **Investigation and Research** Students will be equipped with the skills to conduct in-depth investigations and research into engineering problems, using appropriate research methodologies, experiments, and data analysis. This ability will help them to evaluate solutions, optimize designs, and innovate within their field.
5. **Modern Tool Usage** Graduates will be proficient in using modern engineering tools, technologies, and software relevant to their specialization. They will understand the limitations and appropriate application of these tools in solving engineering problems and designing systems, products, and processes.
6. **The Engineer and Society** Graduates will be aware of the impact of engineering solutions on society, the environment, and public safety. They will be equipped to practice engineering in a socially responsible manner, adhering to professional ethics, and contributing positively to the welfare of society.
7. **Environment and Sustainability** Graduates will understand the importance of sustainability and the need to consider environmental impact when designing solutions. They will be capable of creating engineering solutions that promote environmental sustainability, using renewable resources, and minimizing waste and pollution.
8. **Ethics and Professionalism** Graduates will demonstrate professional ethics in their engineering practices, showing integrity, accountability, and social responsibility. They will follow industry standards, uphold ethical decision-making, and work in a manner that reflects the values of the engineering profession.
9. **Teamwork and Communication** Graduates will have strong interpersonal skills, working effectively in multidisciplinary teams. They will communicate ideas and solutions clearly, both in written and oral forms, and be able to collaborate with peers, colleagues, and stakeholders in a professional manner.
10. **Life-Long Learning** Graduates will have a mindset of continuous improvement and lifelong learning. They will be capable of adapting to new technological advancements, seeking out opportunities for professional development, and staying current with industry trends throughout their careers.
11. **Leadership and Innovation** Graduates will demonstrate leadership qualities, take initiative in projects, and contribute to innovative solutions within their field. They will foster creativity, encourage new ideas, and embrace challenges with an entrepreneurial mindset.

Program Educational Objectives

PEO 1: Apply engineering knowledge and technical skills to build successful careers in the power, electrical, automation, electric vehicle (EV), and allied industries.

PEO 2: Demonstrate professional competence to excel as practicing engineers, researchers, academicians, or entrepreneurs while upholding ethical values, social responsibility, and environmental sustainability.

PEO 3: Engage in lifelong learning and continuous professional development to adapt to emerging technologies and contribute effectively to the engineering profession.

Program Specific Outcomes (PSO'S)

PSO 1: Apply the principles of basic sciences, engineering mathematics, electrical circuits, electrical machines, power systems, and control engineering to analyze Electrical Engineering problems.

PSO 2: Design, analyze, and implement electrical systems using modern engineering tools, laboratory practices, and industry standards to meet technical requirements.

PSO 3: Develop safe, reliable, energy-efficient, and sustainable electrical engineering solutions by applying professional ethics, teamwork, and lifelong learning while addressing societal and environmental needs.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Abbreviations

Sr.No.	Acronym	Definition
1	ISE	In-Semester Examination
2	ISE-I	In-Semester Examination-I
3	ISE-II	In-Semester Examination-II
4	ESE	End Semester Examination
5	ISA	In-Semester Assessment(Term Work)
6	L	Lecture
7	T	Tutorial
8	P	Practical
9	CH	Contact Hours
10	C	Credit

Course/Subject Categories

Sr. No.	Acronym	Definition
1	PCC	Professional Core Course
2	MDM	Multidisciplinary Minor
3	OE	Open Electives
4	HSSM	Humanities social science and Mgmt
5	ELC	Experiential Learning Courses
6	VSEC	Vocational and skill Enhancement course
7	AEC	Ability Enhancement Course

Course/Subject Code

EE	E	3	0	1
Branch Code		Semester	Course Number	

Course Term work and POE Code

EE	E	3	0	1	T/P/A
Branch Code		Semester	Course Number		T- Term Work P-POE A-Audit Course

Tatyasaheb Kore Institute of Engineering and Technology

Third Year B.Tech

In Electrical Engineering

Structure and Syllabus under Autonomy as per the NEP Policy 2020
W.e.f from Academic Year : 2026-27

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Third Year B. Tech. (Electrical Engineering)

Semester-V

(To be implemented from 2026 -27)

Credit Scheme as per NEP 2020 Policy

Sr. No	Category	Sub Category	Course Code	Course Title	Teaching Scheme					Examination & Evaluation Scheme			
					L	T	P	C	CH	Component	Marks	Min for Passing	
1	Programme course	PCC	25UGPCCEE 501	Control System Engineering	3*	--	--	2	3	ESE	60	24	40
										ISE	40	16	
2		PCC	25UGPCCEE 502	Electrical Power Generation	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
3		PCC	25UGPCCEE 503	Power System Analysis	3*	--	--	2	3	ESE	60	24	40
										ISE	40	16	
4	Programme Elective course	PEC-1	25UGPEC1E E504	PEC-I	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
5	Multi disciplinary	MDM-3	25UGMDM3 EE505L	Multi Disciplinary Minor-3	4	--	--	4	4	ESE	60	24	40
										ISE	40	16	
6		OE-2	25UGOE2EE 506	Open elective (OE) - 2	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
7	Programme course	PCC	25UGPCCEE 501LP	Control System Engineering Lab	--	--	2	1	2	ISA	25	10	10
										POE	25	10	10
8		PCC	25UGPCCEE 502T	Electrical Power Generation Tutorial	--	1	--	1	1	ISA	25	10	10
9		PCC	25UGPCCEE 503LP	Power System Analysis Lab	--	--	2	1	2	ISA	25	10	10
										POE	25	10	10
10		PCC	25UGPCCEE 507LP	Mini Project	--	--	2	1	2	OE	50	20	20
11	Programme Elective course	PEC1	25UGPEC1E E504T	PEC I Tutorial	--	1	--	1	1	ISA	25	10	10
					19	02	06	21	27	--	800	320	320

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Third Year B. Tech. (Electrical Engineering)

Semester-VI

(To be implemented from 2026 -27)

Credit Scheme as per NEP 2020 Policy

Sr. No	Category	Sub Category	Course Code	Course Title	Teaching Scheme L	T	P	C	CH	Examination & Evaluation Scheme Component	Marks	Min for Passing	
1	Programme course	PCC	25UGPCCEE601	Switchgear & Protection	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
2		PCC	25UGPCCEE602	Power Electronics	3*	--	--	2	3	ESE	60	24	40
										ISE	40	16	
3		PCC	25UGPCCEE603	Microcontroller and Applications	3*	--	--	2	3	ESE	60	24	40
										ISE	40	16	
4	Programme Elective course	PEC-2	25UGPEC2EE604	PEC-2	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
5		PEC-3	25UGPEC3EE605	PEC-3	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
6	Multi disciplinary course	MDM-4	25UGMDM4EE606L	Multi Disciplinary Minor- 4	2	--	--	2	2	ISA	50	20	20
7	Skill course	VSEC	25UGVSECEE6071	IoT for Electrical Engineers	2	--	--	2	2	ISA	25	10	10
8	Programme course	PCC	25UGPCCEE601LP	Switchgear & Protection Lab	--	--	2	1	2	ISA	25	10	10
										POE	25	10	10
9		PCC	25UGPCCEE602LP	Power Electronics Lab	--	--	2	1	2	ISA	25	10	10
										POE	50	20	20
10		PCC	25UGPCCEE603LP	Microcontroller and Applications Lab	--	--	2	1	2	ISA	25	10	10
										POE	25	10	10
11	Programme Elective course	PEC-2	25UGPEC2EE604T	PEC-2 Tutorial	--	1	--	1	1	ISA	25	10	10
12		PEC-3	25UGPEC3EE605T	PEC-3 Tutorial	--	1	--	1	1	ISA	25	10	10
					19	02	06	21	27	--	800	320	320

Multidisciplinary Courses (MDM) offered by Electrical Engineering Department

MDM Basket Name	Sr. No.	Course Code	Course Name	Semester
Electrical Power System	1.	25UGMDM1EE306L	Electrical Power Generation	III
	2	25UGMDM2EE405L	Power System	IV
	3	25UGMDM3EE505L	Electrical Machines	V
	4	25UGMDM4EE606L	Renewable Energy Sources	VI
	5	25UGMDM5EE705L	Smart Grid	VII

Program Elective-I Theory & Tutorial (Sem-V)

Sr. No.	Course Code	Domain	Course
1	25UGPEC1EE5041	Power and Energy Systems	Energy Storages Technologies
2.	25UGPEC1EE5042		Electrical Estimation & costing
3.	25UGPEC1EE5043	Drives and Control	Electric Vehicles Technology
4.	25UGPEC1EE5044		Electrical Utilization and Traction

Program Elective-II Theory & Tutorial (Sem-VI)

Sr. No.	Course Code	Domain	Course
1	25UGPEC2EE6041	Power and Energy Systems	Electrical Energy Conservation & Audit
2.	25UGPEC2EE6042		Battery Management Systems
3.	25UGPEC2EE6043	Drives and Control	Advanced Control Systems
4.	25UGPEC2EE6044		Application of Microcontrollers in Electrical Engineering

Program Elective-III Theory & Practical (Sem-VI)

Sr. No.	Course Code	Discipline	Course
1	25UGPEC3EE6051	Power and Energy Systems	Wind Energy Conversion System
2	25UGPEC3EE6052		HVDC Transmission Systems
3	25UGPEC3EE6053	Drives and Control	Power System Operation and Control
4	25UGPEC3EE6054		Industrial Automation

Open Elective Course

Sr. No.	Course Code	Course Name	Semester	Offered by Department
1.	25UGOE1EE4061	Energy Audit and Management	IV	Electrical Engineering
2	25UGOE1EE4062	Solar Energy Conversion System	IV	
3	25UGOE2EE5061	Wind Energy Conversion System	V	
4	25UGOE2EE5062	Electric Vehicles Technology	V	

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Third Year B. Tech. (Electrical Engineering)

Semester-V

(To be implemented from 2026 -27)

Credit Scheme as per NEP 2020 Policy

Sr. No	Category	Sub Category	Course Code	Course Title	Teaching Scheme					Examination & Evaluation Scheme			
					L	T	P	C	CH	Component	Marks	Min for Passing	
1	Programme course	PCC	25UGPCCEE 501	Control System Engineering	3*	--	--	2	3	ESE	60	24	40
										ISE	40	16	
2	Programme course	PCC	25UGPCCEE 502	Electrical Power Generation	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
3	Programme course	PCC	25UGPCCEE 503	Power System Analysis	3*	--	--	2	3	ESE	60	24	40
										ISE	40	16	
4	Programme Elective course	PEC-1	25UGPEC1E E504	PEC-I	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
5	Multi disciplinary	MDM-3	25UGMDM3 EE505L	Multi Disciplinary Minor-3	4	--	--	4	4	ESE	60	24	40
										ISE	40	16	
6	Multi disciplinary	OE-2	25UGOE2EE 506	Open elective (OE) - 2	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
7	Programme course	PCC	25UGPCCEE 501LP	Control System Engineering Lab	--	--	2	1	2	ISA	25	10	10
										POE	25	10	10
8	Programme course	PCC	25UGPCCEE 502T	Electrical Power Generation Tutorial	--	1	--	1	1	ISA	25	10	10
9	Programme course	PCC	25UGPCCEE 503LP	Power System Analysis Lab	--	--	2	1	2	ISA	25	10	10
										POE	25	10	10
10	Programme course	PCC	25UGPCCEE 507LP	Mini Project	--	--	2	1	2	OE	50	20	20
11	Programme Elective course	PEC1	25UGPEC1E E504T	PEC I Tutorial	--	1	--	1	1	ISA	25	10	10
					19	02	06	21	27	--	800	320	320

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGPCCEE501 **Course Name:** Control System Engineering

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**02**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Network Analysis, Engineering Mathematics-I & II

Course Objectives:

1). Understand the fundamentals of control systems, including open-loop and closed-loop control systems and their applications.
2).Develop mathematical models of physical systems using transfer functions, block diagrams, and signal flow graphs.
3). Analyze the performance and stability of linear control systems using time-domain and frequency-domain techniques.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the fundamentals of control systems, mathematical modeling, transfer functions, and block diagram reduction techniques.	Understand
CO2	Analyze the time-domain response and performance specifications of feedback control systems.	Apply
CO3	Analyze the stability of control systems using Routh–Hurwitz criterion and Root Locus method.	Analyze
CO4	Analyze the frequency response characteristics of control systems using Polar, Nyquist, and Bode plots.	Analyze
CO5	Evaluate the performance of control systems using P, PI, PD, and PID controllers and compensators.	Evaluate
CO6	Develop state-space models and analyze controllability and observability of control systems.	Evaluate

Course Description: The Control Systems course provides a comprehensive understanding of the principles, analysis, and design of automatic control systems. It covers the mathematical modeling of mechanical, electrical, hydraulic, and pneumatic systems using transfer functions and block diagrams. The course emphasizes time-domain and frequency-domain analysis, stability assessment using classical techniques such as Routh Hurwitz criterion and Root Locus, and the design and performance evaluation of P, PI, PD, and PID controllers. It also introduces state-space modeling, state transition analysis, controllability, and observability of dynamic systems.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content		
Unit-1	**Introduction to Control System**	**6 Hrs**
Importance of Control Systems, Classification of control systems, Open loop system, closed loop system, Applications, Mathematical representation & Transfer function of mechanical, electrical systems, Hydraulic and Pneumatic Systems, Block diagram representation & reduction, Signal flow graph, Mason's gain formula, Numerical Problems		
Unit-2	**Time Domain Analysis**	**6 Hrs**
Time Response, Steady state analysis, Transient response analysis, Transient response Specifications, Feedback characteristics of Control System, Numerical Problems.		
Unit-3	**Stability Analysis**	**6 Hrs**
Concept of stability, Routh Hurwitz stability criteria, Special cases of Routh's criteria, Root Locus method, Effect of pole-zero addition on root locus, Numerical Problems.		
Unit-4	**Frequency Domain Analysis**	**6 Hrs**
Correlation between time domain and frequency domain specification, Polar plot, Nyquist plot, Bode plot, Numerical Problems.		
Unit-5	**PID Controller**	**6 Hrs**
Introduction to P, I & D controller, Individual effect on overall system performance ,PI,PID controller and effect on overall system performance, Numerical Problems, Introduction to compensators.		
Unit-6	**State Space Analysis**	**6 Hrs**
Representation of system in state space, converting transfer function model in to state space model, Non uniqueness of state space model, State space representation, Solution of state equations, State Transition Matrix, Controllability and Observability Test.		

Case Study:

1). Speed Control of a DC Motor Using a PID Controller
2). Automatic Temperature Control
3). Water Level Control in a Tank

Learning Resources:

Text Books

1. I. J. Nagrath, M. Gopal, Control System Engineering, New Age Int. Publishers, 5th Ed, 2008.
2. K. Ogata, Modern Control Engineering, Eastern Economy, 5th Edition, 2011.

Reference Books

1. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 2010.
2. B. C. Kuo, Automatic Control System, Wiley Publication 8th Edition.
3. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw Hill, 3rd Edition.

MOOC / NPTEL/YouTube Links

1. NPTEL – Control System **(**IIT Madras & IIEST Shibpur**)**
2. https://nptel.ac.in/courses/107106081
3. NPTEL – Control System (IIT Madras)
4. SWAYAM Portal**:** https://swayam.gov.in

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	1	-	2	-	-	-	-	-	-	1	2	1
CO2	2	3	2	1	2	-	-	-	-	-	-	-	-	1
CO3	3	3	-	2	2	-	-	-	-	-	1	2	3	-
CO4	2	2	2	2	3	-	-	-	-	-	1	2	-	1
CO5	2	3	-	3	2	-	1	-	-	-	2	1	1	-
CO6	2	3	2	2	3	-	-	-	-	1	2	3	1	1

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGPCCEE501LP **Course Name:** Control System Engineering Lab

Teaching Scheme		Credit	Evaluation Scheme	
Practical:	**02 Hours/Week**	**01**	**ISA:**	**25 Marks**
			POE:	**25 Marks**

Prerequisites: Network Analysis, Engineering Mathematics-I and II

Course Objectives:

- Develop practical knowledge of control system concepts by performing hardware and simulation-based experiments, and model control systems using MATLAB/Simulink or equivalent software.
- Analyze and verify the dynamic response, stability, and performance of first-order and second-order control systems using time-domain, frequency-domain, Routh–Hurwitz, Root Locus, Bode, and Nyquist techniques.
- Design and evaluate P, PI, PD, and PID controllers to improve system performance while developing analytical, problem-solving, and technical reporting skills through laboratory experiments and result interpretation.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Demonstrate the use of MATLAB control system and Simulink toolboxes for analyzing and simulating linear time-invariant systems and block diagram reductions.	Apply
CO2	Evaluate the stability of linear systems by employing MATLAB tools such as Root Locus, Bode Plot, Polar Plot, and Nyquist Plot for second- and third-order systems.	Evaluate
CO3	Develop state models, transfer functions, and PID controllers using MATLAB to improve system performance and control strategies.	Analyze

Course Description:

This laboratory course provides practical exposure to the analysis and design of linear control systems using MATLAB and Simulink. Students become familiar with the MATLAB Control System Toolbox and Simulink environment for modeling, simulation, and performance evaluation of control systems. The course covers the representation of Linear Time-Invariant (LTI) systems, block diagram reduction techniques, and analysis of first- and second-order system responses. Students investigate the time-domain behavior of different system types through step and impulse response simulations and evaluate system stability using graphical methods such as Root Locus, Bode, Polar, and Nyquist plots.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content

List of Experiments

Minimum 8 experiments should be performed

Sr. No.	Name of the Experiment	Hrs.	Cognitive levels of attainment As per Bloom's
1	Familiarization with MATLAB control system toolbox, MATLAB Simulink toolbox.	2	Understand
2	Linear Time-invariant Systems and Representation using MATLAB	2	Analyze
3	Block Diagram Reduction using MATLAB	2	Apply
4	Time Response of Second Order System using MATLAB	2	Apply
5	Simulation of Step response & impulse response for type-0, type-1 & type-2 system with unity feedback using MATLAB	2	Analyze
6	Determination of stability by using Root locus using MATLAB for 2nd and 3rd order system of a Linear Time Invariant System.	2	Apply
7	Determination of stability by using Bode plot using MATLAB for 2nd and 3rd order system of a Linear Time Invariant System.	2	Understand
8	Determination of stability by using Polar plot using MATLAB for 2nd and 3rd order system of a Linear Time Invariant System.	2	Analyze
9	Determination of stability by using Nyquist plot using MATLAB for 2nd and 3rd order system of a Linear Time Invariant System.	2	Apply
10	PID Controller using MATLAB	2	Understand
11.	State Model for Classical Transfer Function & Vice-Versa Using MATLAB.		Apply

Learning Resources:

Text Books

1.I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers - Fourth edition

2. K. Ogata, Modern Control Engineering, Eastern Economy, 5th edition 2011.

Reference Books

1. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 2010
2. B. C. Kuo, Automatic Control System, Wiley Publication 8th Edition.
3. Norman S. Nise, Control System Engineering, John Wiley and Sons, 6th Edition, 2014.
4. M.Gopal, Digital Control and State Variable Methods, Tata Mc Graw Hill, 3rd Edition

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	2	2	3	-	-	-	1	1	1	1	1	1
CO2	1	3	2	2	1	-	-	-	1	1	1	1	1	1
CO3	2	3	3	2	2	-	1	-	1	1	2	2	2	2

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech)

Course Code:25UGPCCEE502 **Course Name:** Electrical Power Generation

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	**03**	**ISE: 40 Marks** **ESE: 60 Marks**

Prerequisites: Electrical Engineering fundamentals, Electrical circuit concepts such as voltage, current, resistance, power, and energy.

Course Objectives:

1) Understand and analyze distribution systems, substations, connection schemes, and voltage drop in AC distribution networks.
2) Analyze the mechanical design of transmission lines, including conductors, insulators, sag, corona, and underground cables.
3) Understand and apply power factor improvement techniques and emerging trends in electrical power systems, including renewable generation and energy storage technologies.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Describe the Electrical power generation methods & major power system components.	Understand
CO2	Explain the terms involved in generation cost & different tariff systems.	Analyze
CO3	Discuss the power factor improvement methods in electrical power systems.	Understand
CO4	Calculate the voltage drop of distributor for given parameters	Analyze
CO5	Apply knowledge of overhead & underground transmission system elements to calculate the parameters in mechanical construction of lines.	Apply
CO6	Analyze the different electrical parameters of overhead transmission lines.	Analyze

Course Description: This course provides a comprehensive understanding of electrical power generation, transmission, distribution, and utilization**.** It covers conventional and renewable power generation, power system elements, economics of generation, distribution systems, transmission line design, underground cables, and substation arrangements. The course also focuses on transmission line parameters, power factor improvement, and emerging power system technologies such as renewable energy sources, wireless power transmission.

Course Content

Unit-1	Generation of Electrical Power & System Elements	8 Hrs

Generation of Electrical Power : AC power system Single line diagram, India's electricity scenario, Thermal power plant, Hydro power plant, Nuclear power plant, Diesel power plant, Wind power plant, solar power plant, Tidal power plant schematic diagram, Selection of site, Advantages & Disadvantages.

Power System Elements: Brief description of power system elements such as Synchronous Machine, Transformer, Bus bar, Circuit Breaker, Isolator, CT, PT.

