K.K. Wagh Institute of Engineering Education and Research, Nashik

Department of Electrical Engineering

T.Y. B.Tech
Electrical Engineering

Curriculum
Pattern: 2022
W.e.f. AY: 2024-25

FY BTECH Electrical Engineering

SEM-I

Applicable for **Group C**= Divisions of Electrical and Robotics & Automation – 3 Divisions

Course Code	Course Type	Title of Course	Teaching Scheme Hrs./week			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	In Sem	End Sem	CCE	TU/ TW	PR/ OR	Total	TH	TU	PR	Total
FYE221001	BSC	Applied Mathematics – I	4	1	0	20	60	20	25	0	125	4	1	0	5
FYE221003	BSC	Applied Physics (A)	3	0	2	20	60	20	50	0	150	3	0	1	4
FYE221007	ESC	Fundamentals of Electronics Engineering	3	0	2	20	60	20	50	0	150	3	0	1	4
FYE221012	ESC	Engineering Drawing	1	1	2	25	50	0	50	0	125	1	1	1	3
FYE221014	LHSM	Communication Skills	1	0	2	0	0	25	50	0	75	1	0	1	2
FYE221016	LHSM	Democracy, Election and Governance	2	0	0	25	25	0	0	0	50	2	0	0	2
		Total	**14**	**2**	**8**	**110**	**255**	**85**	**225**	**0**	**675**	**14**	**2**	**4**	**20**

SEM-II

Course Code	Course Type	Title of Course	Teaching Scheme Hrs./week			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	In Sem	End Sem	CCE	TU/ TW	PR/ OR	Total	TH	TU	PR	Total
FYE221002	BSC	Applied Mathematics – II	4	1	0	20	60	20	25	0	125	4	1	0	5
FYE221005	BSC	Applied Chemistry	3	0	2	20	60	20	50	0	150	3	0	1	4
FYE221006	ESC	Fundamentals of Electrical Engineering	3	0	2	20	60	20	50	0	150	3	0	1	4
FYE221009	ESC	Engineering Mechanics	3	0	2	20	60	20	25	0	125	3	0	1	4
FYE221010	ESC	Programming in C	2	0	2	25	50	0	50	0	125	2	0	1	3
FYE221013	ESC	Workshop Practice	0	0	2	0	0	0	50	0	50	0	0	1	1
FYE221015	PSI	Engineering Explorations	0	0	2	0	0	0	50	0	50	0	0	1	1
		Total	**15**	**1**	**12**	**105**	**290**	**80**	**300**	**0**	**775**	**15**	**1**	**6**	**22**

SY BTECH Electrical Engineering
SEM-III

Course Code	Course Type	Title of the Course	Teaching Scheme Hrs./Week			Evaluation Scheme and Marks							Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TU/TW	PR	OR	Total	TH	TU	PR/OR	Total
SMH222601	BSC	Applied Mathematics-III	3	1	--	20	60	20	25	--	--	125	3	1	--	4
ELE222002	DCC	Analog and Digital Circuits	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222003	DCC	Measurement and Instrumentation	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222004	ESC	Electrical Engineering Materials	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222005	DCC	Transformer and Induction Machines	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222006	LHSM	Engineering Ethics	1	--		--	--	--	25	--	--	25	1			1
ELE222007	DCC	Measurement and Machines Lab	--	--	4	--	--	--	25	50	--	75	--	--	2	2
ELE222008	DCC	Analog and Digital Circuits Lab	--	--	2	--	--	--	25	25	--	50	--	--	1	1
ELE222009	ESC	Electrical Engineering Materials Lab	--	--	2	--	--	--	25	--	25	50	--	--	1	1
ELE222010	PSI	Python for Numerical Methods	--	--	2	--	--	--	25	--	--	25	--	--	1	1
		Total	**16**	**1**	**10**	**100**	**300**	**100**	**150**	**75**	**25**	**750**	**16**	**1**	**5**	**22**

SEM-IV

Course Code	Course Type	Title of the Course	Teaching Scheme Hrs./Week			Evaluation Scheme and Marks							Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TU/TW	PR	OR	Total	TH	TU	PR/OR	Total
ELE222011	DCC	Electrical Network Analysis	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222012	DCC	Microcontroller and Embedded Systems	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222013	DCC	Power Electronics	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222014	DCC	Power System Engineering	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222015	LHSM	Design Thinking for Academic Project	3	--	--	20	60	20	--	--	--	100	3	--	--	3
ELE222016	AC	Solar PV System	1	--		--	--	--	--	--	--	--	--	--	--	--
ELE222017	DCC	Power Electronics Lab	--	--	4	--	--	--	25	50	--	75	--	--	2	2
ELE222018	DCC	Electrical Network Analysis Lab	--	--	2	--	--	--	25	--	25	50	--	--	1	1
ELE222019	DCC	Microcontroller and Embedded Systems Lab	--	--	2	--	--	--	25	--	25	50	--	--	1	1
ELE222020	PSI	Project Based Learning	--	--	2	--	--	--	25	--	--	25	--	--	1	1
		Total	**16**	**0**	**10**	**100**	**300**	**100**	**100**	**50**	**50**	**700**	**15**	**0**	**5**	**20**