Unit-2	Economics of Generation	6 Hrs

Load curve, Load duration curve, Maximum demand, Average Load, Load factor, Demand factor, Diversity factor, Plant capacity factor, Plant use factor (Numerical)

Economics of generation, Cost of the generation, Fixed cost, Semi fixed cost and running cost, Methods of determining depreciation. Tariff, Desirable characteristics of tariff, Tariff methods - two part tariff, Three part tariff & Power factor tariff methods.

Unit-3	Distribution System	6 Hrs

Distribution system introduction, Feeder & Distributor, Classification of distribution systems, Connection schemes of distribution schemes, Voltage drop calculation (Derivation & Numerical) to AC distribution systems of radial and ring system, Substation, Indoor & Outdoor substation, Substation layout.

Unit-4	Mechanical Design of Transmission System	6 Hrs

Main elements of transmission lines, Types of Conductors (ACSR, Expanded ACSR, ACAR, Bundle conductor), Line supports, Types of line supports, Insulators, Types of insulators, Potential distribution over suspension insulators, String efficiency, Methods to improve string efficiency, Sag, Calculation of sag (Numerical), Corona, Factors affecting the corona, Advantages and disadvantages of corona, Methods to reduce the corona.

Unit-5	Electrical Design of Transmission System	6 Hrs

Resistances, Calculation of resistance, Inductance, Flux linkage of the single conductor, Inductance of single phase two - wire line, Three phase line and Double circuit line, Skin effect, Proximity effect, Capacitance, Capacitance of two - wire line, Three phase line with equilateral space, Capacitance of line with unequal spacing, Numerical

Unit-6	Power Factor Improvement & Trends in power system	6 Hrs

Power factor, Disadvantages of low power factor, Causes of low power factor, Methods of improving power factor - static capacitor, Synchronous condensers, Calculations of power factor, Most economical power factor for KW and KVAR loads, Numerical problems

Trends in power system: Alternate sources of power generation, Introduction to wireless power transmission system, Super capacitor.

Case Study:

1). Economic Analysis of a Thermal Power Plant
2). Power Factor Improvement in an Industrial Plant
3). Design of a 132 kV Transmission Line

Learning Resources:

Text Books

1) Principles of Power system VK Mehta &Rohit Mehta S. Chand company PVT LTD Fourth 2007
2) Electrical power systems Ashfaq Hussain CBS publications Fifth 2007
3) Electrical Power Generation, Transmission & Distribution SN Singh PHI learning PVT LTD Second 2003

Reference Books

1) “Electrical Power System Weedy B M, Cory BJ John Wiley Publication Fifth 2013
2) Electrical Power Generation, Transmission & Distribution Leonard L. Grigsby CRC Press Third 2012
3) Electrical Power systems CL Wadhwa New age International (P) Limited Sixth 1997

MOOC / NPTEL/YouTube Links

1.NPTEL – Power System Generation, Transmission and Distribution, Prof. D. P. Kothari, IIT Delhi

2.Introduction to power delivery systems. NPTEL IIT Guwahati
https://share.google/ULwEwFzfM10RLkl0N

3.SWAYAM Portal https://swayam.gov.in

4.NPTEL Official https://www.youtube.com/@nptelhrd

CO-PO/PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	2	1	-	-	-	1	1	-	-	-	-	3	1	2
CO2	3	2	1	-	-	-	-	-	-	1	1	2	1	2
CO3	2	2	1	-	-	1	2	-	-	1	-	3	2	1
CO4	2	1	1	1	1	-	-	-	-	1	-	2	2	1
CO5	2	2	2	1	1	1	1	-	1	1	1	2	3	2
CO6	2	2	2	1	2	1	1	-	-	1	1	2	3	3

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGPCCEE502L **Course Name:** Electrical Power Generation Lab

Teaching Scheme	Credit	Evaluation Scheme
Practical: 02 Hours/Week	**01**	**ISA: 25 Marks**

Prerequisites: Basic knowledge of electrical circuits, electrical machines, and measurement techniques.

Course Objectives:

1) Understand the working and characteristics of conventional and renewable electrical power generation systems.
2) Analyze electricity tariff methods, power factor improvement techniques, and transmission line parameters using suitable calculations and simulations.
3) Develop practical skills to study power system components, interpret experimental results, and evaluate the performance of transmission systems and insulators.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Understand the working and characteristics of conventional and renewable power generation systems.	Understand
CO2	Analyze different electricity tariff methods and economic aspects of power systems	Analyze
CO3	Apply power factor improvement techniques and determine the required KVAR compensation.	Apply
CO4	Analyze the mechanical and electrical parameters of overhead transmission lines.	Analyze

Course Description: This course provides practical knowledge of electrical power generation, transmission, and power system components through simulation, layout study, and analytical experiments. It covers conventional and renewable power generation systems, electricity tariffs, power factor improvement, overhead transmission line parameters, and transmission-line insulators. The course develops students' ability to analyze power system characteristics, perform calculations, interpret results, and understand practical power system operation**.**

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar SWVSM's ★

Course Content

List of Experiments

Minimum 8 experiments should be performed

Sr. No.	Name of the experiment	Hrs.	Cognitive levels of attainment As per Bloom's
1	Draw a layout and Study the working and characteristics of a thermal power plant using a suitable simulation/model.	2	Apply
2	Draw a layout and Study the working and characteristics of a hydroelectric power plant using a suitable simulation/model.	2	Apply
3	Draw a layout and Study the working and characteristics of a nuclear power plant and its major components.	2	Apply
4	Draw a layout and Study the working and characteristics of a diesel power plant.	2	Apply
5	Draw a layout and Study the working and characteristics of a wind power generation system	2	Apply
6	Draw a layout and Study the working and characteristics of a solar photovoltaic (PV) power generation system.	2	Understand
7	Study the working and characteristics of a tidal power generation system.	2	Understand
8	Study and compare different electricity tariff methods, including two-part, three-part, and power-factor tariffs.	2	Understand
9	Study the power factor improvement using static capacitors and determine the required kVAR compensation.	2	Understand
10	Study the mechanical and electrical parameters of overhead transmission lines, including sag, conductor characteristics, resistance, inductance, and capacitance	2	Understand
11.	Study the characteristics of transmission-line insulators, including potential distribution and string efficiency	2	Understand

Learning Resources:

Text Books

1). Principles of Power system VK Mehta &Rohit Mehta S. Chand company PVT LTD Fourth 2007
2)Electrical power systems Ashfaq Hussain CBS publications Fifth 2007
Electrical Power Generation, Transmission & Distribution SN Singh PHI learning PVT LTD Second 2003

Reference Books

1) "Electrical Power System Weedy B M, Cory BJ John Wiley Publication Fifth 2013
2) Electrical Power Generation, Transmission & Distribution Leonard L. Grigsby CRC Press Third 2012
3) Electrical Power systems CL Wadhwa New age International (P) Limited Sixth 1997
4) Transmission & Distribution electrical engineering Dr. CR Bayliss& BJ Hardy Newnes Third

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	-	2	2	-	-	-	-	1	-	2	-	-
CO2	3	3	1	3	2	-	-	-	1	1	-	2	1	-
CO3	3	3	2	3	2	-	-	-	-	1	-	2	2	-
CO4	3	2	2	2	2	-	1	-	1	1	-	2	-	1

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranangar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGPCCEE503 **Course Name: Power System Analysis**

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**02**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Fundamentals of Electrical Engineering, PTDS, Basic Circuit Analysis

Course Objectives:

1) Understand the different conventional and non-conventional energy sources and their operating principles, advantages, disadvantages, and applications.
2) Explain the structure of an electrical power system, various load factors, and different types of electricity tariffs used for consumers.
3) Study the mechanical design of overhead transmission lines, types of insulators, underground cables, and perform basic design calculations such as sag and string efficiency.
4) Analyze the resistance, inductance, and capacitance of transmission lines under different conductor configurations using concepts such as GMR, GMD, and transposition.
5) Evaluate the performance of short and medium transmission lines, including voltage regulation, transmission efficiency, Ferranti effect, and ABCD parameters using appropriate transmission line models.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the typical layout and components of an electrical power system, including hydro, thermal, and nuclear power plants, with emphasis on the construction and function of each component.	Understand
CO2	Recognize different patterns of load curve and calculate associated different factors with it and tariff.	Apply
CO3	Evaluate the mechanical design aspects of overhead lines, including components, supports, conductor spacing, sag calculation, and effects of ice and wind loading.	Analyze
CO4	Analyze the resistance and inductance of transmission lines	Apply
CO5	Analyze the capacitance of transmission lines.	Analyze
CO6	Classify transmission lines based on length and voltage levels, and analyze the performance of short and medium transmission lines.	Analyze

Course Description:

Students learn the mechanical design of overhead transmission lines, including sag calculations, conductor supports, insulators, and underground cable construction and grading. The course also develops analytical skills for determining the resistance, inductance, and capacitance of transmission lines using concepts such as GMR, GMD, transposition, and bundled conductors. Finally, it covers the performance analysis of short and medium transmission lines, including transmission line models, ABCD constants, Ferranti effect, voltage regulation, and transmission efficiency. The course combines theoretical concepts with numerical problem-solving to prepare students for the design, analysis, operation, and maintenance of electrical power systems.

<table>
<tr><th colspan="3">Course Content</th></tr>
<tr><td>Unit-1</td><td>Structure of Electrical Power system</td><td>4 Hrs</td></tr>
<tr><td colspan="3">Structure of electrical power system, Different factors associated with generating stations such as Connected load, Maximum demand, Demand factor, Average load, Load factor, Diversity factor, Plant capacity factor, Reserve capacity, Plant use factor, Load curve, Load duration curve, Concept of base load and peak load stations.</td></tr>
<tr><td>Unit-2</td><td>Tariff</td><td>4 Hrs</td></tr>
<tr><td colspan="3">Introduction of Tariff, Tariff setting principles, desirable characteristics of tariff. various consumer categories and implemented tariff such as two-part tariff, three-part tariff(Numerical on two part and three-part tariff), Time of day tariff for H.T and L.T industrial and commercial consumers, Introduction to Availability based tariff (ABT), kVAh tariff.</td></tr>
<tr><td>Unit-3</td><td>Mechanical Design of Overhead lines and Insulators & Underground Cables</td><td>10 Hrs</td></tr>
<tr><td colspan="3">1). Mechanical Design of Overhead lines: Main components of overhead lines, Various types of line supports, Conductor spacing, Length of span, Calculation of sag for equal and unequal supports and effect of ice and wind loading.
2). Overhead Line Insulators: Types of insulators, its construction and their applications, String efficiency,(Numerical on string efficiency and up to four discs only), Methods of improving string efficiency.
3). Underground Cables: Construction of Cables, Classification of cables, XLPE cables, Capacitance of single core and three core cable, Dielectric stresses in single core cable, grading of cables, inter sheath grading, capacitance grading.</td></tr>
<tr><td>Unit-4</td><td>Resistance and Inductance of Transmission Line</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Resistance of transmission line, Skin effect and proximity effect, Factors responsible for production of these effects. Internal and external flux linkages of single conductor, Inductance of single phase two wire line, Necessity of transposition, Inductance of three phase line with symmetrical and unsymmetrical spacing with transposition, Concept of G.M.R and G.M.D, Inductance of bundled conductors. Electric potential at single charged conductor, Potential at conductor in a group of charged conductors.</td></tr>
<tr><td>Unit-5</td><td>Capacitance of Transmission Line</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Capacitance of single phase line, Capacitance of single phase line with effect of earth's surface on electric field, Concept of G.M.R and G.M.D for capacitance calculations, need of transposition for capacitance calculations, Capacitance of three phase line with symmetrical and unsymmetrical spacing with transposition. Capacitance of single circuit and double circuit three phase line with symmetrical and unsymmetrical spacing considering transposition (without considering earth effect).</td></tr>
<tr><td>Unit-6</td><td>Performance of Transmission Line</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Classification of lines based on length and voltage levels, Performance of short transmission lines with voltage current relationship and phasor diagram, Representation of medium lines as 'Nominal Π' and 'Nominal T' circuits using R, L and C parameters, Ferranti effect, Representation of 'T' and 'T' models of lines as two port networks, Evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of efficiency and regulation of short and medium lines.</td></tr>
<tr><td colspan="3">Case Study:
1). Planning and Performance Analysis of a 132 kV Power Transmission System.
2). Select an appropriate generating station based on energy demand and resource availability.
3). Evaluate the performance of the transmission line using Nominal T and Nominal Π models by calculating voltage regulation, efficiency, ABCD parameters, and studying the Ferranti effect.</td></tr>
<tr><td colspan="3">Learning Resources:</td></tr>
<tr><td colspan="3">Text Books
1). Sivanagaraju S, S Satya Narayana, Electric Power Transmission and Distribution, Pearson Education India, 2009.
2). D. P. Kothari and I. J. Nagrath, Power System Engineering, TMH, India, 2007</td></tr>
</table>

Reference book:

1). C. L. Wadhwa, Electrical Power Systems, New Age International Pvt. Ltd.,
2). HadiSaadat, Power System Analysis, McGraw-Hill, 2004
3). Colin Bayliss and Brian Hardy, Transmission and Distribution Electrical Engineering, ElsevierScience, 2012
4) Ned Mohan, Tore M. Undeland, and WP. Robbins, Electric Power Systems: A First Course,Wiley, 2012.

MOOC / NPTEL/YouTube Links

1).NPTEL – Power System Analysis (IIT Kharagpur)
https://www.nptel.ac.in/courses/117105140
2).NPTEL – Power System Analysis (IIT Kanpur**)**
https://www.nptel.ac.in/courses/108104051
3).NPTEL Courses on YouTube
https://nptel.ac.in/courses/108107167

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	2	2	1	-	1	2	1	-	-	-	1	1	2	2
CO2	3	2	2	1	2	2	1	-	-	-	1	2	2	2
CO3	2	3	2	2	2	2	1	1	-	-	1	2	2	2
CO4	3	1	2	2	3	2	1	1	-	-	2	2	3	2
CO5	2	3	3	2	-	2	2	1	1	-	2	-	3	-
CO6	3	3	1	2	-	2	2	1	1	-	2	-	3	-

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology Department of Electronics & Telecommunication Second Year of Bachelor of Technology (T.Y.B.Tech) Sem-V				
Course Code: 25UGPCCEE502LP **Course Name:** Power System Analysis Lab				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Practical:	**02 Hours/Week**	**01**	**ISA:**	**25 Marks**
			POE:	**25 Marks**

Prerequisites :

Fundamentals of Electrical Circuits, Basic Electrical Engineering Course.

Course Objectives:

1).To understand the construction, operation, and performance characteristics of power generation, transmission, and distribution systems.
2).To analyze load parameters, tariff structures, and power system components for efficient planning and operation.
3).To apply the concepts of transmission line design, parameters, and modeling for evaluating power system performance.
4).To develop practical skills in testing, measurement, and analysis of electrical power system components and networks.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Apply theoretical concepts of power system analysis to interpret experimental results and evaluate the performance of electrical transmission systems.	Understand
CO2	Identify and explain the layout, components, and operation of different types of power plants and transmission substations.	Apply
CO3	Analyze the structure of electrical power systems, including load parameters, generating station factors, and tariff structures, enabling them to effectively integrate available generating stations	Analyze
CO4	Estimate the performance characteristics of transmission lines.	Analyze

Course Description:

This laboratory course provides practical exposure to the operation and analysis of electrical power systems through visits, experiments. The course focuses on measurement and analysis of power system parameters, including load characteristics, overhead line design, underground cable characteristics, and transmission line parameters such as resistance, inductance, and capacitance

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content

List of Experiments

Minimum 8 experiments should be performed

Sr. No.	Name of the experiment	Hrs	Cognitive levels of attainment As per Bloom's
1	Visit to Power Plants Objective:-To study and Understand the layout, components, and functioning of different types of power plants through observation and interaction with plant personnel.	2	Understand
2	Calculation of Load Parameters and Load Duration Curve. Objective: Calculate and analyze various load parameters such as connected load, maximum demand, load factor, and load duration curve from given data.	2	Understand
3	Visit to Transmission Substation - Identification and Functionality of Major Equipment. Objective: Identify and describe the major electrical equipment used in a model power station setup, including alternators, transformers, circuit breakers, and control panels.	2	Understand
4	Testing of Underground Cable Characteristics. Objective: Measure and analyze the characteristics of underground cables, including capacitance and dielectric stresses, using experimental setups.	2	Understand
5	Sag Calculation and Mechanical Design of Overhead Lines. Objective: Calculate sag and design overhead lines considering various factors such as conductor spacing, span length, and environmental conditions.	2	Understand
6	Testing of Overhead Lines Objective: evaluate the string efficiency of overhead line insulators.	2	Understand
7	Measurement of Resistance and Inductance of Transmission Line. Objective: Measure the resistance and inductance of transmission lines.	2	Evaluate
8	Measurement of Capacitance of Transmission Line. Objective: Measure the capacitance of transmission lines.	2	Evaluate
9	Performance Analysis of Short Transmission Lines Objective: Analyze the voltage-current relationship and phasor diagram of short transmission lines to determine efficiency and regulation.	2	Evaluate
10	Modeling and Analysis of Medium Transmission Lines. Objective: Model medium transmission lines as 'Nominal Π' and 'Nominal T' circuits and estimate efficiency and regulation using ABCD parameters.	2	Evaluate

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Learning Resources:

Text Books

1. B.M. Weedy, B.J. Cory, N. Jenkins, and Janaka B. Ekanayake, Electric Power Systems, John Wiley & Sons Limited, 2012.
2. Sivanagaraju S, S Satya Narayana, Electric Power Transmission and Distribution, Pearson Education India, 2009.
3. D. P. Kothari and I. J. Nagrath, Power System Engineering, TMH, India, 2007.
4. Singh S. N, Electric Power Generation, Transmission, and Distribution, PHI Learning, 2008

Reference Books

1. C. L. Wadhwa, Electrical Power Systems, New Age International Pvt. Ltd.,
2. HadiSaadat, Power System Analysis, McGraw-Hill, 2004
3. Colin Bayliss and Brian Hardy, Transmission and Distribution Electrical Engineering, Elsevier Science, 2012
4. Ned Mohan, Tore M. Undeland, and WP. Robbins, Electric Power Systems: A First Course, Wiley, 2012.

CO-PO-PSO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	-	-	2	-	3	2	2
CO2	3	2	1	1	2	2	2	1	-	1	-	3	2	2
CO3	3	3	3	2	2	2	2	1	-	2	1	3	3	3
CO4	3	3	2	2	2	1	2	-	-	2	-	3	3	2

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGPEC1EE5041 **Course Name:** Energy Storages Technologies

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	03 Hours/Week	03	ISE:	40 Marks
			ESE:	60 Marks

Prerequisites: Basic Electrical Engineering, Power Systems .Renewable Energy Systems , Power Electronics (Desirable) Electrical Measurements and Instrumentation

Course Objectives:
1).Understand the fundamentals and importance of energy storage in modern power systems.
2).Study various electrochemical, mechanical, electrical, thermal, and hydrogen energy storage technologies.
3).Analyze the design, operation, control, and management of energy storage systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the principles, characteristics, and classifications of various energy storage technologies.	Understand
CO2	Analyze the operation and performance of battery energy storage systems and battery management systems.	Understand
CO3	Evaluate mechanical, electrical, thermal, and hydrogen-based storage technologies for different applications.	Analyze
CO4	Design and assess energy storage integration with renewable energy systems, electric vehicles, and smart grids.	Apply
CO5	Apply advanced energy management strategies and emerging technologies for sustainable energy storage solutions.	Evaluate
CO6	Develop and recommend suitable energy storage solutions by considering technical, economic, environmental, and sustainability aspects for real-world energy applications.	Create

Course Description:

Energy Storage Technologies is a comprehensive course that introduces students to the principles, design, operation, and applications of modern energy storage systems used in electrical power systems and renewable energy integration. The course covers various storage technologies including electrochemical storage (batteries), mechanical storage (pumped hydro, flywheels, compressed air), electrical storage (super capacitors and superconducting magnetic energy storage), thermal energy storage, and hydrogen-based storage systems.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranenagar SWVSM's

Course Content		
Unit-1	**Fundamentals of Energy Storage Technologies**	**6 Hrs**
Introduction to energy storage, Need for energy storage in modern power systems, Role in renewable energy integration, Classification of energy storage systems, Characteristics of storage technologies, Applications in power systems.		
Unit-2	**Battery Energy Storage Systems**	**6 Hrs**
Primary and secondary batteries, Lead-acid batteries, Nickel-Cadmium batteries, Lithium-ion batteries, Battery charging and discharging characteristics, Battery Management System (BMS), State of Charge (SOC), State of Health (SOH), Thermal management, **(Numerical Treatment)**		
Unit-3	**Mechanical, Electrical and Thermal Energy Storage**	**6 Hrs**
Pumped Hydro Energy Storage (PHES), Compressed Air Energy Storage (CAES), Flywheel Energy Storage, Super capacitors, Superconducting Magnetic Energy Storage (SMES), Thermal energy storage systems, Sensible heat storage,		
Unit-4	**Hydrogen Energy Storage and Fuel Cells**	**6 Hrs**
Hydrogen production methods, Electrolysis, Hydrogen storage technologies, Fuel cell principles, PEM fuel cells, SOFC, Fuel cell characteristics, Hydrogen economy, Grid applications, Renewable hydrogen systems, Safety and environmental aspects.		
Unit-5	**Energy Storage Applications**	**6 Hrs**
Integration with solar PV and wind energy, Micro grids, Smart grids, Electric vehicles, Vehicle-to-Grid (V2G), Peak shaving, Load leveling, Frequency regulation, Voltage support, Grid stability enhancement, Industrial applications, Case studies. **(Numerical Treatment)**		
Unit-6	**Advanced Energy Storage Technologies and Future Trends**	**6 Hrs**
Artificial Intelligence in energy management, Hybrid energy storage systems, Internet of Things (IoT)-based monitoring, Digital twins for battery systems, Solid-state batteries, Emerging research trends, Future scope.		

Case Study:

1).Case Study on Battery Energy Storage System (BESS) for Solar Power Plant
2).Case Study on Energy Storage for an Electric Vehicle Charging Station
3).Case Study on Pumped Hydro Energy Storage for Grid Stability
4).Case Study on Hydrogen Energy Storage in a Smart Micro grid

Learning Resources:

Text Books

1).Huggins, R. A., Energy Storage, Springer.
2).Luo, X., Wang, J., Dooner, M., and Clarke, J., Overview of Current Development in Electrical Energy Storage Technologies, Elsevier.

Reference Books

1).“Robert A. Huggins, Advanced Batteries: Materials Science Aspects, Springer.
2).Chris Mi, M. Abul Masrur and David Gao, Hybrid Electric Vehicles: Principles and Applications, Wiley.
3).Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley.
4).Bent Sørensen, Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning, Academic Press.
5).B. Dunn, H. Kamath and J. M. Tarascon, Electrical Energy Storage for the Grid: A Battery of Choices, Science Journal.

MOOC / NPTEL/YouTube Links:

1).NPTEL – Energy Storage Systems:https://nptel.ac.in/courses
2).NPTEL – Battery Management Systems:https://nptel.ac.in/courses
3).NPTEL – Electric Vehicles:https://nptel.ac.in/courses
4).NPTEL – Renewable Energy Engineering:https://nptel.ac.in/courses

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	1	-	2	-	-
CO2	2	2	2	2	1	-	-	-	1	1	-	2	1	-
CO3	2	2	1	-	-	-	-	-	-	1	-	1	-	-
CO4	2	2	2	3	2	-	-	-	-	1	-	2	2	-
CO5	2	3	2	2	2	-	-	1	-	1	-	1	2	-
CO6	2	2	2	1	-	1	1	-	-	1	1	2	1	1

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGPEC1EE5041T **Course Name:** Energy Storages Technologies Tutorial

Teaching Scheme		Credit	Evaluation Scheme	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites: Basic Electrical Engineering, Power Systems & Renewable Energy Systems, Power Electronics (Desirable), Electrical Measurements and Instrumentation.

Course Objectives:

1).Understand the fundamentals and importance of energy storage in modern power systems.
2).Study various electrochemical, mechanical, electrical, thermal, and hydrogen energy storage technologies.
3).Analyze the design, operation, control, and management of energy storage systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the principles, characteristics, and classifications of various energy storage technologies.	Understand
CO2	Analyze the operation and performance of battery energy storage systems and battery management systems.	Understand
CO3	Evaluate mechanical, electrical, thermal, and hydrogen-based storage technologies for different applications.	Analyze
CO4	Design and assess energy storage integration with renewable energy systems, electric vehicles, and smart grids.	Apply
CO5	Apply advanced energy management strategies and emerging technologies for sustainable energy storage solutions.	Evaluate
CO6	Develop and recommend suitable energy storage solutions by considering technical, economic, environmental, and sustainability aspects for real-world energy applications.	Create

Course Description:

Energy Storage Technologies is a comprehensive course that introduces students to the principles, design, operation, and applications of modern energy storage systems used in electrical power systems and renewable energy integration. The course covers various storage technologies including electrochemical storage (batteries), mechanical storage (pumped hydro, flywheels, compressed air), electrical storage (super capacitors and superconducting magnetic energy storage), thermal energy storage, and hydrogen-based storage systems.

Note: Minimum 6 tutorials to be conducted based on syllabus.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGPEC1EE5042 **Course Name:** Electrical Estimation & Costing

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Basic Electrical Engineering, Electrical Wiring and Installation, Electrical Machines, Power Systems, Engineering Drawing, Electrical Measurements and Instrumentation.

Course Objectives:

1).Understand the principles and standards used in electrical estimation and costing.
2).Develop the ability to prepare detailed estimates for residential, commercial, industrial, and distribution electrical installations.
3).Learn the preparation of material schedules, cost analysis, tender documents, and electrical project reports.
4).Study electrical wiring systems, earthing, illumination, and substation estimation procedures.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the fundamentals, standards, and procedures of electrical estimation and costing.	Understand
CO2	Prepare estimates and material schedules for domestic and commercial electrical installations.	Apply
CO3	Analyze estimation methods for industrial installations, substations, and transmission/distribution systems.	Analyze
CO4	Develop tender documents, project reports, and cost analysis using standard electrical practices.	Apply
CO5	Evaluate modern estimation software, project management techniques, and relevant safety regulations.	Evaluate
CO6	Design economical, safe, and standards-compliant electrical estimation and costing solutions for practical engineering projects.	Create

Course Description:

Electrical Estimation & Costing is a comprehensive course that provides students with the knowledge and practical skills required for planning, estimating, and costing electrical installations in residential, commercial, industrial, and utility sectors. Students will learn estimation procedures for lighting installations, power wiring, substations, overhead and underground distribution systems, earthing systems, and renewable energy installations. The course also introduces relevant Indian Standards (IS), National Electrical Code, energy efficient design practices, safety regulations and software tools used for electrical estimation and project management.

Course Content

Unit	Topic	Hours
Unit-1	**Fundamentals of Electrical Estimation and Costing:**	**6 Hrs**
Introduction to electrical estimation and costing, Purpose and importance of estimation, Types of estimates, Electrical symbols and standards, Indian Electricity Rules, National Electrical Code (NEC), IS specifications, Schedule of rates.		
Unit-2	**Estimation of Residential and Commercial Electrical Installations**	**6 Hrs**
Residential wiring systems, Commercial building wiring, Lighting and power circuits, Internal wiring methods, Conduit wiring, Casing and capping wiring, Cable selection, Switchgear selection, Earthing systems, Preparation of material schedules, Estimation of labor charges, Cost calculations,		
Unit-3	**Industrial Electrical Estimation**	**6 Hrs**
Industrial power distribution, Motor installations, Cable sizing, Bus bar systems, Control panels, Industrial lighting systems, Power factor improvement equipment, Estimation of electrical machinery installations, Earthing systems,		
Unit-4	**Estimation of Substations and Distribution Systems**	**6 Hrs**
Distribution transformers, Pole-mounted substations, Indoor and outdoor substations, HT and LT overhead lines, Underground cable systems, Street lighting systems, Distribution network planning, Material estimation, Cost estimation, Maintenance considerations.		
Unit-5	**Tendering, Cost Analysis and Project Management**	**6 Hrs**
Tender documents, Tender specifications, BOQ (Bill of Quantities), Contract procedures, Cost analysis, Rate analysis, Project scheduling, Resource planning, CPM and PERT basics, Electrical project documentation, Quality control, Safety regulations.		
Unit-6	**Modern Estimation Techniques and Future Trends**	**6 Hrs**
Computer-aided electrical estimation software,Smart electrical installations, Energy-efficient building estimation, Solar PV system estimation, Electric vehicle charging infrastructure estimation, AI-based project planning.		

Case Study:

1).Case Study on Prepare a detailed electrical estimate using standard estimation procedures.
2). Case Study on Develop the Bill of Quantities (BOQ).
3). Case Study on Calculate labour charges and total project cost.

Learning Resources:

Text Books

1. J.B. Gupta, Electrical Estimating and Costing, S.K. Kataria& Sons.
2. K.B. Raina and S.K. Bhattacharya, Electrical Design, Estimating and Costing, New Age International.

Reference Books

1. M. Chakrabarti, Estimating, Costing and Valuation in Electrical Engineering, Wheeler Publishing.
2. B.L. Theraja and A.K. Theraja, A Textbook of Electrical Technology, S. Chand.
3. Bureau of Indian Standards (BIS), National Electrical Code of India (NEC).
4. Central Public Works Department (CPWD), General Specifications for Electrical Works.
5. IEEE Standards on Electrical Installations and Safety.

MOOC / NPTEL/YouTube Links:

1).NPTEL – Electrical Wiring, Estimation and Costing (NPTEL Course Portal) Link:https://nptel.ac.in
2).SWAYAM – NPTEL Electrical Engineering Courses Link:https://onlinecourses.nptel.ac.in
3).NPTEL Official YouTube Channel Link: https://www.youtube.com/@nptelhrd

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	–	–	–	–	–	2	–	–	–	2	–	–
CO2	2	3	2	–	2	–	–	–	–	–	–	3	2	–
CO3	2	3	2	2	2	–	–	–	–	–	–	3	3	–
CO4	2	2	3	–	2	–	–	2	2	2	–	2	3	–
CO5	1	2	–	2	3	–	2	3	2	2	2	2	2	2
CO6	3	3	3	2	3	2	2	2	2	2	2	3	3	3

Tatyasaheb Kore Institute of Engineering and Technology Department of Electrical Engineering Third Year of Bachelor of Technology (T. Y.B.Tech) Sem-V				
Course Code: 25UGPEC1EE5042T		**Course Name:** Electrical Estimation & Costing Tutorial		
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites: Basic Electrical Engineering and Electrical Wiring and Installation, Electrical Machines and Power Systems, Engineering Drawing (Desirable), Electrical Measurements and Instrumentation.

Course Objectives:

1).Understand the principles and standards used in electrical estimation and costing.
2).Develop the ability to prepare detailed estimates for residential, commercial, industrial, and distribution electrical installations.
3).Learn the preparation of material schedules, cost analysis, tender documents, and electrical project reports.
4).Study electrical wiring systems, earthing, illumination, and substation estimation procedures.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the fundamentals, standards, and procedures of electrical estimation and costing.	Understand
CO2	Prepare estimates and material schedules for domestic and commercial electrical installations.	Apply
CO3	Analyze estimation methods for industrial installations, substations, and transmission/distribution systems.	Analyze
CO4	Develop tender documents, project reports, and cost analysis using standard electrical practices.	Apply
CO5	Evaluate modern estimation software, project management techniques, and relevant safety regulations.	Evaluate
CO6	Design economical, safe, and standards-compliant electrical estimation and costing solutions for practical engineering projects.	Create

Course Description:

Electrical Estimation & Costing is a comprehensive course that provides students with the knowledge and practical skills required for planning, estimating, and costing electrical installations in residential, commercial, industrial, and utility sectors. The course covers electrical wiring systems, load calculations, selection of conductors and protective devices, preparation of material schedules, costing, tender documentation, and project estimation techniques.

Note: Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V
Course Code:25UGPEC1EE5043 **Course Name:** Electric Vehicle Technology

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Basic Electrical Engineering, Engineering Physics & Fundamentals of Electronics

Course Objectives:

1) This will help students to understand the fundamentals and architecture of Electric Vehicles (EVs).
2) This will help students to learn different energy storage systems and Battery Management Systems.
3) It intends to students to analyze EV performance, testing, maintenance, and safety.
4) This will help to students to understand Indian EV policies, standards, and future trends.
5)

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the fundamentals, architecture, and classifications of Electric Vehicles.	Understand
CO2	Analyze battery technologies, Battery Management Systems, and energy storage systems used in EVs.	Analyze
CO3	Explain the operation of electric motors, power electronic converters, and propulsion systems used in Electric Vehicles.	Understand
CO4	Demonstrate knowledge of EV charging systems, testing procedures, maintenance practices, and safety standards.	Apply
CO5	Analyze Indian EV policies, emerging technologies, and sustainable mobility solutions.	Analyze

Course Description:

This course provides a comprehensive introduction to Electric Vehicle (EV) Technology, covering the fundamentals of electric mobility, EV architecture, energy storage systems, electric propulsion, power electronics, charging infrastructure, maintenance, safety, government policies, and emerging trends. The course enables students to understand the design, operation, testing, and maintenance of Electric Vehicles while developing knowledge of sustainable transportation technologies and their industrial applications.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content

Unit-1	Fundamentals of Electric Vehicles	6 Hrs

Introduction to Electric Vehicles (EVs), History and evolution of EVs, Need for electric mobility, Environmental impact and sustainability, Comparison of Internal Combustion Engine (ICE) vehicles and Electric Vehicles, Classification of EVs.

Unit-2	Energy Storage Systems	6 Hrs

Fundamentals of batteries, Battery terminology and characteristics, Types of batteries (Lead Acid, Nickel Metal Hydride, Lithium-ion, Solid-State), Battery parameters (SOC, SOH, DOD, C-rate, Energy Density, Power Density), Battery Management System (BMS).

Unit-3	Electric Propulsion System and Power Electronics	6 Hrs

Electric propulsion system, EV drivetrain configuration, Types of electric motors (DC, BLDC, PMSM, Induction Motor, Switched Reluctance Motor), Motor characteristics and selection, Power electronic converters (DC-DC converters).

Unit-4	Charging Infrastructure and EV Performance	6 Hrs

EV charging fundamentals, Charging standards (IEC, Bharat AC/DC standards), AC and DC charging, Fast charging and ultra-fast charging, Wireless charging, Battery swapping technology, Charging station components, Grid integration, Vehicle performance parameters, Energy consumption, Range estimation, Vehicle testing and performance analysis.

Unit-5	Electric Vehicle Maintenance, Safety and Diagnostics	6 Hrs

Preventive and predictive maintenance of EVs, Troubleshooting of battery packs, motors, controllers and charging systems, Diagnostic tools and fault analysis, Electrical safety practices, High-voltage safety, Personal Protective Equipment (PPE), Fire hazards and emergency procedures.

Unit-6	EV Policies, Emerging Technologies and Future Trends	6 Hrs

National Electric Mobility Mission Plan (NEMMP), FAME Scheme, PM E-Drive initiatives, Government incentives and subsidies, BIS and AIS standards for EVs, Smart charging, Vehicle-to-Grid (V2G), Internet of Things (IoT) in EVs, Connected and Autonomous Electric Vehicles, Hydrogen Fuel Cell Vehicles, Recent advancements in battery technology.

Case Study:

1).Case Study on Comparative Analysis of ICE Vehicles and Battery Electric Vehicles (BEVs)
2).Case Study on Performance Comparison of Lithium-ion and Solid-State Batteries
3).Case Study on Comparative Study of AC and DC Fast Charging Stations
4).Case Study on Predictive Maintenance of Electric Vehicle Battery Packs

Learning Resources:

Text Books

4) Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes.
5) C.C. Chan, The Electric Vehicle, Oxford University Press.

Reference Books

1) James Larminie& John Lowry, Electric Vehicle Technology Explained, Wiley.
2) MehrdadEhsani, Yimin Gao & Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press.
3) Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press.

MOOC / NPTEL/YouTube Links

1).Fundamentals of Electric Vehicles: Technology & Economics (IIT Madras)
https://nptel.ac.in/courses/103103206
2).Electric Vehicle: Its Components, Charging Infrastructure and Grid Integration
https://nptel.ac.in/courses/108107002

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	2	2	-	-	1	-	-	-	-	-	-	2	2	-
CO2	2	3	2	2	2	-	-	-	-	-	1	2	3	1
CO3	3	2	-	-	1	-	-	-	-	-	-	3	2	-
CO4	3	3	2	2	2	-	-	-	-	-	1	3	3	1
CO5	2	2	2	-	3	-	-	-	-	1	2	2	2	2
CO6	2	3	3	2	3	1	1	-	2	2	3	2	3	3

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T. Y. B. Tech) Sem-V

Course Code: 25UGPEC1EE5043T **Course Name:** Electrical Vehicle Technology Tutorial

Teaching Scheme		Credit	Evaluation Scheme	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites: Basic Electrical and Electronics Engineering, Engineering Physics

Course Objectives:

1).This will help students to understand the fundamentals and architecture of Electric Vehicles (EVs).
2).This will help students to learn different energy storage systems and Battery Management Systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the fundamentals, architecture, and classifications of Electric Vehicles.	Understand
CO2	Analyze battery technologies, Battery Management Systems, and energy storage systems used in EVs.	Analyze
CO3	Explain the operation of electric motors, power electronic converters, and propulsion systems used in Electric Vehicles.	Understand
CO4	Demonstrate knowledge of EV charging systems, testing procedures, maintenance practices, and safety standards.	Apply
CO5	Analyze Indian EV policies, emerging technologies, and sustainable mobility solutions.	Analyze

Note: Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering and Technology Department of Electrical Engineering Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V				
Course Code: 25UGPEC1EE5044 **Course Name:** Electrical Utilization and Traction				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Knowledge of Electrical Machines, Power Electronics, Drives and Power System.

Course Objectives:

1. To understand the fundamentals of electrical drives and their operating principles.
2. To study the applications of electrical drives in industrial and everyday systems.
3. To understand the principles and applications of electrical heating methods.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain electrical drives and motor characteristics.	Understand
CO2	Analyze industrial applications of electrical drives..	Analyze
CO3	Explain electrical heating and welding methods.	Understand
CO4	Analyze electrical traction systems and performance characteristics.	Analyze
CO5	Explain traction motor control and braking techniques.	Understand
CO6	Apply illumination principles for lighting system design.	Apply

Course Description:

This course primarily deals with utilization of electrical energy generated from various sources. It is important to understand the technical reasons behind selection of motors for electric drives based on the Characteristics of loads. Electric heating, welding and illumination are some important loads in the industry in addition to motor/drives.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar SWVSM's ★

Course Content		
Unit-1	**Fundamentals of Electrical Drives**	**6 Hours**
Fundamentals of electrical drives, including the types of electric drives, selection of motors for different industrial applications, starting and running characteristics, temperature rise in motors, industrial load characteristics.		
Unit-2	**Industrial Applications of Electrical Drives**	**6 Hours**
Applications of electrical drives in textile mills, mines, cranes, hoists, lifts, excavators, refrigeration and air-conditioning systems, electrical heating systems, and IoT-based lighting systems.		
Unit-3	**Electric Heating and Welding**	**8 Hours**
Principles, construction and applications of electrical heating methods including resistance, arc, induction, dielectric, electric welding methods, resistance welding, arc welding, welding equipment and modern welding techniques such as ultrasonic and laser welding.		
Unit-4	**Electrical Traction Systems**	**6 Hours**
Electrical traction systems, including different systems of traction, track electrification, speed–time characteristics, tractive effort, adhesive weight, coefficient of adhesion, specific energy consumption, power supply arrangements, current collection systems and the characteristics of traction motors		
Unit-5	**Traction Motor Control and Modern Traction**	**4 Hours**
Control of DC traction motors, shunt and bridge transition methods, regenerative braking, and the concepts of monorail and advanced traction systems.		
Unit-6	**Illumination Engineering**	**6 Hours**
Fundamentals of illumination engineering, requirements of good lighting, classification of lighting fittings and luminaries, discharge lamps, comparison of mercury vapour, sodium vapour, tungsten filament and fluorescent lamps, and the principles of light control.		

Case Study:

1).Case Study on Energy-Efficient Electrical Drive System in Textile Industry.
2). Case Study on Electric Traction System in Metro Railway
3). Case Study on Smart IoT-Based Illumination System for Commercial Buildings.

Learning Resources:

Text Book

1). P.S. Bimbhra, Power Electronics, Khanna Publishers

2). J.B. Gupta, Utilization of Electrical Energy, S.K. Kataria & Sons

Reference Books

1).C.L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, New Age International Publishers.
2).V.K. Mehta and Rohit Mehta, Principles of Electrical Engineering and Electrical Measurements, S. Chand Publishers.
3).H. Partab, Art and Science of Utilization of Electrical Energy, Dhanpat Rai & Sons.

MOOC / NPTEL/YouTube Links:

1).NPTEL: Fundamentals of Electric Drives (IIT Kanpur) https://nptel.ac.in/courses/108104140

2).Modern EV/Traction Concepts: EV – Vehicle Dynamics and Electric Motor Drives https://nptel.ac.in/courses/108102121

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	1	-	2	-	1	-	-	1	-	1	2	1
CO2	3	3	2	1	2	-	1	-	1	1	1	3	3	2
CO3	2	2	2	1	1	1	2	1	-	1	-	2	2	2
CO4	2	1	2	2	2	1	1	-	1	1	1	3	1	-
CO5	3	3	2	1	3	1	2	-	1	1	1	1	2	3
CO6	3	3	3	2	2	2	3	1	1	1	2	3	3	3

Tatyasaheb Kore Institute of Engineering and Technology Department of Electrical Engineering Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V				
Course Code: 25UGPEC1EE5044T		**Course Name:** Electrical Utilization and Traction Tutorial		
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Pre-requisites:
Knowledge of Electrical Machines, Power Electronics, Drives and Power System..