TY BTECH Electrical Engineering

SEM-V

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
ELE223001	DCC	Control System Engineering	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223002	DCC	Control System Engineering Lab	-	-	2	-	-	-	25	25	**50**	-	-	1	**1**
ELE223003	DCC	Synchronous and Special Purpose Machines	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223004	DCC	Power System Analysis	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223005	DCC	Machines and Power Systems Lab	-	-	2	-	-	-	25	25	**50**	-	-	1	**1**
ELE223006	DEC	Department Elective Course I	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223007	DEC	Department Elective Course Lab I	-	-	2	-	-	-	25	25	**50**	-	-	1	**1**
ELE223008	OEC	IPR and Patents	2	-	-	-	-	50	-	-	**50**	2	-	-	**2**
ELE223009	ESC	Digital Signal Processing	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223010	PSI	Education and Energy Awareness Program	-	1	2	-	-	-	50	-	50	-	1	1	2
Total			**17**	**01**	**08**	**100**	**300**	**150**	**125**	**75**	**750**	**17**	**1**	**4**	**22**

SEM VI

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
ELE223011	DCC	Computer-Aided Machine Design	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223012	DCC	Computer-Aided Machine Design Lab	-	-	2	-	-	-	25	25	**50**	-	-	1	**1**
ELE223013	DCC	Electrical Installation, Maintenance and Testing	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223014	DEC	Department Elective Course II	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223015	DEC	Department Elective Course Lab II	-	-	2	-	-	-	25	25	**50**	-	-	1	**1**
ELE223016	DEC	Department Elective Course III	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223017	ESC	Communication Systems	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE223018	OEC	Finance for Engineers	2	-	-	-	-	50	-	-	**50**	2	-	-	**2**
ELE223019	ASM	Industry connect Lab	1	-	2	-	-	-	25	25	**50**	1	-	1	**2**
ELE223020	PSI	Software for Research	-	-	2	-	-	-	50	-	**50**	-	-	1	**1**
Total			**18**	**00**	**08**	**100**	**300**	**150**	**125**	**75**	**750**	**18**	**0**	**4**	**22**

Department Elective Courses

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
Department Elective Course I (Sem-V) (Students have to choose any one of the following)															
ELE223006A	DEC	High Voltage Engineering	3	-	-	20	60	20	-	-	100	3	-	-	3
ELE223006B		Electrical Mobility													
Department Elective Course Lab I (Sem-V) (Students have to choose a lab based on selected Department Elective Course I)															
ELE223007A	DEC	High Voltage Engineering Lab	-	-	2	-	-	-	25	25	50	-	-	1	1
ELE223007B		Electrical Mobility Lab													
Department Elective Course II (Sem-VI) (Students have to choose any one of the following)															
ELE223014A	DEC	PLC and SCADA Automation	3	-	-	20	60	20	-	-	100	3	-	-	3
ELE223014B		Applications of Power Electronics in Power System													
Department Elective Course Lab II (Sem-VI) (Students have to choose a lab based on selected Department Elective Course II)															
ELE223015A	DEC	PLC and SCADA Automation Lab	-	-	2	-	-	-	25	25	50	-	-	1	1
ELE223015B		Applications of Power Electronics in Power System Lab													
Department Elective Course III (Sem-VI) (Students have to choose any one of the following)															
ELE223016A	DEC	Renewable Energy Systems	3	-	-	20	60	20	-	-	100	3	-	-	3
ELE223016B		Energy Audit and Management													

Final BTECH Electrical Engineering

SEM-VII

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
ELE224001	DCC*	Power System Operation and Control	3	-	-	-	100	-			**100**	3	-	-	**3**
ELE224002	DEC*	Department Elective Course VI	3	-	-	-	100	-	-	-	**100**	3	-	-	**3**
ELE224003	LHSM*	Leadership/Innovation /Entrepreneurship/Startup	2	-	-	-	-	50	-	-	**50**	2	-	-	**2**
ELE224004	PSI	Internship	-	-	24	-	-	-	300	200	**500**	-	-	12	**12**
Total			**08**	**00**	**24**	**-**	**200**	**50**	**300**	**200**	**750**	**8**	**-**	**12**	**20**

*** Considering an Internship of 6 months, these courses are to be offered in online mode.**

SEM VIII

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
ELE224011	DCC	Electrical Controlled Drives	3	-	-	20	60	20			**100**	3	-	-	**3**
ELE224012	DCC	Electrical Controlled Drives Lab	-	-	2	-	-	-	25	25	**50**	-	-	1	**1**
ELE224013	DCC	Switch Gear and Protection	3	-	-	20	60	20			**100**	3	-	-	**3**
ELE224014	DCC	Switch Gear and Protection Lab	-	-	2	-	-	-	25	25	**50**	-	-	1	**1**
ELE224015	DEC	Department Elective Course V	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE224016	DEC	Department Elective Course VI	2	-	-	20	30	-	-	-	**50**	2	-	-	**2**
ELE224017	ASM	Research Methodology	3	-	-	20	60	20	-	-	**100**	3	-	-	**3**
ELE224018	LHSM	Industrial and Technology Management	2	-	-	-	-	50	-	-	**50**	2	-	-	**2**
ELE224019	PSI	Project	-	-	8	-	-	-	100	50	**150**	-	-	4	**4**
Total			**16**	**0**	**12**	**100**	**270**	**130**	**150**	**100**	**750**	**16**	**0**	**6**	**22**

Department Elective Courses

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
Department Elective Course VI(Sem-VI) (Students have to choose any one of the following)															
ELE224002A	DEC	Smart Grid	3	-	-	--	100	--	-	-	100	3	-	-	3
ELE224002B		Design Power Electronic Converter	3	-	-	--	100	--	-	-	100	3	-	-	3
Department Elective Course IV(Sem-VIII) (Students have to choose any one of the following)															
ELE224015A	DEC	Power Quality Assessment and Mitigation	3	-	-	20	60	20	-	-	100	3	-	-	3
ELE224015B		Microgrid and Control													
Department Elective Course V (Sem-VIII) (Students have to choose any one of the following)															
ELE224016A	DEC	AI and ML Applications in Electrical Engineering	3	-	-	20	60	20	-	-	100	3	-	-	3
ELE224016B		Advanced Control System													

B. Tech (Electrical) Hon./minor* degree with MdM

Sem	Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
				TH	TU	PR	INSEM	ENDSEM	CCE	TUT/TW	PR/OR	TOTAL	TH	TU	PR	TOTAL
VI	ELE223021	PCC	Power Electronic Converter Design	04	-	-	20	60	20	-	-	100	04	-	-	04
	ELE223022	PCC	Power Electronic Converter Design Lab	-	-	04	-	-	-	50	50	100	-	-	02	02
VII	ELE224021	PCC	Controllers Design in Power Electronics	04	-	-	20	60	20	-	-	100	04	-	-	04
	ELE224022	PCC	Controllers Design in Power Electronics Lab	-	-	04	-	-	-	50	50	100	-	-	02	02
VIII	ELE224023	PCC	AC and DC Microgrid	03	-	-	20	60	20	-	-	100	03	-	-	03
	ELE224024	PCC	Energy Storage and Power Train in EV	03	-	-	20	60	20	-	-	100	03	-	-	03
			Total	**14**	**-**	**08**	**80**	**240**	**80**	**100**	**100**	**600**	**14**	**-**	**04**	**18**

* These courses are an Honors Degree Award Course for Electrical Engineering Students and a Minors Degree Award Course (multi-disciplinary) for other branches

T.Y.B.Tech.
Pattern:2022 Semester: V (Electrical Engineering)
ELE223001:Control System Engineering

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 3 Hrs/week	**TH: 3**	**Continuous Comprehensive Evaluation: 20Marks** **In Sem Exam: 20 Marks** **End Sem Exam: 60Marks**

Prerequisite Courses: Applied Mathematics III, Electrical Network Analysis

Course Objectives: The course objectives are to

1. Impart a basic understanding of control system engineering
2. Introduce basic terminologies and principles of control system engineering
3. Acquaint with the time-domain and frequency-domain methods for determining the stability of the system
4. Present fundamental controller design methods typically used in industries

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Define various terminologies in the control system	2-Understand
CO2	Analyze system stability using time-domain and frequency-domain techniques	4-Analyze
CO3	Apply root locus method for determining parameters of PID controller	3-Apply
CO4	Evaluate the controllability and observability properties of the system	5-Evaluate
CO5	Design PID and state feedback-based controller for the system	6- Create

COURSE CONTENTS

Unit I	Introduction	9 Hrs.	COs Mapped: CO1

Types of control systems, open- and closed-loop systems. Modeling and representations of control systems: Mechanical, Electrical, Transfer functions, Block diagram reduction, Signal flow graphs, Control system case study

Unit II	Concept of Stability	9 Hrs.	COs Mapped: CO1, CO2

Standard Test Signals, Time-domain analysis, Second-order systems, Characteristic-equation and roots, Steady-state-error, Routh-Hurwitz criteria, Root-locus methods, Control system case study

Unit III	Frequency-domain techniques	9 Hrs.	COs Mapped: CO1, CO2

Relationship between time and frequency response, Frequency responses, Bode-plots, Gain-margin and phase-margin, Polar Plot, Nyquist plots, Control system case study

Unit IV	Compensator design:	9 Hrs.	COs Mapped: CO1, CO2, CO3, CO5

Proportional, PI and PID controllers, Lead-lag compensator designs using root locus, analog and digital implementation of the controller, Control system case study

Unit V	State-space concepts	9 Hrs.	COs Mapped: CO1, CO2, CO4, CO5

State-space representations, Diagonalization, Solution of state equations, Eigenvalues and Stability Analysis, Controllability, Observability, pole placement, Concept of the observer, Control system case study