Course Objectives: The objective of the course is to

1). To understand the fundamentals of electrical drives and their operating principles.
2). To understand the principles and applications of electrical heating methods.
3). To study the fundamentals and modern techniques of electrical welding , principles of electrical traction systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain electrical drives and motor characteristics.	Understand
CO2	Analyze industrial applications of electrical drives..	Analyze
CO3	Explain electrical heating and welding methods.	Understand
CO4	Analyze electrical traction systems and performance characteristics.	Analyze
CO5	Explain traction motor control and braking techniques.	Understand
CO6	Apply illumination principles for lighting system design.	Apply

Course Description:

This course primarily deals with utilization of electrical energy generated from various sources. It is important to understand the technical reasons behind selection of motors for electric drives based on the Characteristics of loads. Electric heating, welding and illumination are some important loads in the industry in addition to motor/drives

Note: Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGMDM3EE505L **Course Name:** Electrical Machines

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**04 Hours/Week**	**04**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Basic knowledge of Electrical Circuit Theory and AC/DC circuit analysis, electrical measurements and power systems.

Course Objectives:

1).To understand the construction, operating principles, characteristics, and performance of DC motors, induction motors, transformers, and fractional horsepower motors.
2).To analyze the performance of electrical machines using speed, torque, efficiency, and power equations and solve related numerical problems.
3). To explain the starting, speed control, and protection methods of electrical machines used in industrial applications.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the construction, operating principles, characteristics, and speed control methods of DC motors and solve related numerical problems	Apply
CO2	Analyze the performance characteristics, torque-speed relationship, and power stages of three-phase induction motors	Analyze
CO3	Apply appropriate starting, speed control, and direction control methods for three-phase induction motors in industrial applications.	Apply
CO4	Evaluate the performance of single-phase and three-phase transformers based on EMF equation, efficiency, voltage regulation, and transformer connections.	Evaluate
CO5	Explain the construction, operating principles, characteristics, and applications of fractional horsepower motors used in automation and control systems.	Understand
CO6	Select suitable electrical drives and motors for various industrial applications based on load characteristics, operating requirements, and energy-efficient practices.	Evaluate

Course Description:

This course introduces the construction, operating principles, characteristics, and applications of commonly used electrical machines. It covers DC motors, three-phase induction motors, transformers, fractional horsepower motors, and electrical drives. Students will study machine performance, speed control techniques, starting methods, and power characteristics through theoretical concepts and numerical problems. The course also focuses on the selection of appropriate motors and drives for industrial applications. Upon completion, students will be able to analyze, operate, and apply electrical machines effectively in engineering practice.

Course Content

Unit-1	DC Motors	7 Hrs

Construction, Working, Types, Back EMF, Speed equation, Torque equation, Speed torque characteristics, and Power losses in DC. Motors. Speed control of DC Shunt and series motor. **(Numerical treatment)**

Unit-2	Three Phase Induction Motor	7 Hrs

Construction, Types, Working, Speed equation, Torque equation, Torque speed characteristics, Power stages in motor, Advantages of 3- Phase Induction motor. **(Numerical treatment on power stages)**

Unit-3	Three Phase Induction Motor Control	7 Hrs

Need of starter, Star delta starter, DOL starter, Autotransformer starter, Rotor resistance starter. Speed control methods- Pole changing, Voltage control, frequency control, Block diagram of VFD control, Reversal rotation 3- Phase Induction motor

Unit-4	Transformers	7 Hrs

1).Single Phase Transformer: working principle of single-phase transformer, EMF equation, transformer losses and efficiency, voltage regulation, applications.
2).Three Phase Transformer: Three-phase transformer connections (Star-Star, Delta-Delta, Star-Delta, Delta-Star), Scott connection, parallel operation, auto transformer, advantages, disadvantages, applications.

Unit-5	Fractional Horse Power Motors	7 Hrs

Construction, Working, characteristics and Applications of Single phase permanent capacitor type Induction motor, AC servo motor, DC servo motor, Stepper motor (VR type and PM type).

Unit-6	Electrical Drives	7 Hrs

Advantages of electrical drives, Types – Individual & Group drive, Criteria for selection of motors for applications like lathe, Traction, pumps, Conveyors, Lift,etc.

Case Study:
1).Case Study on Speed Control of DC Shunt Motor in Conveyor Belt.
2). Case Study on Energy Saving Using Three-Phase Induction Motor with VFD
3). Case Study on Selection of Transformer and Motors for Industrial Workshop.

Learning Resources:

Text Books

1).Electrical Machines – P. S. Bimbhra, Khanna Publishers.
2). Electrical Machines – I. J. Nagrath & D. P. Kothari, McGraw Hill Education.
3). Electrical Technology (Volume II) – B. L. Theraja & A.K.Theraja, S.Chand Publications.

Reference Books

1). Electrical Machines – Ashfaq Husain, Dhanpat Rai Publications.
2). Electric Machinery Fundamentals – Stephen J. Chapman, McGraw Hill Education.
3). A Textbook of Electrical Technology (Vol. II) – H. Cotton, CBS Publishers

MOOC / NPTEL/YouTube Links:

1).NPTEL – Electrical Machines : https://nptel.ac.in/courses/108105017
2).NPTEL – Electrical Machines-I (IIT Kharagpur) : https://onlinecourses.nptel.ac.in
3).YouTube – Neso Academy (Electrical Machines Playlist) :https://www.youtube.com/@NesoAcademy

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	2	1	1	–	–	–	–	1	–	3	2	1
CO2	3	3	2	2	1	–	1	–	–	1	–	3	2	2
CO3	3	3	3	2	2	1	1	1	–	1	1	2	3	2
CO4	3	2	2	2	1	–	1	–	2	1	–	3	2	2
CO5	3	2	2	1	2	–	1	–	2	1	1	2	3	2
CO6	3	3	3	2	2	2	3	2	2	2	2	3	3	3

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGOE2EE5061 **Course Name:** Wind Energy Conversion System

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Basic Electrical Engineering, Engineering Mechanics & Electrical Machines,Power Electronics & Power Systems.

Course Objectives:

1).This will help student to understand the principles of wind energy, wind characteristics, and the components of Wind Energy Conversion Systems, wind turbine performance, control strategies, power generation, and grid integration techniques.

2).It intends to develop the ability to analyze 3).It intends to develop the ability to design and implement testing, monitoring, maintenance, and fault diagnosis techniques for wind energy systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain wind energy principles, wind resource assessment, and the components of Wind Energy Conversion Systems.	Understand
CO2	Analyze wind turbine systems, generators, power electronic converters, and control mechanisms used in WECS.	Analyze
CO3	Analyze the electrical systems, generators, power electronic converters, MPPT techniques, and grid synchronization methods employed in wind energy systems.	Analyze
CO4	Apply wind power generation, grid integration, and control strategies for efficient wind energy conversion.	Apply
CO5	Demonstrate testing, performance evaluation, maintenance, and fault diagnosis of wind energy systems.	Apply
CO6	Evaluate advanced wind energy technologies, off shore wind farms, hybrid renewable systems, and sustainable energy applications.	Evaluate

Course Description:

This course provides comprehensive knowledge of Wind Energy Conversion Systems (WECS), including wind resource assessment, aerodynamics, wind turbine technologies, electrical generators, power electronics, grid integration, control systems, operation and maintenance, and emerging trends in wind energy. The course emphasizes the design, analysis, testing, and performance evaluation of wind energy systems for sustainable power generation and renewable energy applications systems.

Course Content		
Unit-1	**Fundamentals of Wind Energy**	**6 Hrs**
Introduction to renewable energy, Wind energy potential, History and development of wind power, Wind characteristics, Wind speed measurement, Wind resource assessment, Wind energy conversion principles, Betz limit, Wind power density, Classification and applications of Wind Energy Conversion Systems		
Unit-2	**Wind Turbine Systems and Components**	**6 Hrs**
Converter station layout, Converter transformers, Thyristor valves, Line Commutated Converter (LCC), Voltage Source Converter (VSC), 6-pulse and 12-pulse converters, Converter bridges, Smoothing reactors, DC filters, AC filters, Reactive power requirements.		
Unit-3	**Electrical Systems and Power Electronics**	**6 Hrs**
Generators used in WECS (SCIG, DFIG, PMSG, Synchronous Generator), Generator characteristics, Power electronic converters, AC-DC-AC converters, Maximum Power Point Tracking (MPPT), Grid synchronization, Reactive power compensation, Power quality improvement techniques.		
Unit-4	**Wind Farm Integration and Control Systems**	**6 Hrs**
Grid integration of wind power, Grid codes, SCADA systems, Supervisory control, Wind farm communication systems, Energy storage integration, Hybrid wind-solar systems, Protection schemes, Power forecasting, Economic analysis of wind farms.		
Unit-5	**Operation, Maintenance and Performance Analysis**	**6 Hrs**
Installation and commissioning of wind turbines, Preventive and predictive maintenance, Condition monitoring, Fault diagnosis, Vibration analysis, Performance testing, Reliability analysis, Safety practices, Environmental impact assessment, Standards and regulations.		
Unit-6	**Advanced Wind Energy Technologies and Future Trends**	**6 Hrs**
Off shore wind farms, Floating wind turbines, Smart wind farms, Digital Twin technology, Artificial Intelligence in wind energy, Internet of Things (IOT), Hydrogen production using wind energy, Microgrids, Recent developments, Future trends, Industrial case studies.		

Case Study:

1).Case Study on Assessment of Wind Energy Potential in a Selected Geographic Region Using Wind Resource Data
2).Case Study on Design and Analysis of Converter Systems Used in Modern Wind Turbines
3).Case Study on Comparative Study of SCIG, DFIG, and PMSG-Based Wind Turbine Generator Systems
4).Case Study on Grid Integration Challenges and Solutions for Large-Scale Wind Farms

Learning Resources:

Text Books

1).S. N. Bhadra, D. Kastha, and S. Banerjee**,** Wind Electrical Systems, Oxford University Press.
2).Tony Burton, David Sharpe, Nick Jenkins, and Ervin Bossanyi, Wind Energy Handbook, Wiley.

Reference Books

1).Erich Hau**,** Wind Turbines: Fundamentals, Technologies, Application, Economics, Springer.
2).E. W. Kimbark**,** Direct Current Transmission, Wiley.
3).Gary L. Johnson, Wind Energy Systems, Prentice Hall.

MOOC / NPTEL/YouTube Links

1).NPTEL-Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems (IIT Guwahati) https://nptel.ac.in/courses/103103206
2).NPTEL – Sustainable Energy Technology https://nptel.ac.in/courses/112106318

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	2	-	-	-	-	3	2	2
CO2	3	3	2	2	2	-	2	-	-	-	1	3	3	2
CO3	3	3	3	2	1	-	2	-	-	1	2	3	3	2
CO4	2	3	3	2	1	2	3	-	1	2	2	2	2	3
CO5	2	3	2	3	1	1	2	1	2	2	2	3	2	3
CO6	2	2	3	2	2	3	3	2	1	3	3	2	2	3

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V

Course Code: 25UGOE2EE5062 **Course Name**: Electric Vehicle Technology

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Basic Electrical Engineering, Engineering Physics and Fundamentals of Electronics

Course Objectives:

1).This will help students to understand the fundamentals and architecture of Electric Vehicles (EVs).
2).This will help students to learn different energy storage systems and Battery Management Systems.
3).It intends to students to analyze EV performance, testing, maintenance, and safety, Indian EV policies, standards, and future trends.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Identify the difference between conventional and electric vehicle operation.	Remember
CO2	Select proper propulsion motor for EV by understanding the power train requirement.	Understand
CO3	Analyze battery technologies, Battery Management Systems, and energy storage systems used in EVs.	Analyze
CO4	Demonstrate knowledge of EV charging systems, testing procedures, maintenance practices, and safety standards.	Apply
CO5	Analyze Indian EV policies, emerging technologies, and sustainable mobility solutions.	Apply

Course Description:

This course provides a comprehensive introduction to Electric Vehicle (EV) Technology, covering the fundamentals of electric mobility, EV architecture, energy storage systems, electric propulsion, charging infrastructure, maintenance, safety, government policies, and emerging trends. The course enables students to understand the design, operation, testing, and maintenance of Electric Vehicles while developing knowledge of sustainable transportation technologies and their industrial application.

Course Content		
Unit-1	**Environmental Impact and Vehicle Fundamentals**	**6 Hrs**
Petroleum resources, induced cost ,Air pollution ,Global warming, Importance of different transportation development ,History of electric and hybrid electric vehicles, Vehicle resistance, Power train, tractive effort and vehicle speed vehicle performance, operating fuel economy, braking performance.		
Unit-2	**Propulsion Systems**	**6 Hrs**
IC Engine- Spark ignition and compression ignition engines-Operating principle, Operating parameters. Electrical drives: DC motor drives-Principle of operation and performance, Chopper control of DC motor drives, Induction motor drive-Basic operating principle, volt/hertz control, BLDC motor Drive-basic principle.		
Unit-3	**Energy Storage Systems**	**6 Hrs**
Fundamentals of batteries, Battery terminology and characteristics, Types of batteries (Lead Acid, Nickel Metal Hydride, Lithium-ion, Solid-State), Battery parameters (SOC, SOH, DOD, C-rate, Energy Density, Power Density), Battery Management System (BMS), Thermal management, Battery charging methods, Battery safety, testing, maintenance, recycling, and second-life applications.		
Unit-4	**Charging Infrastructure and EV Performance**	**6 Hrs**
EV charging fundamentals, Charging standards (IEC, Bharat AC/DC standards), AC and DC charging, Fast charging and ultra-fast charging, Wireless charging, Battery swapping technology, Charging station components, Grid integration, Vehicle performance parameters, Energy consumption, Range estimation, Vehicle testing and performance analysis.		
Unit-5	**Electric Vehicle Maintenance, Safety and Diagnostics**	**6 Hrs**
Preventive and predictive maintenance of EVs, Troubleshooting of battery packs, motors, controllers and charging systems, Diagnostic tools and fault analysis, Electrical safety practices, High-voltage safety, Fire hazards and emergency procedures, Standards and regulations for EV servicing, Workshop practices.		
Unit-6	**EV Policies, Emerging Technologies and Future Trends**	**6 Hrs**
National Electric Mobility Mission Plan (NEMMP), FAME Scheme, PM E-Drive initiatives, Government incentives and subsidies, BIS and AIS standards for EVs, Smart charging, Vehicle-to-Grid (V2G), Internet of Things (IoT) in EVs, Connected and Autonomous Electric Vehicles,		

Case Study:

1).Case Study on Comparative Analysis of ICE Vehicles and Battery Electric Vehicles (BEVs)
2).Case Study on Performance Comparison of Lithium-ion and Solid-State Batteries
3).Case Study on Comparative Study of AC and DC Fast Charging Stations
4).Case Study on Predictive Maintenance of Electric Vehicle Battery Packs

Learning Resources:

Text Books

1).Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes.
2).C.C. Chan, The Electric Vehicle, Oxford University Press.

Reference Books

1).James Larminie& John Lowry, Electric Vehicle Technology Explained, Wiley.
2).MehrdadEhsani, Yimin Gao & Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press.
3).Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press.

MOOC / NPTEL/YouTube Links

1).NPTEL-Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems (IIT Guwahati) https://nptel.ac.in/courses/103103206
2).NPTEL – Sustainable Energy Technology https://nptel.ac.in/courses/112106318

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	2	2	-	-	1	-	2	-	-	-	-	1	2	-
CO2	2	3	2	2	2	-	2	-	-	-	1	1	3	-
CO3	2	2	3	2	1	-	2	-	-	1	-	1	1	1
CO4	2	2	2	2	1	2	2	-	1	2	2	2	-	-
CO5	2	2	2	2	1	1	2	1	2	2	-	3	2	1
CO6	2	2	3	2	2	3	2	2	1	3	2	2	2	3

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranangar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-V
Course Code: 25UGPCCEE507LP **Course Name**: Mini Project-I

Teaching scheme		Credit	Evaluation Scheme	
Practical :	02 Hour/Week	01	OE:	50 Marks

Prerequisites:

Basic Electrical and Electronics Engineering, Electrical Measurement, AC & DC Machine, Control system, power system

Course Objectives: The objective of the course is to

1)	The project is a part of addressing societal and industrial needs. An ideathon is a brief, intense event where students can work on some of the most important problems that the world is facing today.
2)	Ideations are brainstorming events where people with diverse knowledge backgrounds , skill sets and interest get together to predetermined problems and come with substantive, innovative and compressive solutions.
3)	An ideathon's output might be ideas, a road map or an actionable plan.
4)	Teams leverage design thinking and cutting- edge techniques to brainstorm and collaborate on potential solutions within a given time frame.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Identify and formulate engineering problems based on societal, industrial, or research needs through literature survey and problem analysis.	Analyze
CO2	Design and develop an appropriate engineering solution by applying the principles of electrical engineering and modern engineering tools.	Create
CO3	Analyze the proposed solution using theoretical, simulation, or experimental methods, and interpret the obtained results.	Analyze
CO4	Evaluate the technical, economic, environmental, and societal impacts of the developed solution with emphasis on sustainability and engineering ethics.	Evaluate
CO5	Demonstrate effective teamwork, communication, self-directed learning, and project management skills throughout the project execution.	Apply

Course Description:

The Mini Project course is designed to provide third-year Electrical Engineering students with an opportunity to apply theoretical concepts and engineering principles to solve practical problems. Students work individually or in teams to identify, design, develop, and implement a project related to electrical engineering domains such as power systems, electrical machines, power electronics, control systems, renewable energy, industrial automation, embedded systems, electric vehicles, or smart grid technologies.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranangar SWVMS ★

Course Content

Sr. No.	Topic of Practical / Experiment / Tutorial	Bloom's Level
Week No.1	**Activity-1-Higher education and case study pedagogy**	**Understand**
	• Students shall form a group of three to four students, while forming a group shall not be allowed less than three or more than four students as it is a group activity. • Allocation of Mentor	
Week No.2	**Activity-2 -Topic selection**	**Understand**
	• Briefly interact with students to provide hand-holding for topic selection. • Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with factory supervisor.	
Week No.3	**Activity-3-Case study design, ideathon**	**Apply**
	• If needed, provide hand holding to students for finalizing objectives. • Review the objectives of the case study groups. • Identify what can be quantified related to your topic and how. • Decide objectives for your case studies. • Continue reading especially recent work specific to your topic.	
Week No.4	**Activity-4-Survey design**	**Apply**
	• Prepare a questionnaire and try it out with your group members as mock. • Decide sampling strategy. • Prepare a detailed schedule for field work.	
Week No.5	**Activity-5 - Analysis phase-1**	**Analyze**
	• Students in a group shall understand problem effectively, propose multiple solution. • The students have to work on different approaches and search for the different methodology to solve the problem in consultation with the project guide. • The students have to finalize the best methodology to solve the problem in consultation with the project guide. • Synopsis (50%) presentation has to be conducted by mentor/guide based on above activity.	
Week No.6	**Activity-6- Analysis phase-II**	**Analyze**
	• Identify appropriate data visualization tools for your case study. • Analyze the data.	
Week No.7	**Activity-7- Trails and Experimentation**	**Evaluate**
	• Initial set up and configuration. • Prototyping, functionality testing • Hardware mounting • 75% presentation has to be conducted by guide based on above activity.	

Week No.8	Activity-8 - Results and Validation	Evaluate
	• Co-ordinator has to check and verify functional performance, accuracy and precision, efficiency and safety. • Co-ordinator has to check and verify testing, compliance with standards.	
Week No.9	**Activity-9-Integration Testing**	**Evaluate**
	• Validate that the hardware integrates seamlessly with other systems or components as intended. • Perform compatibility tests with software, hardware and network systems.	
Week No.10	**Activity-10-Documentation and Reporting**	**Apply**
	• Maintain comprehensive documentation of design, development, testing and validation process. • Provide detail reports on test results, issues found and corrective actions taken.	
Week No.11	**Activity-11-Final Presentation**	**Evaluate**
	• 100% presentation has to be conducted by mentor/guide based on above activity. • Prototype/ final software solution is mandatory at the time of final presentation along with report.	
Week No.12	**Activity-12-PBL Day/Project competition/Exhibition**	**Evaluate**
	• Mini project exhibition will be scheduled with interdepartmental evaluation.	

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	3	2	2	1	2	2	1	1	1	1	3	1	2
CO2	2	3	2	1	1	3	2	2	3	2	2	2	2	3
CO3	2	3	2	3	2	1	1	-	1	2	1	3	3	2
CO4	1	1	2	1	1	3	3	2	1	1	1	1	2	3
CO5	1	1	1	2	2	1	1	2	2	3	2	1	1	3
CO6	2	2	3	2	2	2	1	2	3	2	3	2	3	2

Member Secretary
Board of Studies

Chairman
Board of Studies
HEAD
Department of Electrical Engg.
TKIET,Warananagar
Tal.Panhala,Dist.Kolhapur.