Text Books
1. Nise N. S. “Control Systems Engineering”, John Wiley & Sons, Incorporated, 2011 2. I.J. Nagrath, M. Gopal, “Control System Engineering”, New Age International Publishers, 6th edition, 2017
Reference Books
1. Richard C Dorf and Robert H Bishop, “Modern control system”, Pearson Education, 12th edition, 2011. 2. Katsuhiko Ogata, “Modern control system engineering”, Prentice Hall, 2010.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment1(Based on Units I and II)(Deadline: before Insem)	5
2	Assignment2(Based on Units III and IV)(Deadline: before Endsem)	5
3	LMS Tests(Best5out of minimum 10)	5
4	Class Test (Before End sem on Units III, IV, V)	5

T.Y.B.Tech. Pattern:2022 Semester: V (Electrical Engineering) ELE223002:Control System Engineering Lab		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical:2 Hrs/Week	**PR:2**	**Term Work:25Marks** **Practical:25 Mark**

Prerequisite Courses: Engineering Mathematics III, Electrical Network Analysis

Course Objectives: The objectives of the course are to

1. Develop a deeper understanding of concepts in control system engineering.
2. Connect theoretical control engineering knowledge to physical applications
3. Provide exposure to experimental skills like system modeling, simulation, analysis, observation, design, and use of equipment in a step-by-step manner

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Understand the use of MATLAB for system matrices calculations, closed-loop and open-loop system analysis, and controller design purposes	1-Remember
CO2	With team-based laboratory assignments, students will be able to demonstrate the ability to interact effectively with fellow students and will develop the ability to divide up and share task responsibilities to complete assignments	2-Understand
CO3	Write professional quality textual and graphical write-ups using experiment analytical and simulation results	3-Apply
CO4	Communicate the observations and conclusions of the experiment with the clarity of the thoughts	4-Analyse

List of Laboratory Experiments

Perform any 8 Experiments. One experiment out of 9 and 10 is compulsory. An industrial visit is additional.

Sr.No.	Laboratory Experiments	COs Mapped
1	**Pre-Lab:** Derive the transfer function of the system (Electrical circuit, DC Motor, etc.) **Lab:** Obtain the transfer function of the same system using MATLAB and get a pole-zero plot. **Post-Lab:** Observer the effect of change in pole-zero locations with the change of system parameters	CO1, CO2, CO3, CO4
2	**Pre-Lab:** Derive the transfer function of the Separately Excited DC motor using individual blocks and get the transfer function by using the block-diagram reduction technique. **Lab:** Obtain the torque-speed Characteristics of a separately excited DC motor and its parameters, and hence determine the transfer function of a D.C Machine. **Post-Lab:** Verify the results with MATLAB and comment on the change in the results	CO1, CO2, CO3, CO4
3	**Pre-Lab:** Consider the RLC circuit and develop a 2^{nd} order system. For given values of R, L and C determine time-domain specifications. Later take different values to get different locations of poles. **Lab:** Plot the step response of all these systems using MATLAB/Simulink	CO1, CO2, CO3, CO4

	and find time domain specifications **Post-Lab:** Note observations of time-domain specifications for actual RLC circuits and simulation for different pole-zero locations.	
4	**Pre-Lab:** Draw root locus/Bode Plot for the DC motor model mathematically. Consider gain as 1. **Lab:** Obtain root locus/Bode Plot using MATLAB of the same system. **Post-Lab:** Study the effect of the addition of poles and zeros on root locus/Bode Plot	CO1, CO2, CO3, CO4
5	**Pre-Lab:** Determine parameters of PID controller for flow loop/DC motor and obtain a closed-loop response. **Lab:** Investigate the PID controller to the actual Flow loop system and evaluate performance. **Post-Lab**: Develop the same system in MATLAB using the SISO tool and compare results.	CO1, CO2, CO3, CO4
6	**Pre-Lab:** Derive state model of the DC motor/electrical circuit **Lab:** Obtain the State-space representation of the same system using Linear system analysis of MATLAB **Post-Lab**: Verify the answer and check the controllability and observability properties of the system	CO1, CO2, CO3, CO4
7	**Pre-Lab:** Determine controllability and observability of the system **Lab:** Get controllability and observability matrices using MATLAB and check them. **Post-Lab**: Identify uncontrollable and unobservable states	CO1, CO2, CO3, CO4
8	**Pre-Lab:** Determine state feedback gain for the system of DC motor or electrical circuit **Lab:** Obtain state feedback gain using MATLAB and get the closed-loop response **Post-Lab**: Check response for various initial conditions and verify it with calculations	CO1, CO2, CO3, CO4
9	Implement of 2^{nd} order system using hardware	CO2, CO3, CO4
10	Process flow loop control using PID controller	CO3, CO4
11	Industrial Visit to the Control and Automation Industry	

Guidelines for Laboratory Conduction
1. The teacher will brief the given experiment to students for its procedure, observations, calculations, and outcome. 2. The apparatus and equipment required for the allotted experiment will be provided by the lab technician. 3. Students will perform the allotted experiment in a group (2-3 students in each group) under the supervision of faculty and lab technician. 4. After performing the experiment students will check their readings and calculations from the teacher. 5. After checking they have to write the conclusion on the final results. 6. A minimum 4 sets of the experiment should be made ready for the conduction of the experiment in a batch for hardware experiments
Guidelines for Student's Lab Journal

The write-up should include a title, aim and apparatus, circuit or block diagram, waveforms, brief theory, procedure, observations, graphs, calculations, conclusion, and answers to the questions, if any.
Guidelines for Term Work Assessment
Each experiment from the lab journal is assessed for thirty marks based on three rubrics.Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech.
Pattern:2022 Semester: V (Electrical Engineering)
ELE223003:Synchronous and Special Purpose Machines

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 3 Hrs/week	TH: 3	Continuous Comprehensive Evaluation: 20Marks InSem Exam: 20 Marks EndSem Exam: 60Marks

Prerequisite Courses: Measurement and Instrumentation, Transformer and Induction Machines

Course Objectives: The objectives of the course are

1. Explain the construction and working principle of three-phase synchronous machines and special-purpose motors
2. Enable students to calculate the voltage regulation of the Alternator by different methods.
3. Study the applications of different machines in industrial, commercial and social sectors

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Understand the construction and working principle of three-phase Synchronous Machines and Special Purpose Motors.	1-Remember 2-Understand
CO2	Draw and explain the characteristics of three-phase Synchronous Machines and Special Purpose Motors.	2-Understand
CO3	Select appropriate machines for applications in Power Systems, industrial sector, household and Military Engineering applications.	3-Apply
CO4	Explain testing methods to evaluate the performance of machines through experimentation.	4-Analyze

COURSE CONTENTS

Unit I	**Three-phase Synchronous Machines** Construction, rotating-field type and rotating type and their comparison. ExcitationMethods. **Three phase Synchronous generator (cylindrical rotor type):** Principle of operation. Emf equation and winding factors (No derivation), rating of the generator. Generator on no-load and on balanced load. Armature reaction and its effect under different load power factors. Voltage drops due to armature resistance, leakage flux and synchronous reactance, per phase equivalent circuit, Power - power angle relation. **Three-phase Synchronous generator (salient pole type):** Armature reaction as per Blondel's two reaction theory for salient-pole machines, Direct-axis and quadrature-axis synchronous reactance's and their determination by slip test. Phasor diagram of the salient-pole generator and calculation of voltage regulation.	**09 hrs**	**CO1, CO2, CO3**
Unit II	**Voltage regulation of Three-phase Synchronous generator** Performance of open circuit and short circuit test on the synchronous generator, determination of voltage regulation by emf, mmf, and Potier triangle methods. Determination of voltage regulation by direct loading. Short circuit ratio. **Parallel operation of 3-phase alternators:** Necessity, conditions, Load sharing between two alternators in parallel (Descriptive treatment only). Process of synchronizing alternator with infinite bus-bar by lamp methods and by use of synchroscope (one dark & two equally bright methods). Synchronizing current, power and torque (no	**09 hrs**	**CO2, CO4**

	numerical).		
Unit III	**Three-phase synchronous motor** Principle of operation, Methods of starting. Equivalent circuit, significance of torque angle, Losses, efficiency and Power flow chart. Operation of 3-phase Synchronous motor with constant load and variable excitation ('V' Curves and 'inverted V' curves). The phenomenon of hunting and its remedies. Applications of 3-phase synchronous motors. Comparison of 3-phase synchronous motor with 3-phase induction motor. Transient Behavior: Sudden 3-Phase Short Circuit, Time Constants and Equivalent Circuit Diagrams, Damper Windings. Numerical on power input, power factor, and torque.	**09 hrs**	**CO1, CO2, CO3**
Unit IV	**A.C. series motor** Operation of D.C. series motor on a.c. supply, nature of torque developed, and problems associated with AC. operation and remedies. Compensated series motor: Compensating winding, conductively and inductively compensated motor. Approximate phasor diagram. Use of compiles for improving commutation. Ratings and applications of Compensated Series motors. Universal motors: Ratings, performance and applications, comparison of their performance on A.C. and D.C. supply.	**09 hrs**	**CO2**
Unit V	**Special Purpose Motors** Construction, principle of working, characteristics, ratings and applications of Brush less D.C. motors, Stepper motors (permanent magnet and variable reluctance type only), Permanent Magnet motor (A.C. & D.C.). AC commutator machines, PMSM Motor, ac servomotors	**09 hrs**	**CO1, CO2, CO3**

Text Books

1. P. S. Bimbhra, Electric Machinery, Khanna Publications
2. Grainger John J and W D Stevenson Jr., "Power system analysis" Mc-Graw Hill.
3. J. Nagrath, D. P. Kothari, "Modern Power System Analysis" (3rd Edition), Tata McGraw Hill.Publishing Co. Ltd., 2003.
4. V. K. Mehta and Rohit Mehta, Principles of Electrical Machines, S Chand Publication
5. B. L Theraja –Electrical Technology, Vol. II, S. Chand publication.
6. A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans, "Electric Machinery", Tata McGraw Hill Publication, sixth edition 2002.