Academic Dean
TKIET Warananagar
Dean, Academic
Tatyasaheb Kore Institute of Engg.
& Technology (Autonomous)
Warananagar, Dist. Kolhapur

Principal
TKIET Warananagar
Chairman
Academic Council
Tatyasaheb Kore Institute of Engg.
& Technology (Autonomous)
Warananagar, Dist. Kolhapur

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Third Year B. Tech. (Electrical Engineering)

Semester-VI

(To be implemented from 2026 -27)

Credit Scheme as per NEP 2020 Policy

Sr. No	Category	Sub Category	Course Code	Course Title	Teaching Scheme L	T	P	C	CH	Examination & Evaluation Scheme Component	Marks	Min for Passing	
1	Programme course	PCC	25UGPCCE E601	Switchgear & Protection	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
2		PCC	25UGPCCE E602	Power Electronics	3*	--	--	2	3	ESE	60	24	40
										ISE	40	16	
3		PCC	25UGPCCE E603	Microcontroller and Applications	3*	--	--	2	3	ESE	60	24	40
										ISE	40	16	
4	Programme Elective course	PEC-2	25UGPEC2 EE604	PEC-2	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
5		PEC-3	25UGPEC3 EE605	PEC-3	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
6	Multi disciplinary course	MDM-4	25UGMDM 4EE606L	Multi Disciplinary Minor- 4	2	--	--	2	2	ISA	50	20	20
7	Skill course	VSEC	25UGVSEC EE6071	IoT for Electrical Engineers	2	--	--	2	2	ISA	25	10	10
8	Programme course	PCC	25UGPCCE E601LP	Switchgear & Protection Lab	--	--	2	1	2	ISA	25	10	10
										POE	25	10	10
9		PCC	25UGPCCE E602LP	Power Electronics Lab	--	--	2	1	2	ISA	25	10	10
										POE	50	20	20
10		PCC	25UGPCCE E603LP	Microcontroller and Applications Lab	--	--	2	1	2	ISA	25	10	10
										POE	25	10	10
11	Programme Elective course	PEC-2	25UGPEC2 EE604T	PEC-2 Tutorial	--	1	--	1	1	ISA	25	10	10
12		PEC-3	25UGPEC3 EE605T	PEC-3 Tutorial	--	1	--	1	1	ISA	25	10	10
					19	02	06	21	27	--	800	320	320

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPCCEE601 **Course Name:** Switchgear and Protection

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**02**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Power System, Electrical Measurement and Instrumentation, DC and AC Machines

Course Objectives:

1) Understand the fundamentals of switchgear, circuit breakers, relays, and protection schemes used in electrical power systems.
2) Apply the principles of power system protection to protect electrical equipment from faults and ensure the safe and reliable operation of power systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain Principle of Circuit Interruption	Understand
CO2	Explain Circuit Breakers	Apply
CO3	Explain Protective relaying used for power system protection	Analyze
CO4	Explain Digital and Numerical Protection	Apply
CO5	Select Protection schemes used for protection of Alternator and Transformer	Analyze
CO6	Select Protection schemes used for protection of Bus bar, Feeder and Transmission line	Analyze

Course Description: This course introduces the principles of switchgear and power system protection. It covers the construction, operation, and selection of switchgear, protective relays, circuit breakers, fuses, and earthing systems. Students learn how to detect electrical faults, protect power system equipment, and ensure the safe and reliable operation of electrical power systems.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content

Unit-1	**Circuit Interruption**	**5 Hrs**
Voltage-current characteristics of arc, arc phenomenon, Restricting and recovery voltage. Arc quenching methods, Current Chopping., Resistance Switching, Auto reclosing.		
Unit-2	**Circuit Breakers**	**5 Hrs**
Classification, Construction, working and application of Air blast, Bulk Oil, Minimum Oil, SF and Vacuum circuit breakers, Circuit breaker ratings.		
Unit-3	**Protective Relaying**	**6 Hrs**
Desirable qualities of protective relaying, Classification of relays, working of attracted armature, balanced beam, induction disc and cup type relays, Current Setting and Time setting of over-current relay, Time-current characteristics of over current Relays; Directional Relay.		
Unit-4	**Digital and Numerical Protection**	**6 Hrs**
Introduction, Advantages and Disadvantages of Numerical relays, Numerical relaying algorithms techniques Numerical over current protection, Numerical Distance protection, Numerical Differential protection.		
Unit-5	**Protection of Alternators and Transformers**	**8 Hrs**
Alternators: Stator fault protection, Percentage differential protection, Negative phase sequence [NPS] protection, Excitation Failure and Protection against motoring. **Transformer:** Use of Buccholz relay, differential protection, restricted earth fault protection, Generator-Transformer unit protection		
Unit-6	**Protection of Bus Bar, Feeder and Transmission line**	**6 Hrs**
Bus bar protection, Transmission line protection using over current & differential relay. Principles of distance relay, impedance, reactance And mho type relay.		

Case Study:

1).Case Study on Transformer Protection Using Differential Relay
2).Case Study on Distance Protection of Transmission Lines
3).Case Study on Circuit Breaker Failure in a Power Distribution System

Learning Resources:

Text Books

1).Sunil S. Rao, Switchgear Protection and Power Systems (Theory, Practice and Solved Problems), Khanna Publications.
2).B.Ram and B.N.Vishwakarma, Power System Protection and Switchgear, Tata McGraw Hill Education Private Limited, New Delhi.

Reference Books

1).Patara Basu and Chaudhary, Power System Protection, New Delhi Oxford and Engineering Circuit Analysis, John Wiley, 8th dEdition
2).L.P.Singh, Digital Protection Protective Relaying from Electromechanical to Microprocess, New Age International Publishers, 2nd Edition, 2017

MOOC / NPTEL/YouTube Links

1).NPTEL – Power System Protection and Switchgear (IIT Roorkee) https://nptel.ac.in/courses/108107167?
2).NPTEL – Power System Protection and Switchgear (IIT Roorkee https://youtu.be/QsGn7H_14VY?si=uZoZdHT6x6PCedz0
3). NPTEL Courses on YouTube https://nptel.ac.in/yt-courses
4).NPTEL – Power System Protection (IIT Kharagpur) https://nptel.ac.in/courses/108105167

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

CO-PO-PSO mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	1	-	1	2	1	-	-	-	1	3	2	2
CO2	3	2	2	1	2	2	1	-	-	-	1	3	2	2
CO3	3	3	2	2	2	2	1	1	-	-	1	3	2	3
CO4	3	3	2	2	3	2	1	1	-	-	2	3	3	3
CO5	3	3	3	2	3	2	2	1	1	-	2	3	3	3
CO6	3	3	3	2	3	2	2	1	1	-	2	3	3	3

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electronics & Telecommunication
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPCCEE601LP **Course Name:** Switchgear and Protection Lab

Teaching Scheme		Credit	Evaluation Scheme	
Practical:	**02 Hours/Week**	**01**	**ISA:**	**25 Marks**
			POE:	**25 Marks**

Prerequisites: Power System, Electrical Measurement and Instrumentation, DC and AC Machines. operation, testing and protection of electrical power system equipment effectively.

Course Objectives:

1).To understand the operation of switchgear and protective devices.
2).To perform testing and analysis of protective relays and circuit breakers.
3).To study different fault conditions and protection schemes.
4).To develop practical skills in power system protection.
5).To follow safe laboratory practices while handling electrical equipment.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Select over current relay for different applications.	Apply
CO2	Explain microprocessor based impedance relay.	Analyze
CO3	Demonstrate Power system protection equipment's.	Analyze

Course Description:

This laboratory course provides practical knowledge of switchgear and protection systems used in power systems. Students perform experiments on protective relays, circuit breakers, CTs, PTs, and fault analysis to understand the operation, testing, and coordination of power system protection equipment.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content

List of Experiments

Minimum 8 Experiments Should be Performed

Sr. No.	Name of the Experiment	Hrs.	Cognitive levels of attainment As per Bloom's
1	Experimental study of working of electromechanical over current relay.	2	Understand
2	Experimental study of working of a Directional over current relay.	2	Understand
3	Experimental realization of microprocessor based over current relay.	2	Understand
4	Experimental study of working of microprocessor based impedance relay.	2	Understand
5	Demonstration of LT Switchgear by Industrial visit.	2	Understand
6	Demonstration of operation of protection systems for Feeder, Transmission lines by Industrial visit.	2	Understand
7	Study of Transformer protection system in substation by Industrial visit.	2	Evaluate
8	Study of Generator protection system by field visit.	2	Evaluate
9	Study of Substation equipment's in power system by field system.	2	Evaluate

Learning Resources:

Text Books

1).B. Ravindranath & M. Chander – Power System Protection and Switchgear
2).Sunil S. Rao – Switchgear and Protection
3).Badri Ram & D. N. Vishwakarma – Power System Protection and Switchgear

Reference Books.

1) J. David Irwin and R. Mark Nelms, Basic Engineering Circuit Analysis, John Wiley, 8th Edition, 2006.
2) Roy Choudhury, Networks and Systems, 2nd Edition, New Age International Publications, 2006.
3) Joseph A. Edminister, Mahmood Maqvi, "Theory and Problems of Electric Circuits", Schaum's Outline Series.
4) Robert L Boylestad, "Introductory Circuit Analysis", Pearson Publications

CO-PO-PSO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	3	2	2	3	1	1	-	1	-	1	3	3	2
CO2	3	2	2	2	3	1	1	-	-	-	1	3	3	2
CO3	3	3	2	3	3	2	1	1	2	1	2	3	3	3

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranenagar SWVSM'S ★

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPCCEE602 **Course Name:** Power Electronics

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites : Basic Electrical Engineering ,Network Theory and Electronic Devices and Circuits, Electrical Machines and Mathematics

Course Objectives:

1).Understand the fundamentals, characteristics, and applications of power semiconductor devices.
2).Study the operation and analysis of uncontrolled and controlled power electronic converters.
3).Analyze DC-DC converters, DC-AC inverters, and AC voltage controllers.
4).Develop the ability to design and analyze practical power electronic systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the construction, characteristics, and operation of power semiconductor devices.	Understand
CO2	Analyze the operation of controlled rectifiers and AC voltage controllers.	Analyze
CO3	Evaluate the performance of DC-DC converters and DC-AC inverters.	Analyze
CO4	Apply power electronic converters in industrial drives and renewable energy systems.	Apply
CO5	Design and assess power electronic systems considering efficiency, control, and protection techniques.	Evaluate
CO6	Evaluate and recommend suitable power electronic converter topologies for industrial, electric vehicle, and renewable energy applications based on performance, reliability, and efficiency.	Evaluate

Course Description:

Power Electronics is a core course that deals with the efficient conversion, control, and conditioning of electrical power using semiconductor switching devices. The course introduces students to modern power semiconductor devices, controlled rectifiers, choppers, inverters, cycloconverters, and AC voltage controllers. It also covers converter control techniques, protection methods, and applications in motor drives, renewable energy systems, electric vehicles, industrial automation, and smart power systems

Course Content		
Unit-1	**Power Semiconductor Devices**	**6 Hrs**
Introduction to Power Electronics, Applications, Characteristics of power semiconductor devices, Power Diodes, SCR, TRIAC, DIAC, GTO, Power MOSFET, IGBT, MCT, Static and dynamic characteristics, Gate drive circuits, Protection of semiconductor devices, Snubber circuits.		
Unit-2	**AC-DC Controlled Rectifiers**	**6 Hrs**
Single-phase half-wave controlled rectifier, Full-wave controlled rectifier, Fully controlled bridge rectifier, Three-phase controlled rectifiers, Effect of source inductance, Freewheeling diode, Performance parameters, Power factor improvement, Harmonic analysis, Applications. **(Numerical Treatment)**		
Unit-3	**DC-DC Converters (Choppers):**	**6 Hrs**
Principle of chopper operation, Step-down (Buck) converter, Step-up (Boost) converter, Buck-Boost converter, Cuk converter, PWM control techniques, Continuous and discontinuous conduction modes, Applications in battery charging, Electric vehicles, and DC motor drives.**(Numerical Treatment)**		
Unit-4	**DC-AC Inverters and AC Voltage Controllers**	**6 Hrs**
Single-phase voltage source inverter, Three-phase inverter, PWM techniques, Harmonic reduction, Multilevel inverters, AC voltage controllers using TRIAC and SCR, Cyclo converters, Matrix converters, Industrial applications.		
Unit-5	**Power Electronic Applications**	**6 Hrs**
Power electronic converters in DC and AC motor drives, Electric traction, UPS systems, HVDC transmission, FACTS controllers, Renewable energy systems, Solar photovoltaic converters, Wind energy conversion systems, Electric vehicles.		
Unit-6	**Advanced Power Electronics and Emerging Technologies**	**6 Hrs**
Wide Bandgap semiconductor devices (SiC and GaN), Digital control of converters, , Resonant converters, Smart power modules, IoT-enabled power converters, Artificial Intelligence in converter control, Future trends.		

Case Study:

1).Case Study on Performance Analysis of Single-Phase Fully Controlled Rectifier for DC Motor Drives.
2).Case Study on Three-Phase Controlled Rectifier for Industrial DC Power Supply Applications.
3).Case Study on Design and Performance Comparison of Buck, Boost, and Buck–Boost Converters.
4).Case Study on Application of DC–DC Converters in Solar Photovoltaic (PV) Systems.

Learning Resources:

Text Books

1).M. H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education.
2).P. S. Bimbhra, Power Electronics, Khanna Publishers.

Reference Books:

1).Muhammad H. Rashid, Power Electronics Handbook, Academic Press.
2).V. R. Moorthi, Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press.
3).Daniel W. Hart, Power Electronics, McGraw-Hill.
4).B. K. Bose, Modern Power Electronics and AC Drives, Pearson Education.

MOOC / NPTEL/YouTube Links:

1).NPTEL – Power Electronics (IIT Bombay) **:** https://nptel.ac.in/courses/108101038
2).NPTEL Course Portal**:** https://nptel.ac.in
3).SWAYAM – NPTEL Courses**:** https://swayam.gov.in
4).NPTEL YouTube Channel**:** https://www.youtube.com/@nptelhrd

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	1	-	2	-	-
CO2	2	2	2	2	1	-	-	-	1	1	-	2	1	-
CO3	-	2	-	-	-	-	-	-	-	1	-	-	-	-
CO4	-	2	2	3	2	-	-	-	-	1	-	2	2	-
CO5	2	3	-	2	2	-	-	1	-	1	-	1	2	-
CO6	2	-	2	1	-	1	1	-	-	1	1	2	1	1

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPCCEE602LP **Course Name:** Power Electronics Lab

Teaching Scheme		Credit	Evaluation Scheme	
Practical:	**02 Hours/Week**	**01**	**ISA:**	**25 Marks**
			POE:	**50 Marks**

Prerequisites: Basic Electrical Engineering, Network Theory and Electronic Devices and Circuits, Electrical Machines and Mathematics.

Course Objectives:

1) Understand the fundamentals, characteristics, operation, and applications of power semiconductor devices and power electronic converters.
2) Analyze and apply power electronic converters, including DC–DC converters, DC–AC inverters, and AC voltage controllers, in the design of electrical drives, renewable energy systems, electric vehicles, and other practical power electronic systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the construction, characteristics, and operation of power semiconductor devices.	Understand
CO2	Analyze the operation of controlled rectifiers and AC voltage controllers.	Analyze
CO3	Evaluate the performance of DC-DC converters and DC-AC inverters.	Analyze
CO4	Apply power electronic converters in industrial drives and renewable energy systems.	Apply
CO5	Design and assess power electronic systems considering efficiency, control, and protection techniques.	Evaluate
CO6	Evaluate and recommend suitable power electronic converter topologies for industrial, electric vehicle, and renewable energy applications based on performance, reliability, and efficiency.	Evaluate

Course Description: Power Electronics is a core course that deals with the efficient conversion, control, and conditioning of electrical power using semiconductor switching devices. The course introduces students to modern power semiconductor devices, controlled rectifiers, choppers, inverters, cyclo converters, and AC voltage controllers. It also covers converter control techniques, protection methods, and applications in motor drives, renewable energy systems, electric vehicles, industrial automation, and smart power system.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content

List of Experiments

Minimum 8 Experiments Should be Performed

Sr. No.	Name of the experiment	Hrs.	Cognitive levels of attainment As per Bloom's
1.	Study of power semiconductor devices (Power Diode, SCR, TRIAC, DIAC, MOSFET and IGBT) and their V-I characteristics.	2	Understand
2.	Performance analysis of Single-Phase Half-Wave Controlled Rectifier with R and RL loads.	2	Apply
3.	Performance analysis of Single-Phase Fully Controlled Bridge Rectifier using SCRs.	2	Analyze
4.	Study and performance analysis of Single-Phase AC Voltage Controllers using TRIAC.	2	Understand
5.	Design and testing of Step-Down (Buck) DC-DC Converter.	2	Apply
6.	Design and testing of Step-Up (Boost) DC-DC Converter.	2	Analyze
7.	Study and performance evaluation of Single-Phase PWM Voltage Source Inverter.	2	Analyze
8.	Simulation of Controlled Rectifiers, Choppers and Inverters using MATLAB/Simulink or PSIM.	2	Create
9.	Performance analysis of PWM techniques and harmonic reduction in inverter circuits.	2	Evaluate
10.	Design, simulation and hardware implementation of a Power Electronic Converter for Renewable Energy, Electric Vehicle or Industrial Drive application.	2	Create

Learning Resources:

Text Books

1. M. H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education.
2. P. S. Bimbhra, Power Electronics, Khanna Publishers

Reference Books

1. Muhammad H. Rashid, Power Electronics Handbook, Academic Press.
2. V. R. Moorthi, Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press.
3. Cyril W. Lander, Power Electronics, McGraw-Hill.
4. Daniel W. Hart, Power Electronics, McGraw-Hill.
5. B. K.Bose, Modern Power Electronics and AC Drives, Pearson Education.

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	1	-	2	-	-
CO2	2	2	2	2	1	-	-	-	1	1	-	2	1	-
CO3	-	2	-	-	-	-	-	-	-	1	-	-	-	-
CO4	-	2	2	3	2	-	-	-	-	1	-	2	2	-
CO5	2	3	-	2	2	-	-	1	-	1	-	1	2	-
CO6	2	-	2	1	-	1	1	-	-	1	1	2	1	1

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPCCEE603 **Course Name:** Microcontroller and Applications

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**02**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

1).Basic knowledge of Electronics Engineering fundamentals.
2).Analog and Digital electronics.

Course Objectives:

1).It intends to develop the ability to design and implement memory and I/O interfacing techniques, programmable peripheral interfaces, and data transfer methods used in microprocessor-based systems.
2).It intends to equip students with the knowledge and practical skills required to interface external devices such as LCDs, ADCs, sensors, and communication modules with microcontroller-based systems.
3).This will help students to understand the Arduino platform and Embedded system.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the architecture of 8085 Microprocessor and its programming	Understand
CO2	Analyze the 8085 interfacing technique	Apply
CO3	Explain the architecture of 8051 Microcontroller and its programming	Understand
CO4	Analyze the functions of 8051 Microcontroller	Apply
CO5	Explain the architecture of Arduino Microcontroller and its features	Understand
CO6	Develop the Arduino microcontroller programming	Apply

Course Description:

This course provides a comprehensive introduction to microprocessors and microcontrollers, covering their architecture, operation, programming, and real-world applications. This course also introduced to the Arduino platform, its hardware architecture, embedded C programming, sensor interfacing, and communication modules such as GSM/GPRS.

Course Content		
Unit-1	**8051 Microcontroller**	**7 Hrs**
Basic introduction to microprocessor, Architecture of 8051 microcontroller and pin diagram, Memory Organization, Addressing modes, Instruction set, basic arithmetic and logical programs		
Unit-2	**8051 Peripheral Functions**	**6 Hrs**
8051 interrupts, Timer and serial functions, parallel port features, Interfacing of 8051 - LCD interfacing and ADC interfacing & DAC interfacing		
Unit-3	**8051 Microcontroller – Applications**	**6 Hrs**
Design and development of embedded systems for industrial and consumer electronics, Digital control systems for home automation and smart appliances, Traffic light and elevator control systems. Data acquisition and monitoring systems, Security and access control systems using microcontrollers, Basic automation using sensors and actuators.		
Unit-4	**Introduction to Arduino microcontroller**	**6 Hrs**
Introduction to Arduino, Types – Uno, Mega, Micro. Arduino Uno - Pin configuration and architecture, features, digital and analog ports, I/O Functions, Sensors, serial and parallel communication.		
Unit-5	**Arduino microcontroller programming and Interfacing**	**6 Hrs**
Introduction to embedded C in Arduino platform, Basic Arithmetic and logical programs. Interfacing- Display interfacing, GSM/GPRS Arduino Interfacing, ADC interfacing		
Unit-6	**Arduino Applications**	**5 Hrs**
Arduino is widely used in home automation systems to control lighting, fans, appliances, and security devices,robotics for controlling motors, sensors, and autonomous robotic systems. IoT applications by interfacing with Wi-Fi, Bluetooth, and GSM modules for remote monitoring and control. Arduino is used in environmental monitoring systems to measure temperature, humidity, air quality, and other environmental parameters. Arduino is employed in smart agriculture for automated irrigation, soil moisture monitoring, and greenhouse control ,Arduino is used in industrial automation for process monitoring, machine control, and data acquisition.		

Case Study:

1).Case Study on Traffic Light Control System Using 8051 Microcontroller
2).Case Study on Digital Data Acquisition System Using 8085 Microprocessor
3).Case Study on Obstacle Detection Robot Using Arduino
4).Case Study on Automatic Street Light Control Using 8051 Microcontroller

Learning Resources:

Text Books

1).Goankar, R.S.,―Microprocessor Architecture Programming and Applications with the 8085/8080A", 3rd Edition, Penram International Publishing House, 1997.
2).M.A. Mazidi, R.D.McKinlay, J.G. Mazidi,―The 8051 Microcontroller: A Systems Approach‖, Pearson, 2013.
3).Richard Blum, ―Arduino Programming‖, Sams Publishing, 1st Edition 2014.