Reference Books

1. M.G. Say, Performance and Design of A.C. Machines (3rd Ed.), ELBS
2. P.C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley and Sons Publication, second edition 1997
3. J B Gupta - Theory and performance of Electrical Machines, S K Kataria Publication
4. E G Janardanan, Special Electrical Machines, Prentice Hall of India

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment1(Based on Units I and II) (Deadline: before Insem)	5
2	Assignment2(Based on Units III and IV) (Deadline: before Endsem)	5
3	LMS Test (Best5outofMinimum10)	5
4	Class Test (Before Endsem on Units III, IV, V)	5

T.Y.B.Tech.
Pattern:2022 Semester: V (Electrical Engineering)
ELE223004: Power System Analysis

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory:3 hrs/week	TH: 3	Continuous Comprehensive Evaluation: 20Marks InSem Exam: 20Marks EndSem Exam: 60Marks

Prerequisite Courses: Power System Engineering

Course Objectives: The objectives of the course are to

1. Develop analytical skills to solve problems related to power systems.
2. Enable students to apply different algorithms and numerical techniques to power system analysis.
3. Develop critical thinking ability to solve problems in power systems

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Classify and define types of faults, stabilities, and load flow methods	1-Remember
CO2	Calculate per unit values and draw per unit impedance diagram of power system components.	3-Apply
CO3	Analyze power system faults, stability conditions, load frequency control	4-Analyze
CO4	Evaluate load flow analysis, power system stability and load frequency control	5-Evaluate

COURSE CONTENTS

Unit I	Representation of Power System Components and Load Flow	08hrs	CO1, CO2, CO4

Introduction, single-phase solution of balanced three-phase networks, the one-line diagram and the impedance or reactance diagram, per-unit (pu) system, Network model formulation, formation of Y bus, power flow problem, different types of buses, approximate power flow, Newton-Raphson method, Decoupled Power flow studies, Fast Decoupled power flow studies, comparison of power flow methods

Unit II	Symmetrical Fault Analysis	09hrs	CO1, CO2, CO3

Introduction, transient on a transmission line, short circuit of a synchronous machine on no load, short circuit of a loaded synchronous machine, balanced three-phase fault, short circuit capacity, fault analysis using bus impedance matrix, selection of protective equipment.

Unit III	Unsymmetrical Fault Analysis	09hrs	CO1, CO2, CO3

Symmetrical component analysis of unsymmetrical faults, single line to ground (LG) fault, line to line (LL) fault, double line to ground (LLG) fault, open conductor faults, bus impedance matrix method for analysis of unsymmetrical faults.

Unit IV	Power System Stability	10hrs	CO1, CO3, CO4

Importance of stability analysis in power system planning and operation - classification of power system stability - angle and voltage stability – simple treatment of angle stability into small-signal and large-signal (transient) stability Single Machine Infinite Bus (SMIB) system: Development of swing equation - equal area criterion - determination of critical clearing angle and time by using modified Euler method and Runge-Kutta second order method. Algorithm and flow chart.

Unit V	Load Frequency Control (LFC)	09hrs	CO1, CO3, CO4
Introduction to LFC, modelling of the turbine, governor and generator load model, single area LFC: First order and exact system LFC, PI controlled LFC, two area LFC, PID based automatic generation control.			

TextBooks

1. Hadi Saadat, Power System Analysis, 5th reprint, Tata McGraw Hill publishing Company Ltd, New Delhi, 2004. 3. I. J.
2. Nagrath and D. P. Kothari, Power System Engineering, Tata McGraw Hill publishing Company Ltd., New Delhi, 3rd Edition, 2014.
3. Ashfaq Hussain, Electrical power system fifth edition, CBS Publishers & Distributors Pvt Ltd.

Reference Books

1. J. J. Grainger and W. D. Stevenson, Power System Analysis, McGraw Hill, New Delhi, 1st Edition, 1994.
2. Duncan Glover, S. MulkutlaSarma and Thomas Overby, Power System Analysis and Design, 5th Edition Cengage Learning 2012.
3. Arthur R. Bergen, Vijay Vittal, Power Systems Analysis, Prentice Hall of India, Inc., 2nd Edition, 2000

NPTEL Course:

1. Dr. Debpriya Das, "Power System Analysis" https://onlinecourses.nptel.ac.in/noc19_ee62/preview

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II) (Dead line: before Insem)	5
2	Assignment 2 (Based on Units III and IV) (Dead line: before Endsem)	5
3.	LMS Test (Best 5 out of Minimum 10)	5
4.	Certificate course on ETAP/MATLAB Simulation/DIgSalient Power Factory/PSCAD	5

T.Y.B.Tech.
Pattern:2022 Semester: V (Electrical Engineering)
EL223005: Machines and Power System Lab

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical:2 Hrs/Week	PR:1	Term Work:25 Marks Practical: 25 Marks

Prerequisite Courses: Power System Engineering, Transformer and Induction Machines

Course Objectives: The objectives of the course are to

1. Introduce the components of a power system, including generators, transformers, transmission lines, and loads, and understand their interactions and behaviors.
2. Enable students to use various measurement instruments and techniques to measure electrical quantities such as voltage, current, power, and frequency.
3. Empower students to conduct tests on electrical machines to analyze their performance, determine efficiency, and obtain characteristics under different operating conditions.
4. Expose to software tools for simulating and analyzing electrical machines and power systems, allowing for virtual experimentation and system analysis.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Elaborate on the construction, operation, and applications of synchronous and special-purpose machines.	2-Understand
CO2	Utilize software tools commonly used in power system analysis, such as MATLAB/PSCAD/ETAP/DiGSalient power factory, to perform complex power system studies and analyze the results.	3-Apply
CO3	Analyze the test results to determine the synchronous and special machine's performance parameters, including voltage regulation, efficiency, and power factor.	4-Analyze
CO4	Perform power flow studies to analyze and understand the steady-state behavior of power systems, and evaluate the system under fault conditions to assess its stability.	5- Evaluate
CO5	Interpret the results from experiments accurately and present them effectively through lab reports.	5-Evaluate

List of Laboratory Experiments

1) Perform any FIVE experiments from Sr. No. 1 to 7.
2) Perform any FOUR Experiments from Sr. 8 to 12
3) Industrial visit is compulsory Sr. No. 13

Sr.No.	Laboratory Experiments	COs Mapped
1	Determine voltage regulation of cylindrical rotor alternator by a) EMF method and b) MMF method	CO1, CO3, CO5
2	Determine of voltage regulation of the cylindrical rotor alternator by the Potier method.	CO1, CO3, CO5
3	Plot V and inverted V curves of the synchronous motor at constant load.	CO1, CO3, CO5
4	Perform Load Test on AC Series motor.	CO1, CO3, CO5
5	Perform speed control on the BLDC motor	CO1, CO3, CO5

6	Determine the sub-synchronous direct and quadrature axis reactance of a salient pole synchronous machine.	CO1, CO3, CO5
7	Determine the negative and zero sequence impedance of synchronous machines.	CO1, CO3, CO5
8	Perform the load flow analysis using MATLAB/ ETAP/ PSCAD / DiGSalient software	CO2, CO4,CO5
9	Find the fault level and plot the related voltage and current waveforms of a given power system subjected to symmetrical faults with professional software.	CO2, CO4,CO5
10.	Find the fault level and plot the related voltage and current waveforms of a given power system subjected to unsymmetrical faults with professional software.	CO2, CO4,CO5
11	Analyze the stability of the system using equal area criteria in the SIMB system for any two cases from the following a) Bolted fault at machine terminal bus bar b) Fault at the centre of one of the lines in parallel transmission. c) Change in mechanical input	CO2, CO4,CO5
12	Simulate the behaviors of frequency of single area load frequency control for a) First order LFC b) Exact system LFC c) Exact system LFC with PI controller	CO2, CO4,CO5
13	Industrial visit to synchronous machines manufacturing unit.	CO1, CO5

Guidelines for Laboratory Conduction
1. The teacher will brief the given experiment to students for its procedure, observations, calculations, and outcome. 2. Apparatus and equipment required for the allotted experiment will be provided by the lab technician using SOP. 3. Students will perform the allotted experiment in a group (2-3 students in each group) under the supervision of faculty and lab technician. 4. After performing the experiment students will check their readings and calculations from the teacher. 5. After checking they have to write the conclusion on the final results. 6. Minimum 4 sets of the experiment should be made ready for the conduction of a batch for hardware experiments
Guidelines for Student's Lab Journal
The write-up should include a title, aim and apparatus, circuit or block diagram, waveforms, brief theory, procedure, observations, graphs, calculations, conclusion, and questions, if any.
Guidelines for Term Work Assessment
Each experiment from the lab journal is assessed for thirty marks based on three rubrics. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech.
Pattern:2022 Semester: V (Electrical Engineering)
ELE223006A: High Voltage Engineering

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 3 hrs/week	TH – 3	Continuous Comprehensive Evaluation: 20 Marks In-Sem Exam: 20 Marks End-Sem Exam: 60 Marks

Prerequisite Courses: Fundamentals of Electrical Engineering, Electrical Engineering Materials

Course objectives: The objectives of the course are to introduce to the fundamentals of insulating materials and their applications in electrical and electronics engineering, the breakdown phenomenon in insulating material (solid, liquid, and gases), generation and measurement of high D.C.A.C. and impulse voltages and currents, the over-voltage phenomenon in electrical power system and insulation coordination, high voltage testing techniques.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Explain the basic terminologies concepts of high voltage engineering, insulation and breakdown	1-Remember
CO2	Describe the measurement techniques for high voltage and current	2-Understand
CO3	Discuss the testing methods and procedures of high voltage along with the apparatus used for it	2-Understand

COURSE CONTENTS

Unit I	High voltage Engineering	08 hrs	CO2

Cascade transformers-seriesresponse circuits DC voltages, voltage doubler cascade circuit electrostatic machines, impulse voltage: single stage and multistage circuits wave shaping tripping and control of impulse generators generation of switching surge voltage and impulse currents.