Reference Books

1).Singh. I.P.,"Microprocessor Systems", Module 9:Microcontrollers and their Applications", IMPACT Learning Material Series IIT, New Delhi, 1997.
2).Douglas, V.Hall. "Microprocessor and Interfacing Programming and Hardware", 2ndEdition, McGraw Hill Inc., 1992.
3).Kenneth, L.Short., "Microprocessors and Programmed Logic", Prentice Hall of India, 2nd Edition, 1987

MOOC / NPTEL/YouTube Links

1).NPTEL – Microprocessors and Microcontrollers (IIT Kharagpur)
https://www.nptel.ac.in/courses/108105102
2).NPTEL – Embedded System Design (IIT Kharagpur) https://nptel.ac.in/courses/106105193

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	-	-	-	-	-	1	2	-
CO2	3	3	2	2	2	-	-	-	-	-	1	2	3	1
CO3	3	2	-	-	1	-	-	-	-	-	-	3	2	-
CO4	3	3	2	2	2	-	-	-	-	-	1	3	2	1
CO5	2	2	2	-	3	-	-	-	-	1	2	2	2	2
CO6	2	3	3	2	3	1	1	-	2	2	3	2	3	3

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T. Y. B. Tech) Sem-VI

Course Code: 25UGPCCEE603LP **Course Name:** Microcontroller and Applications Lab

Teaching Scheme		Credit	Evaluation Scheme	
Practical:	**02 Hours/Week**	**01**	**ISA:**	**25 Marks**
			POE:	**25 Marks**

Prerequisites: Basic knowledge of Electronics Engineering fundamentals, Analog and Digital electronics.

Course Objectives:

1).This will help students to understand the architecture and instruction sets of the 8085 microprocessor, 8051 microcontroller, and Arduino platform for embedded system development.
2).It intends to students to apply embedded system programming techniques to design, implement, and evaluate microprocessor- and microcontroller-based applications.
3).This will help students to build Arduino-based applications by interfacing sensors, actuators, and output devices to solve basic real-world engineering problems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Develop 8085 microprocessor arithmetic and logical programs	Apply
CO2	Develop 8051 microcontroller programs	Apply
CO3	Build Arduino Microcontroller programs for basic applications.	Apply

Course Description:

This laboratory course provides hands-on experience in programming and interfacing 8085 microprocessors, 8051 microcontrollers and Arduino-based embedded systems**.** Students learn the fundamentals of assembly language programming, digital input/output interfacing, sensor integration, motor control, and real-time embedded applications through practical experiments. The course emphasizes hardware implementation, debugging, and problem-solving skills required for the design and development of embedded systems.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar SWVSM's ★

Course Content

List of Experiments

Minimum 8 experiments should be performed

Sr. No.	Name of the experiment	Hrs.	Cognitive levels of attainment As per Bloom's
1	Assembly language program's for 8085 arithmetic operations	2	Understand
2	Assembly language program's for 8085 logical operations	2	Understand
3	Rolling display using 8051 microcontroller	2	Apply
4	LED flashing using 8051 microcontroller	2	Apply
5	Speed and direction control of dc motor using 8051 microcontroller	2	Apply
6	Speed and direction of stepper motor using 8051 microcontroller	2	Apply
7	Automatic Street light control using 8051 microcontroller	2	Apply
8	Seven segment display using 8051 microcontroller	2	Apply
9	IR obstacle sensor using Arduino microcontroller	2	Apply
10	Relay control using Arduino microcontroller	2	Apply
11	Temperature controlled fan using Arduino microcontroller	2	Apply

Learning Resources:

Text Books

1).“Goankar, R.S.,―Microprocessor Architecture Programming and Applications with the 8085/8080A‟, 3rd Edition, Penram International Publishing House, 1997.
2).M.A. Mazidi, R.D.McKinlay, J.G. Mazidi,―The 8051 Microcontroller: A Systems Approach‖, Pearson, 2013.
3).Richard Blum, ―Arduino Programming‖, Sams Publishing, 1st Edition 2014.

Reference Books

1).Singh. I.P.,“Microprocessor Systems”, Module 9:Microcontrollers and their Applications”, IMPACT Learning Material Series IIT, New Delhi, 1997.
2).Douglas, V.Hall. “Microprocessor and Interfacing Programming and Hardware”, 2ndEdition, McGraw Hill Inc., 1992.
3).Kenneth, L.Short., “Microprocessors and Programmed Logic”, Prentice Hall of India, 2nd Edition, 1987.

CO-PO-PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	2	3	3	2	3	-	-	-	1	2	2	3	3	1
CO2	2	3	3	2	3	-	-	-	1	2	2	3	3	1
CO3	2	3	3	2	3	2	2	-	2	3	3	2	3	3

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranangar

Tatyasaheb Kore Institute of Engineering and Technology
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPEC2EE6041 **Course Name:** Electrical Energy Conservation and Audit

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Pre-requisites: Basic knowledge of electrical circuits and electrical machines. power systems energy fundamentals

Course Objectives: The objective of the course is to

1) Understand the principles of electrical energy conservation, energy management, and energy auditing for improving the performance and efficiency of electrical systems.
2) Analyze and evaluate energy consumption patterns, identify energy-saving opportunities, and recommend sustainable measures for efficient energy utilization.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the concepts of electrical energy conservation, energy management, and energy efficiency.	Understand
CO2	Analyze electrical energy consumption patterns and identify energy-saving opportunities.	Analyze
CO3	Apply energy conservation techniques for electrical equipment and systems.	Apply
CO4	Perform basic energy audits using suitable measurement techniques and instruments.	Apply
CO5	Evaluate energy audit results and recommend suitable energy efficiency improvement measures.	Evaluate
CO6	Develop effective energy management strategies for sustainable electrical energy utilization.	Create

Course Description:

This course focuses on electrical energy conservation, energy management, and auditing techniques to improve energy efficiency, reduce energy consumption, and promote sustainable electrical energy utilization.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content		
Unit-1	**Fundamentals of Energy Conservation**	**6 Hours**
Study the basic concepts of energy, different energy resources, the need for energy conservation, energy efficiency, energy management, and relevant energy conservation standards.		
Unit-2	**Electrical Energy Management**	**6 Hours**
Understand electrical energy consumption, load management, power factor improvement, demand control, energy-efficient equipment, electricity tariffs, and demand-side management techniques.		
Unit-3	**Energy Conservation in Electrical Equipment**	**6 Hours**
Learn energy-saving methods for transformers, induction motors, variable frequency drives, lighting systems, HVAC systems, pumps, fans, and compressors.		
Unit-4	**Energy Auditing**	**6 Hours**
Study the principles, types, methodology, instruments, data collection, analysis, report preparation, and economic evaluation of energy audits.		
Unit-5	**Power Quality and Energy Monitoring**	**6 Hours**
Understand power quality issues, harmonics, voltage disturbances, energy monitoring systems, smart metering, power quality analyzers, and energy management systems.		
Unit-6	**Energy Conservation Applications and Case Studies**	**6 Hours**
Explore industrial and commercial energy conservation practices, electrical safety, case studies, ISO 50001 standards, government policies, and emerging technologies such as smart grids, IoT, and AI in energy management.		

Case Study:

1). Case study on Energy Audit of an Industrial Plant

2). Case study on Energy Monitoring Using Smart Metering Systems

3). Case study on Power Factor Improvement in Industries

Learning Resources:

Text Books

1). “Electrical Energy Utilization and Conservation” Author**:** S. C. Tripathi Publisher: Tata McGraw-Hill Education

2). Energy Management and Conservation” Author: D. P. Kothari, K. C. Singal, and Rakesh Ranjan Publisher: New Age International

Reference Books

1). Bureau of Energy Efficiency (BEE) – Energy Audit Guidelines and Energy Manager/Energy Auditor Study Material

2). ISO 50001: Energy Management Systems – Requirements with Guidance for Use

3). IEEE Standards on Energy Efficiency and Power Quality

MOOC / NPTEL/YouTube Links

1) NPTEL Course: https://nptel.ac.in/courses/112105221

2) NPTEL Course: https://nptel.ac.in/courses/112105221

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranagar

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	2	-	-	-	1	1	-	1	-	1	-	2	1	1
CO2	2	2	1	2	2	1	-	-	-	1	1	2	2	2
CO3	2	2	2	1	3	2	1	1	-	1	1	-	1	2
CO4	1	1	1	-	3	1	-	-	-	-	-	-	1	-
CO5	2	2	-	-	-	1	1	2	-	-	-	-	2	-
CO6	2	2	-	-	-	2	1	2	-	-	-	1	-	-

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology Department of Electrical Engineering Third Year of Bachelor of Technology (T. Y. B. Tech) Sem-VI				
Course Code: 25UGPEC1EE6041t **Course Name:** Energy Conservation and Audit Tutorial				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Tutorial:	**01 Hours/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites: Basic knowledge of electrical circuits and electrical machines. power systems energy fundamentals.

Course Objectives:

1) .Understand the concepts of electrical energy conservation and management.

2). Provide knowledge of energy conservation techniques and energy auditing procedures for improving electrical system performance.

3).Enable students to evaluate energy audit results and recommend effective measures for efficient and sustainable energy utilization.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the concepts of electrical energy conservation, energy management, and energy efficiency.	Understand
CO2	Analyze electrical energy consumption patterns and identify energy-saving opportunities.	Analyze
CO3	Apply energy conservation techniques for electrical equipment and systems.	Apply
CO4	Perform basic energy audits using suitable measurement techniques and instruments.	Apply
CO5	Evaluate energy audit results and recommend suitable energy efficiency improvement measures.	Evaluate
CO6	Develop effective energy management strategies for sustainable electrical energy utilization.	Create

Course Description:

This course focuses on electrical energy conservation, energy management, and auditing techniques to improve energy efficiency, reduce energy consumption, and promote sustainable electrical energy utilization.

Note: Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar SWVSM's

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T. Y. B. Tech) Sem-VI

Course Code: 25UGPCEC2EE6042 **Course Name:** Battery Management System

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites : Basic knowledge of Electrical Engineering fundamentals, Electronics Engineering, Electrical Measurements and Instrumentation

Course Objectives:

1) Understand the fundamentals of battery technologies, Battery Management Systems (BMS), and battery pack design.
2) Analyze battery performance using SOC, SOH, SOP, charging, and balancing techniques.
3) Apply BMS concepts for battery testing, protection, diagnostics, and sustainable energy applications.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain battery technologies, battery characteristics, and the architecture of Battery Management Systems..	Understand
CO2	Analyze battery pack design, charging methods, protection circuits, and thermal management systems.	Analyze
CO3	Apply SOC, SOH, SOP estimation methods, battery monitoring techniques, and cell balancing algorithms.	Apply
CO4	Demonstrate battery testing, diagnostics, communication protocols, fault detection, and maintenance practices.	Apply
CO5	Evaluate battery safety standards, emerging battery technologies, recycling methods, and industrial BMS applications	Evaluate

Course Description:

This course provides an overview of Electric Vehicle (EV) technology**,** including EV architecture, battery systems, electric propulsion, charging infrastructure, maintenance, and safety. It also covers EV policies, emerging technologies, and future trends, enabling students to understand the design, operation, and applications of sustainable electric mobility systems.

Course Content

Unit-1	Fundamentals of Electric Vehicles	6 Hrs

Introduction to Electric Vehicles (EVs), History and evolution of EVs, Need for electric mobility, Environmental impact and sustainability, Comparison of Internal Combustion Engine (ICE) vehicles and Electric Vehicles, Classification of EVs, Components and architecture of Electric Vehicles, Advantages, limitations, and applications of EVs.

Unit-2	Energy Storage Systems	6 Hrs

Fundamentals of batteries, Battery terminology and characteristics, Types of batteries, Battery parameters, Battery Management System (BMS), Battery charging methods, Battery safety, testing, maintenance, recycling, and second-life applications.

Unit-3	Electric Propulsion System and Power Electronics	6 Hrs

Electric propulsion system, EV drivetrain configuration, Types of electric motors, Motor characteristics and selection, Power electronic converters (DC-DC converters), Inverters, Motor controllers, Torque-speed characteristics, Regenerative braking system.

Unit-4	Charging Infrastructure and EV Performance	6 Hrs

EV charging fundamentals, Charging standards (IEC, Bharat AC/DC standards), AC and DC charging, Fast charging and ultra-fast charging, Wireless charging, Battery swapping technology, Charging station components, Grid integration, Vehicle performance parameters, Energy consumption, Range estimation, Vehicle testing and performance analysis.

Unit-5	Electric Vehicle Maintenance, Safety and Diagnostics	6 Hrs

Preventive and predictive maintenance of EVs, Troubleshooting of battery packs, motors, controllers and charging systems, Diagnostic tools and fault analysis, Electrical safety practices, High-voltage safety, Personal Protective Equipment (PPE), Fire hazards and emergency procedures, Standards and regulations for EV servicing.

Unit-6	EV Policies, Emerging Technologies and Future Trends	6 Hrs

National Electric Mobility Mission Plan (NEMMP), FAME Scheme, PM E-Drive initiatives, Government incentives and subsidies, BIS and AIS standards for EVs, Smart charging, Vehicle-to-Grid (V2G), Internet of Things (IoT) in EVs, Connected and Autonomous Electric Vehicles, Hydrogen Fuel Cell Vehicles, Recent advancements in battery technology, Future scope.

Case Study:

1). Case Study on Battery Management System (BMS) in Electric Vehicles
2). Case Study on Fast Charging Infrastructure and Battery Swapping for EVs
3). Case Study on Adoption of Electric Buses in India
4). Case Study on Electric Vehicle Policies and Future Technologies in India

Learning Resources:

Text Books

1).Gregory L. Plett, Battery Management Systems**,** Volumes I–III, Artech House
2).Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs**,** Artech House

Reference Books

1).Alfred Rufer, Energy Storage Systems and Batteries**,** CRC Press
2).RuiXiong, Battery Management Systems for Electric Vehicles, Wiley.
3).MehrdadEhsani, Yimin Gao, and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles**,** CRC Press.

MOOC / NPTEL/YouTube Links

1).NPTEL – Electric Vehicles Technology– Part II (IIT Madras) https://nptel.ac.in/courses/108106170

2).NPTEL – Introduction to Hybrid and Electric Vehicles (IIT Guwahati) https://nptel.ac.in/courses/108103009

3).SWAYAM Portal https://swayam.gov.in

4).NPTEL Official https://www.youtube.com/@nptelhrd

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	1	2	1	-	1	-	1	-	-	1	-	2	2	2
CO2	2	3	3	2	-	1	2	-	-	1	1	1	-	1
CO3	2	2	2	3	-	1	2	-	1	2	1	-	-	2
CO4	3	3	2	2	2	2	1	1	1	2	1	1	-	-
CO5	-	1`	2	2	2	3	3	3	1	3	3	3	1	-

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T. Y. B. Tech) Sem-VI

Course Code: 25UGPCEC2EE6042T **Course Name:** Battery Management Systems Tutorial

Teaching Scheme		Credit	Evaluation Scheme	
Tutorial :	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites : Basic Electrical and Electronics Engineering, Electrical Measurements and Instrumentation

Course Objectives:

1) Understand the fundamentals of battery technologies, Battery Management Systems (BMS), battery pack design, and charging methods.
2) Analyze battery performance using SOC, SOH, SOP, battery balancing, and thermal management techniques.
3) Apply BMS concepts for battery testing, diagnostics, protection, safety, and sustainable energy applications..

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain battery technologies, battery characteristics, and the architecture of Battery Management Systems..	Understand
CO2	Analyze battery pack design, charging methods, protection circuits, and thermal management systems.	Analyze
CO3	Apply SOC, SOH, SOP estimation methods, battery monitoring techniques, and cell balancing algorithms.	Apply
CO4	Demonstrate battery testing, diagnostics, communication protocols, fault detection, and maintenance practices.	Apply
CO5	Evaluate battery safety standards, emerging battery technologies, recycling methods, and industrial BMS applications	Evaluate

Course Description:

This course provides an overview of Electric Vehicle (EV) technology**,** including EV architecture, battery systems, electric propulsion, charging infrastructure, maintenance, and safety. It also covers EV policies, emerging technologies, and future trends, enabling students to understand the design, operation, and applications of sustainable electric mobility systems.

Note: Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPEC2EE6043 **Course Name:** Advanced Control System

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	03 Hours/Week	03	ISE:	40 Marks
			ESE:	60 Marks

Prerequisites:- Basic Control System Engineering, Electrical and Electronic Circuits, Linear Algebra and State Variables, MATLAB/Simulink Basics, Feedback Control Concepts

Course Objectives:

1).Understand the fundamentals of digital control systems and sampling techniques.
2).Design and analyze digital controllers for control applications.
3).Evaluate the stability and performance of digital control systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain basic concepts of Z and Laplace transform related to digital control systems.	Understand
CO2	Design of digital control system using Root locus, Controllers, compensators.	Apply
CO3	Explain state space representation and its forms.	Analyze
CO4	Illustrate state space equations, state transition matrix	Apply
CO5	Design of controller by using Pole placement	Analyze
CO6	Design of observer by using Pole placement	Analyze

Course Description: This course covers the principles of digital control systems, including sampling theory, discrete-time system modeling, Z-transform, pulse transfer functions, stability analysis, state-space analysis, and digital controller design. It focuses on the analysis, design, and implementation of digital control techniques used in modern automation and industrial control applications.

Course Content		
Unit-1	**Digital Control System**	**6 Hrs**
Review of Z transforms, Z transform method for solving difference equation, Impulse Sampling and Data Hold, Pulse Transfer Function, Sampling Theorem, Mapping between S Plane and Z Plane, Stability Analysis, Transient and Steady State Analysis.		
Unit-2	**Design of Digital Control System**	**6 Hrs**
Construction of Root Locus, Design based on Root Locus, P, PI, PD, PID Controllers, Lead, Lag, Lead-Lag Compensators, Frequency Response Analysis, Bode Diagram.		
Unit-3	**State Space Analysis of Digital Control System I**	**6 Hrs**
State Space representation of Digital System, Controllable Canonical form, Observable Canonical form, Diagonal form, Jordan form		
Unit-4	**State Space Analysis of Digital Control System II**	**6 Hrs**
State Space Equations, solving State Space Equations, State Transition Matrix, Properties of State Transition Matrix, Pulse Transfer Function Matrix. Discretization of Continuous Time State Space Equation.		
Unit-5	**State Space Design for Controller**	**6 Hrs**
Controllability, Controller Design in State Space, Design via Pole Placement for Controller Design, Ackermann's Formula for Controller Design.		
Unit-6	**State space Design for Observer**	**6 Hrs**
Observability, Observer Design, Design via Pole Placement for observer, Design, Response. Ackermann's Formula for observer, Design Deadbeat Design, Design for deadbeat.		

Case Study:

1).Case Study on Digital Control of a DC Motor Using PID Controller
2). Case Study on State Space Control of an Inverted Pendulum.
3). Case Study on Observer Design for Temperature Control System.

Learning Resources:

Text Books

1).M. Gopal, Digital Control and State Variable Methods, Tata McGraw-Hill Education.
2).K. Ogata, Discrete-Time Control Systems, Pearson Education.

Reference Books

1).B. C. Kuo, Digital Control Systems, Oxford University Press.
2).Gene F. Franklin, J. David Powell, and Michael L. Workman, Digital Control of Dynamic Systems, Pearson Education.
3).Katsuhiko Ogata, Modern Control Engineering, Pearson Education.

MOOC / NPTEL/YouTube Links

1).NPTEL – Digital Control Systems : https://nptel.ac.in/
2).NPTEL YouTube channel : https://www.youtube.com/@nptelhrd
3).MIT open course ware Digital control and control system:https://ocw.mit.edu/
4).MATLAB - Control Systems tutorials https://www.youtube.com/@MATLA

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	-	2	-	-	1	-	-	-	-	-	1	-	-	-
CO2	2	3	3	2	2	-	-	-	1	-	1	2	2	1
CO3	1	2	2	1	1	-	-	-	-	-	1	1	1	-
CO4	2	2	2	2	2	-	-	-	-	-	1	1	1	-
CO5	2	1	3	2	2	-	-	-	1	-	2	2	2	2
CO6	2	2	3	2	3	-	-	-	1	-	2	2	-	2

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Second Year of Bachelor of Technology (T.Y.B.Tech Sem-VI)
Course Code: 25UGPEC2EE6043T **Course Name:** Advanced Control System Tutorial

Teaching Scheme		Credit	Evaluation Scheme	
Tutorial :	**01Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites:

Basic Control System Engineering, Electrical and Electronic Circuits, Linear Algebra and State Variables, MATLAB/Simulink Basics, Feedback Control Concepts.

Course Objectives:

1).Understand the fundamentals of digital control systems and sampling techniques..
2).Design and analyze digital controllers for control applications.
3).Evaluate the stability and performance of digital control systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain basic concepts of Z and Laplace transform related to digital control systems.	Understand
CO2	Design of digital control system using Root locus, Controllers, compensators.	Apply
CO3	Explain state space representation and its forms.	Analyze
CO4	Illustrate state space equations, state transition matrix	Apply
CO5	Design of controller by using Pole placement	Analyze
CO6	Design of observer by using Pole placement	Analyze

Course Description: This course covers the principles of digital control systems, including sampling theory, discrete-time system modeling, Z-transform, pulse transfer functions, stability analysis, state-space analysis, and digital controller design. It focuses on the analysis, design, and implementation of digital control techniques used in modern automation and industrial control applications.

Note: Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranangar SWVSM's ★

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T. Y. B. Tech) Sem-VI

Course Code: 25UGPCEC2EE6044 **Course Name**: Application of Microcontrollers in Electrical Engineering

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Basic knowledge of Electrical and Digital Electronics, Computer Organization and Architecture, Microprocessor Concepts, Fundamentals of Programming and Analog and Digital Signals

Course Objectives:

1) Understand the architecture, memory organization, and working principles of microcontrollers, and develop Assembly and Embedded C programs using suitable software tools.
2) Interface I/O devices, timers, counters, PWM, and communication protocols such as SPI, I²C, and UART/USCI with microcontrollers.
3) Develop microcontroller-based applications using ADC, DAC, DC motors, stepper motors, and other peripheral devices.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Differentiate amongst various architectures of microcontrollers	Analyze
CO2	Implement microcontroller programming and design skills	Apply
CO3	Choose an appropriate microcontroller for different applications.	Evaluate
CO4	Interface various peripheral devices with microcontrollers and perform their operations	Apply
CO5	Analyze the features and applications of different microcontrollers for practical use	Analyze
CO6	Evaluate the performance of microcontrollers	Evaluate

Course Description:

This course introduces the basics of microcontrollers, their architecture, programming, and working. It covers interfacing of input/output devices, communication protocols, ADC/DAC, and motor control to develop simple microcontroller-based embedded system applications.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Course Content		
Unit-1	**Introduction to Microcontroller**	**6 Hrs**
Numbering system, Microcontrollers Vs Microprocessors, RISC and CISC architecture comparison. Von-Neumann vs. Harvard architecture, comparison between 8-bit, 16-bit, 32-bit microcontroller. Stack and use of stack pointer. Memory structure, Data Memory, Program Memory and execution of programs.		
Unit-2	**Programming with microcontroller**	**6 Hrs**
Programming: Concept of assembler directives, editor, linker, loader, debugger, simulator, emulator. Instruction set, basic programming using assembly instructions. Introduction to embedded-C,Integrated Development Environment (IDE), cross compiler, ISP, software delay generation.		
Unit-3	**8 Bit micro-controller**	**6 Hrs**
Introduction to 8 bit microcontroller, Addressing Modes & Instruction Set, architecture and PIN description, Interrupts and Operating Modes, Analog Input-Output and PWM, Digital Input-Output,Memory Mapping (internal as well as external) of microcontroller.		
Unit-4	**I/O Interfacing**	**6 Hrs**
I/O programming, interfacing with simple switch, LED, Keypad programming. Timers, various modes of operations of timers, counters, PWM programming.		
Unit-5	**Communication Protocols**	**6 Hrs**
Serial peripheral interface (SPI), SPI based memory interfacing, Universal Serial Communications Interface (USCI) interfacing and programming, Interrupt understanding and interfacing, I2C based RTC interfacing , WDT (Watch dog timer).		
Unit-6	**External Peripheral Interfacing**	**6 Hrs**
Analog to digital convertor, interfacing with external serial and parallel ADC's, Digital to analog convertor (DAC), Interfacing with DAC, Interfacing with stepper motor and DC motor, Comparative analysis of different 8 bit microcontrollers.		

Case Study:

1).Case Study on Automatic Street Light System
2).Case Study on Digital Temperature Monitoring System
3).Case Study on Automatic Water Level Controller & Home Appliance Control System

Learning Resources:

Text Books

1).Mazidi, "8051 microcontroller & embedded system" 3rdEdition ,Pearson
2).Kenneth J. Ayala, "8051 Microcontroller: Programming, Architecture and Interfacing", Thomas Delmar Learning, Third ed, 2007.

Reference Books

1).Kenneth J. Ayala, "The 8051 Micro-controller – Architecture, Programming & Applications", Penram International & Thomson Asia, Second Edition.
2).John B. Peatman, "Design with PIC Micro-controllers", Pearson Education Asia, Low Price Edition MSP430 Technical Reference Manual
3).Newnes Publication, 2009 *Texas Instruments MSP 430 microcontroller, Guide and Datasheet

MOOC / NPTEL/YouTube Links

1).NPTEL – Introduction to Microcontrollers (8051 & PIC) https://nptel.ac.in/courses/117104072
2).NPTEL – Introduction to Embedded System Design https://onlinecourses.nptel.ac.in
3).SWAYAM Portal https://swayam.gov.in
4).NPTEL Official https://www.youtube.com/@nptelhrd

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	-	-	-	1	-	2	1	-
CO2	3	2	3	1	3	-	-	-	1	1	2	2	3	1
CO3	3	3	3	2	2	-	-	-	1	1	2	3	3	2
CO4	2	2	3	2	3	-	-	-	1	1	1	2	3	2
CO5	3	3	2	2	2	2	1	-	-	2	2	3	2	2
CO6	3	3	2	3	2	1	-	-	-	2	2	3	2	1

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electronics & Telecommunication
Third Year of Bachelor of Technology (T. Y. B. Tech)

Course Code: 25UGPCEC2EE6044T **Course Name:** Application of Microcontrollers in Electrical Engineering Tutorial

Teaching Scheme		Credit	Evaluation Scheme	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites :

1).Students should have basic knowledge of Electrical and Electronics Engineering, Digital Electronics, Microcontroller architecture, C programming, Number Systems, and Analog and Digital Signals.
2).Familiarity with basic electronic components and programming concepts is desirable

Course Objectives:

1).Understand the basic operation and programming of microcontroller peripherals.
2).Develop programs for GPIO, seven-segment displays, keypads, timers, counters, ADC, and interrupts.
3).Implement UART communication and PWM generation using a microcontroller.
4).Apply microcontroller programming skills to interface input/output devices and develop simple embedded system applications

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Write and execute simple programs using a microcontroller.	Apply
CO2	Interface and use different input and output devices with a microcontroller	Apply
CO3	Use communication protocols such as UART, I²C, and SPI to exchange data between devices	Apply
CO4	Evaluate simple microcontroller-based applications by integrating different hardware and software components.	Evaluate

Course Description:

This course helps students learn the basics of microcontroller programming through hands-on experiments. Students will interface LEDs, seven-segment displays, keypads, ADC, timers, UART, PWM, motors, and communication modules such as I²C and SPI. The course develops practical skills in building simple microcontroller-based embedded system applications.

Note:-Minimum 6 tutorials to be conducted based on syllabus.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI
Course Code: 25UGPEC3EE6051 **Course Name:** Wind Energy Conversion System

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Basic Electrical Engineering,Engineering Mechanics & Electrical Machines ,Power Electronics & Power Systems

Course Objectives:

1).This will help student to understand the principles of wind energy, wind characteristics, and the components of Wind Energy Conversion Systems (WECS).
2).It intends to develop the ability to analyze wind turbine performance, control strategies, power generation, and grid integration techniques.
3).It intends to develop the ability to design and implement testing, monitoring, maintenance, and fault diagnosis techniques for wind energy systems.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain wind energy principles, wind resource assessment, and the components of Wind Energy Conversion Systems.	Understand
CO2	Analyze wind turbine systems, generators, power electronic converters, and control mechanisms used in WECS.	Analyze
CO3	Analyze the electrical systems, generators, power electronic converters, MPPT techniques, and grid synchronization methods employed in wind energy systems.	Analyze
CO4	Apply wind power generation, grid integration, and control strategies for efficient wind energy conversion.	Apply
CO5	Demonstrate testing, performance evaluation, maintenance, and fault diagnosis of wind energy systems.	Apply
CO6	Evaluate advanced wind energy technologies, off shore wind farms, hybrid renewable systems, and sustainable energy applications.	Evaluate

Course Description:

This course provides comprehensive knowledge of Wind Energy Conversion Systems (WECS), including wind resource assessment, aerodynamics, wind turbine technologies, electrical generators, power electronics, grid integration, control systems, operation and maintenance, and emerging trends in wind energy. The course emphasizes the design, analysis, testing, and performance evaluation of wind energy systems for sustainable power generation and renewable energy applications systems.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

<table>
<tr><th colspan="3">Course Content</th></tr>
<tr><td>Unit-1</td><td>Fundamentals of Wind Energy</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Introduction to renewable energy, Wind energy potential, History and development of wind power, Wind characteristics, Wind speed measurement, Wind resource assessment, Wind energy conversion principles, Betz limit, Wind power density, Classification and applications of Wind Energy Conversion Systems (WECS).</td></tr>
<tr><td>Unit-2</td><td>Wind Turbine Systems and Components</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Converter station layout, Converter transformers, Thyristor valves, Line Commutated Converter (LCC), Voltage Source Converter (VSC), 6-pulse and 12-pulse converters, Converter bridges, Smoothing reactors, DC filters, AC filters, Reactive power requirements.</td></tr>
<tr><td>Unit-3</td><td>Electrical Systems and Power Electronics</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Generators used in WECS (SCIG, DFIG, PMSG, Synchronous Generator), Generator characteristics, Power electronic converters, AC-DC-AC converters, Maximum Power Point Tracking (MPPT), Grid synchronization, Reactive power compensation, Power quality improvement techniques.</td></tr>
<tr><td>Unit-4</td><td>Wind Farm Integration and Control Systems</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Grid integration of wind power, Grid codes, SCADA systems, Supervisory control, Wind farm communication systems, Energy storage integration, Hybrid wind-solar systems, Protection schemes, Power forecasting, Economic analysis of wind farms.</td></tr>
<tr><td>Unit-5</td><td>Operation, Maintenance and Performance Analysis</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Installation and commissioning of wind turbines, Preventive and predictive maintenance, Condition monitoring, Fault diagnosis, Vibration analysis, Performance testing, Reliability analysis, Safety practices, Environmental impact assessment, Standards and regulations.</td></tr>
<tr><td>Unit-6</td><td>Advanced Wind Energy Technologies and Future Trends</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Off shore wind farms, Floating wind turbines, Smart wind farms, Digital Twin technology, Artificial Intelligence in wind energy, Internet of Things (IOT), Hydrogen production using wind energy, Microgrids, Recent developments, Future trends, Industrial case studies.</td></tr>
</table>

Case Study:

1).Case Study on assessment of Wind Energy Potential in a Selected Geographic Region Using Wind Resource Data
2).Case Study on design and Analysis of Converter Systems Used in Modern Wind Turbines
3).Case Study on comparative Study of SCIG, DFIG, and PMSG-Based Wind Turbine Generator Systems
4).Case Study on grid Integration Challenges and Solutions for Large-Scale Wind Farms

Learning Resources:

Text Books

1).S. N. Bhadra, D. Kastha, and S. Banerjee, Wind Electrical Systems, Oxford University Press.
2).Tony Burton, David Sharpe, Nick Jenkins, and Ervin Bossanyi, Wind Energy Handbook, Wiley.

Reference Books

1).Erich Hau, Wind Turbines: Fundamentals, Technologies, Application, Economics, Springer.
2).E. W. Kimbark, Direct Current Transmission, Wiley.
3).Gary L. Johnson, Wind Energy Systems, Prentice Hall.

MOOC / NPTEL/YouTube Links

1).NPTEL–Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems (IIT Guwahati) https://nptel.ac.in/courses/103103206

2).NPTEL–Renewable Energy Sources: Fundamentals and Technologies (IIT Roorkee) https://nptel.ac.in/courses/127107001

3).NPTEL – Sustainable Energy Technology**:** https://nptel.ac.in/courses/112106318

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	1	2	-	-	1	-	2	-	-	-	-	2	2	-
CO2	2	3	2	2	2	-	2	-	-	-	1	1	3	-
CO3	2	2	3	2	2	-	2	-	-	1	2	3	3	-
CO4	2	1	3	2	1	2	3	-	1	2	2	2	2	2
CO5	2	3	2	3	3	1	2	1	2	2	2	3	1	1
CO6	2	2	3	2	2	3	3	2	1	3	3	2	3	3

Tatyasaheb Kore Institute of Engineering and Technology Department of Electrical Engineering Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI **Course Code:**25UGPEC3EE6051T **Course Name :** Wind Energy Conversion System Tutorial				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites: Basic Electrical Engineering,Engineering Mechanics & Electrical Machines, Power Electronics & Power Systems

Course Objectives:

1)To understands the construction, operating principles, and performance characteristics of wind energy conversion systems and their major components.
2)Develop MATLAB/Simulink models of wind energy conversion systems and simulate the operation of SCIG- and DFIG-based wind turbine generators under different operating conditions.
3)Analyze the performance of different wind turbine configurations, determine key performance parameters such as power coefficient (Cp) and Tip Speed Ratio (TSR), and implement Maximum Power Point Tracking (MPPT) techniques.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Identify the components of a Wind Energy Conversion System (WECS)	Understand
CO2	Perform modeling and simulation of wind energy conversion systems using MATLAB/Simulink	Apply
CO3	Evaluate the performance of grid-connected wind energy systems	Evaluate

Course Description:

This laboratory course provides hands-on experience in the analysis, modeling, simulation, and performance evaluation of Wind Energy Conversion Systems (WECS). Through these experiments, students acquire practical skills in renewable energy system analysis, simulation, and power quality improvement, preparing them for the design and operation of modern wind energy systems.

Note:-Minimum 6 tutorials to be conducted based on syllabus.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI
Course Code: 25UGPEC3EE6052 **Course Name:** HVDC Transmission System

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Engineering fundamentals, Power electronics, Electrical Measurements and Instrumentation, Electrical machines.

Course Objectives:

1).This course intends to understand the basic concepts, components, and applications of HVDC transmission systems
2).It intends to learn the working of HVDC converters, converter stations, and other important equipment.
3).This will help to understand the control, protection, harmonics, and reactive power compensation used in HVDC systems.
4).This will help to study the use of HVDC systems for renewable energy integration, smart grids, modern power transmission , latest HVDC technologies, future developments.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Understand the principles, advantages, and applications of High Voltage Direct Current (HVDC) transmission systems.	Understand
CO2	Explain the operation of HVDC converters, converter stations, and associated equipment used in modern power transmission systems.	Understand
CO3	Analyze HVDC system control, protection, harmonics, reactive power compensation, and insulation coordination.	Analyze
CO4	Apply simulation, testing, fault diagnosis, and performance evaluation techniques for HVDC transmission systems.	Apply
CO5	Evaluate modern HVDC technologies, renewable energy integration, multi-terminal HVDC systems, and future trends in power transmission.	Evaluate

Course Description:

This course provides comprehensive knowledge of High Voltage Direct Current (HVDC) Transmission Systems used for long-distance bulk power transmission and interconnection of asynchronous power grids. The course covers HVDC principles, converter technologies, control and protection, converter stations, harmonics, filters, insulation coordination, multi-terminal HVDC systems, renewable energy integration, and recent developments such as Voltage Source Converter (VSC)-HVDC and Flexible AC Transmission Systems (FACTS). The course emphasizes design, analysis, operation, testing, and industrial applications of modern HVDC systems.

Course Content

Unit	Title	Hours
Unit-1	**Fundamentals of HVDC Transmission**	**6 Hrs**
Introduction to HVDC transmission, Historical development, Need for HVDC, Comparison between HVAC and HVDC systems, Advantages and limitations, Types of DC links,Components of HVDC transmission system, Applications of HVDC in modern power systems.		
Unit-2	**HVDC Converter Stations and Power Converters**	**6 Hrs**
Converter station layout, Converter transformers, Thyristor valves, Line Commutated Converter (LCC), Voltage Source Converter (VSC), 6-pulse and 12-pulse converters, Converter bridges, Smoothing reactors, DC filters, AC filters, Reactive power requirements.		
Unit-3	**HVDC Control and Protection**	**6 Hrs**
Harmonic generation in converters, Characteristic and non-characteristic harmonics, Harmonic filters, Reactive power compensation, Static VAR Compensators (SVC), STATCOM, Corona effects, Insulation coordination, Overvoltage protection, Surge arresters, Earthing systems.		
Unit-4	**Harmonics, Reactive Power and Insulation Coordination**	**6 Hrs**
Harmonic generation in converters, Characteristic and non-characteristic harmonics, Harmonic filters, Reactive power compensation, Static VAR Compensators (SVC), STATCOM, Corona effects, Insulation coordination, Overvoltage protection, Surge arresters, Earthing systems.		
Unit-5	**Multi-terminal HVDC Systems and Renewable Energy Integration**	**6 Hrs**
Multi-terminal HVDC systems, Offshore HVDC transmission, Wind and Solar integration using HVDC, HVDC for smart grids, HVDC cables, Underground and submarine cables, Power flow control, Reliability and economic analysis, Industrial applications and case studies.		
Unit-6	**Advanced HVDC Technologies and Future Trends**	**6 Hrs**
Modular Multilevel Converter (MMC), Flexible HVDC systems, Hybrid HVDC transmission, Digital control systems, Artificial Intelligence in HVDC, FACTS and HVDC coordination, Cybersecurity in HVDC systems, Recent developments, Future scope and research trends.		

Case Study:

1). Case Study on Raigarh Pugalur ±800 kV UHVDC Transmission System (India)
2). Case Study on Integration of Offshore Wind Farms Using VSC-HVDC
3). Case Study on Harmonic Mitigation and Reactive Power Compensation in HVDC Systems
4). Case Study on Future HVDC Technologies for Smart Grid Applications

Learning Resources:

Text Books

1).K. R. Padiyar, HVDC Power Transmission Systems, New Age International.
2).S. Rao, EHV-AC, HVDC Transmission and Distribution Engineering, Khanna Publishers.

Reference Books

1).J. Arrillaga**,** High Voltage Direct Current Transmission, IET.
2).E. W. Kimbark**,** Direct Current Transmission, Wiley.
3).Narain G. Hingorani and Laszlo Gyugyi, Understanding FACTS*:* Concepts and Technology of Flexible AC Transmission Systems, Wiley.

MOOC / NPTEL/YouTube Links

1).NPTEL – Power System Analysis https://onlinecourses.nptel.ac.in
2).NPTEL – Power System Protection https://onlinecourses.nptel.ac.in
3).SWAYAM Portal https://swayam.gov.in
4).NPTEL Official https://www.youtube.com/@nptelhrd

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	1	2	1	-	1	1	2	-	-	1	0	1	1	2
CO2	1	2	3	1	2	1	1	-	-	1	1	1	-	2
CO3	2	3	2	3	2	2	1	-	-	1	1	2	-	2
CO4	1	3	2	3	3	1	1	-	1	2	1	1	2	2
CO5	2	3	3	2	3	2	3	1	1	3	3	2	1	3

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPEC3EE6052T **Course Name:** HVDC transmission systems Tutorial

Teaching Scheme		Credit	Evaluation Scheme	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites : Electrical Power System Engineering and Power System Analysis, DC machines, transformers, and Power Electronics, Basic knowledge of MATLAB/Simulink or equivalent simulation software.

Course Objectives:

1) Understand the operation and configuration of different HVDC transmission systems and their components.
2) Perform simulation and analysis of HVDC converters, transmission systems, and associated equipment using modern software tools
3) Study the performance of HVDC systems under different operating conditions, including harmonics, filters, and converter control and develop practical skills in designing and evaluating HVDC systems for renewable energy integration and modern power transmission applications.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Identify and explain the operation of various HVDC transmission system components and converter configurations.	Understand
CO2	Simulate and analyze HVDC transmission systems, converters, and harmonic filters using MATLAB/Simulink or PSCAD	Analyze
CO3	Evaluate the performance of HVDC systems by studying converter characteristics, harmonics, and renewable energy integration	Evaluate
CO4	Design and implement a simple HVDC transmission system for real-world power system applications using modern engineering tools.	Create

Course Description:

This laboratory course provides hands-on experience in the analysis, simulation, and design of High Voltage Direct Current (HVDC) transmission systems. Students study HVDC components, converter technologies, harmonic analysis, and filter design using MATLAB/Simulink or PSCAD. The course also covers renewable energy integration, industrial case studies, and performance evaluation of HVDC systems. A mini project enables students to design and simulate an HVDC transmission system, enhancing their practical skills in modern power transmission technology.

Note:-Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar SWVSM's

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPEC3EE6053 **Course Name:** Power System Operation and Control

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:
Basic knowledge of Power System Analysis, Electrical Machines, Control Systems, Power Electronics, and Engineering Mathematics.

Course Objectives: The objective of the course is to

1). To Understand Power System Operations and Control
2). To Analyze Economic Operation of Power Systems
3). To Optimize Unit Commitment in Power Systems

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the fundamentals of power system operation, control, and economic operation of power systems.	Understand
CO2	Analyze economic load dispatch problems considering generation constraints and transmission losses.	Analyze
CO3	Explain the principles, objectives, and methods of unit commitment in power system operation.	Understand
CO4	Explain the concepts and methods of hydrothermal scheduling for optimal utilization of available energy resources.	Understand
CO5	Analyze the operation of Automatic Generation Control (AGC) for maintaining system frequency and tie-line power.	Analyze
CO6	Evaluate different voltage control methods and reactive power compensation techniques for maintaining voltage stability in power systems.	Evaluate

Course Description: This course offers an in-depth exploration of the fundamental principles and advanced techniques in the operation and control of power systems. Designed for students pursuing a career in electrical engineering or energy management, the course covers a range of topics essential for understanding the complexities of modern power grids.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar SWVSM's ★

Course Content

Unit-1	Introduction to Power System Operation and Control	4 Hours
Operating States of a Power System, Objectives of Power System Control, Key Concepts for Reliable Operation, Major Threats to System Security, Preventive and Emergency Controls, Major Components of Energy Centers, Modern scenario of power system		
Unit-2	**Economic Operation of Power Systems**	**6 Hours**
Generator Operating Cost, Performance Curves, Input-Output Curve for Thermal Plants, Heat Rate Curve, Incremental Fuel Rate Curve, Incremental Cost Curve, Input-Output Curve for Hydroelectric Unit, Economic Dispatch.**(Numerical treatment)**		
Unit-3	**Unit Commitment**	**8 Hours**
Constraints in Unit Commitment, Spinning Reserve, Thermal Unit Constraints, Start-Up Costs of Thermal Units, Network Constraints, Emission Constraints, Capacity Limits of Generations, Fuel Constraints, Security Constraints, Hydel Plant Constraints, Priority List Method, Dynamic Programming, Dynamic Programming Methods for Unit Commitment, **(Numerical treatment).**		
Unit-4	**Hydrothermal Scheduling**	**4 Hours**
Scheduling Hydro Systems, Discrete Time Interval Method, Short Term Hydrothermal Scheduling Using γ-λ Iterations, Short Term Hydrothermal Scheduling Using Penalty Factors, **(Numerical treatment)**		
Unit-5	**Automatic Generation Control**	**6 Hours**
Basic Generator Control Loops, commonly used Terms in AGC, Functions of AGC, Speed Governors, Mathematical Model of Automatic Load Frequency Control, AGC Controller, Proportional Integral Controller, introduction to power system stabilizer (PSS), steady state and transient response including PSS.		
Unit-6	**Voltage Control and power system security**	**8 Hours**
Production and Absorption of Reactive Power, Methods of Voltage Control, Dependence of Voltage on Reactive Power, Sensitivity of Voltage to Changes in P And Q, Cost Saving, Methods of Voltage Control by Reactive Power Injection, Voltage Control Using Transformers, Voltage Stability. Definition and Importance of Power System Security, Types of Power System Security- Operational Security, Threats to Power System Security, Key Objectives of Power System Security..		

Case Study:

1). Case Study on The 2012 India Power Grid Blackout

2). Case Study on Economic Dispatch in a Thermal Power Station

3). Case Study on Load Frequency Control during Sudden Load Increase

Learning Resources:

Text Books:

1). Power System Operation and Control K. Uma Rao Wiley 1st Edition, 2012

2). Power system operation and control, by Sivanagaraju, Pearson publication

Reference Books:

1) P. S. R. Murty, Power System Operation and Control, Tata McGraw-Hill.
2) K. Uma Rao, Power System Operation and Control, Wiley India, 2012.

MOOC / NPTEL/YouTube Links

1). Power Systems Operation and Control – IIT Kanpur (Prof. S. N. Singh)
nptel.ac.in/courses/108104052

2). Power System Dynamics, Control and Monitoring – IIT Kharagpur (Prof.Debapriya Das)
nptel.ac.in/courses/108105133

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	2	2	-	-	-	-	-	-	-	1	-	2	1	-
CO2	2	3	2	1	2	-	1	-	-	-	-	2	2	1
CO3	2	2	-	-	1	-	-	-	-	-	-	1	2	-
CO4	1	2	2	1	2	-	2	-	-	-	-	1	2	2
CO5	1	1	2	2	2	-	1	-	-	-	1	2	-	2
CO6	2	2	1	2	2	1	2	1	-	-	1	-	-	-

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPEC3EE6053T **Course Name:** Power system operation and control Tutorial

Teaching Scheme		Credit	Evaluation Scheme	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites: Electrical Power Systems and Synchronous Machines. Power System Operation, Stability and Control concepts. Control Systems, MATLAB programming, and Simulink modeling, simulation results and prepare laboratory reports.

Course Objectives:

1).To analyze economic dispatch, voltage regulation, and load frequency control using MATLAB/Simulink.
2).To study transient stability using swing equation, power-angle curve, and equal area criterion.
3).To develop skills in modeling, simulation, and analysis of power system control techniques.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Analyze power system operation and control problems using MATLAB/Simulink.	Analyze
CO2	Implement and evaluate economic dispatch, voltage regulation, and load frequency control techniques.	Apply
CO3	Analyze power system stability using swing equation, power-angle curve, and equal area criterion.	Analyze
CO4	Develop simulation models and interpret results for improving power system performance and reliability.	Create

Course Description:

The Power System Operation and Control Laboratory focuses on MATLAB/Simulink-based analysis and simulation of economic dispatch, voltage regulation, excitation systems, load frequency control, and power system stability**.** It enables students to understand power system operation, develop simulation models, and analyze system performance under various operating conditions .

Note:-Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPEC3EE6054 **Course Name:** Industrial Automation

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Electrical Engineering fundamentals, Digital electronics, control systems, microcontrollers, sensors, transducers etc

Course Objectives:

1).To introduce concepts of PLC, input/ output devices
2).To understand different instructions in PLC programming
3).To introduce different SCADA components

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Understand the basics of industrial automation, its need, benefits, types, components, and applications	Understand
CO2	Understand the architecture of PLC	Understand
CO3	Apply ladder programming techniques and PLC instructions to create basic PLC control programs	Apply
CO4	Develop PLC-based control programs using timers, counters, and control circuits for industrial applications.	Apply
CO5	Analyze the working and application of advanced PLC functions including data handling, analog signal processing, and PID control in industrial systems	Analyze
CO6	Understand the basics of SCADA systems, their components, communication methods, and industrial applications.	Understand

Course Description:

This course introduces the fundamentals of Industrial Automation, PLC, and SCADA systems used in industrial control applications. It covers automation concepts, PLC architecture, hardware components, programming methods, and control applications using timers, counters, analog functions, and PID control. The course also explains SCADA components, communication protocols, and PLC-SCADA integration. Students will gain basic knowledge to understand and implement industrial automation systems.

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Waranangar

Course Content		
Unit-1	**Introduction to Industrial Automation**	**6 Hrs**
Definition, Need and benefits of automation, History of Automation, General Structure of an Automated Process, Industrial Automation Hierarchy, Types of automation- Fixed, Programmable and Flexible, Industrial Automation Components: Smart Sensors, PLC, DCS and SCADA, Examples of Automated Systems.		
Unit-2	**Basic of PLC**	**6 Hrs**
Definition of a PLC, Block diagram of PLC, Internal architecture of PLC, I/O module, PLC power supply and grounding basics, Classification of I/O Modules, Discrete I/O module, Analog I/O Module, Special Input Modules, I/O Field Devices, Types of PLC, Selection criteria for PLC, PLC hardware safety & industrial environment considerations, Advantages of a PLC.		
Unit-3	**Basic PLC Programming**	**6 Hrs**
Different programming languages, Ladder diagram method, Basic components & their symbols in ladder diagram, Rules to be followed to construct ladder diagram, Practical ladder programming standards (tag naming, comments), Ladder diagrams of digital logic gates, PLC I/O addressing, Instructions-Latching, Multiple Outputs.		
Unit-4	**Intermediate PLC Functions**	**6 Hrs**
Jump,Subroutine,Timers-Ondelay,Offdelay,Pulsetimer,Retentivetimer, Format of Timer Instructions, Counters- Up counter, down counter, Operation of a PLC Counter, Real-life applications using timers & counters, Ladder diagrams for DOL starter, Star delta starter, Autotransformer starter,		
Unit-5	**Advanced PLC Functions**	**6 Hrs**
Data Movement Instructions, Logical Instructions, Data Handling Instructions, Types of PLC analog modules and systems, PLC analog signal processing, Analog scaling(4–20mA,0–10V), BCD or multibit data processing, PLC analog output application examples.,		
Unit-6	**Introduction to SCADA**	**6 Hrs**
Objectives of DAS, Types of DAS, Analog to digital converter – Integrating type, Successive approximation type, SCADA components- Remote terminal unit (RTU), Intelligent electronic device (IED), Data concentrators and Merging units, Human Machine Interface (HMI), Block diagram of SCADA, benefits of SCADA, SCADA network architecture (Levels, Purdue Model – basic), Communication technologies in SCADA.		

Case Study:

1).Case Study on PLC-Based Conveyor Belt Automation System
2).Case Study on PLC-Based Automatic Temperature Control System Using PID
3).Case Study on SCADA-Based Power Distribution Monitoring and Control System
4). Case Study on PLC-Based Automatic Motor Control System for Industrial Applications

Learning Resources:

Text Books

1).Programmable logic controllers-Principles & Applications, 5^{th}Edition, John W. Webb, Ronald A Reis, Pearson, 2016.
2).Introduction to Programmable Logic Controllers, 2^{nd} Edition, Gary Dunning, Thomson, 2012.

Reference Books

1).Programmable Logic Controllers Programming Method sand Applications, 4thEdition, John R. Hackworth, Frederick D., Hackworth Jr., McGraw Hill, 2007.
2).Programmable Controllers, 2^{nd} Edition,Batten G.L, McGraw Hill Inc, 2008.
3).PowerSystemAnalysis,1^{st} Edition, Hadi Sadat, McGraw Hill,2002.
4).SCADA-Supervisory Control and Data Acquisition 5th Edition, Stuart A. Boyer, Instrument Society of America Publications, USA, 2004.

MOOC / NPTEL/YouTube Links

1).NPTEL – Introduction to Industrial Automation and Control – IIT Kharagpur
https://nptel.ac.in/courses/108 105063
2).NPTEL -Automation in Manufacturing – https://nptel.ac.in/courses/112105910
3).SWAYAM Portal https://swayam.gov.in
4).NPTEL Official https://www.youtube.com/@nptelhrd

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	1	-	2	1	1	-	-	2	1	1	2	2
CO2	1	2	1	-	3	-	-	-	-	2	1	1	2	1
CO3	3	2	2	2	2	-	-	1	2	1	2	3	1	2
CO4	1	2	2	2	3	1	1	1	2	1	1	2	3	1
CO5	2	3	3	3	2	-	1	-	1	3	2	3	2	1
CO6	3	2	1	2	3	2	1	1	2	3	2	1	3	2

SWVSM's Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electronics & Telecommunication
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGPEC3EE6054T **Course Name:** Industrial Automation Tutorial

Teaching Scheme		Credit	Evaluation Scheme	
Tutorial:	**01 Hour/Week**	**01**	**ISA:**	**25 Marks**

Prerequisites: Basic knowledge of Electrical Engineering fundamentals, digital electronics, control systems, microcontrollers, sensors, transducers , PLC etc

Course Objectives:

1) Understand PLC architecture, hardware, I/O modules, wiring, and ladder logic programming.
2) Develop and implement PLC-based automation applications using motor control, PID, HMI, SCADA, and troubleshooting techniques

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Understand PLC architecture, hardware components, I/O modules, and perform PLC wiring and configuration.	Understand
CO2	Develop ladder logic programs for basic logic operations, latching, interlocking, timers, counters, and comparison functions.	Apply
CO3	Implement PLC-based industrial control applications such as conveyor systems, motor control, temperature control, and PID control.	Apply
CO4	Interface PLC with HMI and SCADA systems for monitoring, control, data communication, and automation applications.	Apply
CO5	Troubleshoot PLC-based automation systems by analyzing hardware, communication, and I/O faults using fault diagnosis techniques.	Analyze

Course Description:

This course provides hands-on experience in PLC programming, industrial automation, and SCADA systems. Students will learn PLC hardware configuration, I/O interfacing, ladder programming, timers, counters, and control applications. The course includes motor control, PID-based temperature control, HMI interfacing, and PLC-SCADA communication. Students will develop skills for implementing and troubleshooting industrial automation systems.

Note:-Minimum 6 tutorials to be conducted based on syllabus.

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGMDM4EE606L **Course Name:** Renewable Energy Sources

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**02 Hours/Week**	**02**	**ISA:**	**50 Marks**

Prerequisites: Basic Physics, Electrical Engineering Fundamentals & Environmental Sciences & Hydro-Electric Generation.

Course Objectives:

1).Understand renewable energy sources.
2).Explain and analyze Solar Photovoltaic , thermal systems. wind energy
3).Understand the basics of Hydrogen energy and fuel cell technology.

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Explain the fundamentals, principles, and significance of renewable energy sources.	Understand
CO2	Classify and compare various renewable energy sources and their applications.	Understand
CO3	Understand the basics of hydrogen energy and fuel cell technology.	Understand
CO4	Explain the construction, working principles, and types of hydrogen fuel cells.	Understand
CO5	Explain and analyze Solar Photovoltaic and thermal systems.	Evaluate
CO6	Explain and analyze wind energy conversion systems.	Evaluate

Course Description:

This course provides a comprehensive introduction to renewable energy sources, focusing on solar and wind energy systems. Students will explore the global and Indian renewable energy scenarios, the need for alternative energy. The course delves into the technical aspects of solar energy, covering both thermal and photovoltaic power generation, along with the design, analysis, and operation of solar photovoltaic systems. Wind energy principles, including energy conversion, site selection, and economic and environmental factors. Students will gain hands-on knowledge of wind turbine technologies, including various types of turbines and generators, and the analysis of wind data for energy estimation.

Tatyasaheb Kore Institute of Engineering & Technology (Autonomous) Warananagar SWVSM'S ★

<table>
<tr><th colspan="3">Course Content</th></tr>
<tr><td>Unit-1</td><td>Renewable Energy Sources</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Introduction & Importance of Renewable Energy Sources, Principles of renewable energy; energy and sustainable development, fundamentals and social implications. Carbon Credits from Renewable Energy Projects. Worldwide Renewable Energy availability, renewable energy availability in India, brief descriptions on tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy.</td></tr>
<tr><td>Unit-2</td><td>Solar Photovoltaic Energy Conversion System</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Basics of PV cell, materials used, efficiency of PV cell, equivalent electrical circuit, open circuit voltage and short circuit current, I-V & P-Curves, effects of different electrical parameters on I-V&P-V curves. Configuration of PV power generation system-off-grid system & grid-connected PV system, Photovoltaic applications.</td></tr>
<tr><td>Unit-3</td><td>Solar Thermal Energy Conversion System</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Principle of conversion of solar radiation into heat, Collectors used for solar thermal conversion:Flat plate collectors and Concentrating collectors, Classification of concentrating collectors. Solar Thermal Power generation: - Solar central receiver system - Heliostats and receiver, Solar thermal applications- Solar heating/cooling techniques, Solar hot water systems - Solar distillation and drying, Solar greenhouses.</td></tr>
<tr><td>Unit-4</td><td>Wind Energy Conversion system</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Wind Energy Scenario, Power in the wind , Wind characteristics , Principles of wind energy conversions , Components of wind energy conversion system (WECS) ,Classification of WECS – Advantages and disadvantages of WECS. Wind Turbine: Torque speed characteristics</td></tr>
<tr><td>Unit-5</td><td>Wind Electric Generators</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Concept of fixed speed and variable speed Wind Electric Generators, Type of Wind Electric Generator: -Fixed Speed Induction Generators. DFIG ,Direct driven FRC Synchronous Generator, Direct driven Permanent Magnet Synchronous Generator</td></tr>
<tr><td>Unit-6</td><td>Green Energy</td><td>6 Hrs</td></tr>
<tr><td colspan="3">Hydrogen:Basics in Production Techniques Hydrogen- Purity Index of water - Physical and chemical properties -Salient characteristics - Production of hydrogen technologies (electrolysis method only). Benefits of hydrogen. Economic and environmental analysis on usage of hydrogen. Fuel Cells, Comparison on battery Vs fuel cell.</td></tr>
<tr><td colspan="3">Case Study:
1). Case Study on Solar PV Electrification of a Remote Village
2). Case Study on Grid Connected Rooftop Solar System for an Educational Institution
3). Case Study on Performance Analysis of a Solar Water Heating System
4). Case Study on Hybrid Solar Wind Power System for Rural Electrification

Learning Resources:</td></tr>
<tr><td colspan="3">Text Books
1).Boyle, Godfrey, “Renewable Energy”, (2ndedition), Oxford UniversityPress,2004.
2).G. S. Sawhney, “Non-Conventional Resources of Energy”, PHI Publication2012.</td></tr>
<tr><td colspan="3">Reference Books:
1).Gary-L. Johnson Wind Energy Systems Tata Mc-Graw-Hill Book Company.
2).James Manwell, J. F. Manwell Wind Energy Explained: Theory, Design and Application.
3).Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma
4).Bent Sorensen (Sorensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier Academic Press, UK.</td></tr>
</table>

MOOC / NPTEL/YouTube Links:

1).NPTEL :Chemical Engineering - Fuel Cell Technology,

2). NPTEL :Chemical Engineering - NOC:Hydrogen Energy: Production, Storage, Transportation and Safety.

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	1	-	2	-	-
CO2	2	1	2	2	1	-	-	-	1	1	-	2	1	-
CO3	-	2	-	-	-	-	-	-	-	1	-	-	-	-
CO4	-	2	2	3	2	-	-	-	-	1	-	2	2	-
CO5	2	1	-	2	2	-	-	1	-	1	-	1	2	-
CO6	2	-	2	1	-	1	1	-	-	1	1	2	1	1

Tatyasaheb Kore Institute of Engineering and Technology
Department of Electrical Engineering
Third Year of Bachelor of Technology (T.Y.B.Tech) Sem-VI

Course Code: 25UGVSECEE6071 **Course Name:** IOT For Electrical Engineers

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	**02 Hours/Week**	**02**	**ISA:**	**25 Marks**

Prerequisites: Knowledge of microcontrollers, Programming concept.

Course Objectives: The objective of the course is to

1). To understand fundamentals, architecture and various technologies of Internet of Things.
2). To impart knowledge on the infrastructure, sensor technologies and networking technologies of IoT
3). To know the connectivity of devices using web and internet in the IoT environment..

Course Outcomes: After successful completion of the course, student will be able to

COs	At the end of successful completion of the course the student will be able to	Bloom's Level
CO1	Familiarize students with the architecture and protocols associated with IoT	Understand
CO2	Explain a fundamental understanding of the Internet of Things and its significance	Understand
CO3	Develop skills in selecting appropriate technologies to implement IoT solutions effectively.	Apply
CO4	Implement the IoT solution for smart home and smart security etc.	Apply

Course Description:
This course discusses internet of things its architecture, connectivity, interfacing and application.

Course Content

Unit-1	Introduction to IoT	6 Hours
Definition and significance of IoT, Characteristics and architecture of IoT systems, Physical and logical design of IoT Functional blocks, Communication models, Communication Application Programming Interfaces (API).		
Unit-2	**IoT Communication Networks and Protocols**	**8 Hours**
Overview of communication networks: Home Area Network (HAN), Neighborhood Area Network (NAN), Field Area Network(FAN),Wide Area Network(WAN),Controller Area Network(CAN) Wireless Sensor Networks (WSNs), Access technologies and communication protocols, Overview of IEEE standards: 802.15.4, 802.11ah, LoRa WAN, Application layer protocols: CoAP, MQTT		
Unit-3	**IoT Sensors and Actuators**	**6 Hours**
Types of sensors used in IoT: environmental, medical, RFID, Actuator technologies and their applications, Challenges in IoT implementation: security, privacy, data management		
Unit-4	**Applications of IoT**	**4 Hours**
Smart homes: appliances, security systems, Smart energy solutions: smart meters, smart grids, Other applications: smart cities, automotive sector, healthcare, agriculture.		

Learning Resources:

Text Books

1). Internet of Things by Rajkamal, Tata Mc Graw Hill Publication.
2). Internet of Things: A Hands-on Approach by Vijay Madisetti and Arshdeep Bahga, Universities Press.

Reference Books

1). The Internet of Things: Connecting Objects by Hakima Chaouchi, Wiley Publication
2). The Internet of Things –Key Applications and Protocols by Olivier Hersentetal., Wiley

MOOC / NPTEL/YouTube Links

1). NPTEL https://nptel.ac.in/courses/106105166
2). NPTEL https://nptel.ac.in/courses/106106145

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	If applicable		
												PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	1	-	-	1	-	-	-	-
CO2	-	1	-		-	-	1	-		1	1	-	1	-
CO3	1	1	1	2	2	2	-	1		1	-	1	1	1
CO4	1	1	1	2	2	2	1	1	1	1	1	1	1	-

Member Secretary
Board of Studies

Chairman
Board of Studies

HEAD
Department of Electrical Engg.
TKIET,Warananagar
Tal.Panhala,Dist.Kolhapur.

Academic Dean
TKIET Warananagar

Dean, Academic
Tatyasaheb Kore Institute of Engg.
& Technology (Autonomous)
Warananagar, Dist. Kolhapur

Principal
TKIET Warananagar

Chairman
Academic Council
Tatyasaheb Kore Institute of Engg.
& Technology (Autonomous)
Warananagar, Dist. Kolhapur