Unit II	Measurement of High voltage and current	08 hrs	CO1, CO3

DC, AC and impulse voltages and currents – DSO – electrostatic and peak voltmeters - sphere, gaps-factors affecting measurements –potential divider (capacitance and resistive) - series impedance ammeters - Rogowski coils Hall effect generators.

Unit III	High voltage testing of materials and apparatus:	08 hrs	CO1, CO3

Preventative and diagnostic tests-dielectric loss measurement-Schering bridge-inductively coupled ratio arm bridge-partial discharge and radio interference measurement-testing of circuit breakers and surge diverting.

Unit IV	Insulation materials and system	08 hrs	CO1, CO4

Insulation system in practice, dielectric losses, ageing and life expectancy, Outdoor insulation: materials, ageing, diagnostic, polymeric materials (EPDM, SIR), semi-conducting ceramic, glazes.

Unit V	Breakdown in Solid, Liquid and Gaseous Dielectrics	08 hrs	CO1, CO4

Breakdown in gas and gas mixtures-breakdown in uniform, in the non-uniform field, Paschens law-Townsends criterion-streamer mechanism-corona discharge-breakdown in electronegative gases. Breakdown in liquid dielectrics-suspended particle mechanism.Breakdown in solid dielectrics-intrinsic, streamer, thermal breakdown

Text Books

1. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers Ltd.
2. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Publication Co. Ltd. New Delhi

Reference Books
1. E. Kuffel, W. S. Zaengl, J. Kuffel, “High Voltage Engineering Fundamentals”, Newnes Publication 2. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, “High Voltage Engineering", Khanna Publishers, New Delhi 3. Ravindra Arora, Wolf Gang Mosch, “High Voltage Insulation Engineering”, New Age International 4. High Voltage Engineering Theory and Practice by M. Khalifa Marcel Dekker Inc. New York and Basel 5. Subir Ray, “An Introduction to High Voltage Engineering” PHI Pvt. Ltd. New Delhi

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II) (Deadline: before In-sem)	5
2	Assignment 2 (Based on Units III and IV) (Deadline: before End-sem)	5
3.	LMS Tests (Best 5 out of Minimum 10)	5
4.	Class Test (based on Units III, IV and V)	5

T.Y.B.Tech.
Pattern:2022 Semester: V (Electrical Engineering)
ELE223006B: Electrical Mobility

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory:3Hrs/week	TH: 3	Continuous Comprehensive Evaluation: 20Marks InSem Exam: 20 Marks EndSem Exam: 60 Marks

Prerequisite Courses:- Fundamentals of Electrical Engineering, Electrical Motors, Power Electronics

Course Objectives: The objectives of the course are to

1. Make students understand the need and importance of Electric and Hybrid Electric vehicles.
2. Impart the knowledge about architecture and performance of Electric and Hybrid Vehicles
3. Enable students to differentiate and analyze the various energy storage devices.
4. Introduce various charging technologies for electric vehicle

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Understand the concepts of Hybrid and Electric vehicles.	1-Remember
CO2	Describe the different modes of operation for hybrid vehicle	2-Understand
CO3	Choose appropriate electrical machines in electric vehicles and hybrid vehicle configurations	3-Apply
CO4	Analyze different types of energy storage systems	4-Analyze
CO5	Differentiate between Vehicle to home & Vehicle to grid concepts.	4-Analyze

COURSE CONTENTS

Unit I	**Introduction to Electric and Hybrid Vehicles:**	**9**	**CO1**

Need of Electric Vehicle and Hybrid Electric Vehicles, Environmental significance of Hybrid and Electric vehicles. Advantages and challenges in EV and HEV. Comparison of Conventional Vehicles with Electric Vehicles

Unit II	**Electric Vehicles**:	**9**	**CO2**

Main components and working principles of a HEV, PHEV, FCEV. Different configurations of hybrid electric vehicles. Operation Modes and Control Strategies for Hybrid Vehicle.

Unit III	**Motors and Drives**	**9**	**CO3**

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Induction Motor working principle, construction and characteristics and their applicability in EV.

Unit IV	**Energy Storage**	**9**	**CO4**

Batteries: Types, Parameters and Technical characteristics, Selection of Battery pack, Properties of Batteries. Ultracapacitor, Fuel Cells, Flywheel

Unit V	**EV Technologies**	**9**	**CO5**

Classification of different charging technology for EV charging stations, Introduction to Grid-to-Vehicle, Vehicle to Grid (V2G), Vehicle to Home (V2H) operations, Vehicle to Home (V2V), Vehicle to Everything

Text Books
1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011. 2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
Reference Books
1. MehrdadEhsani, YiminGao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010. 2. Tom Denton, "Automobile Electrical and Electronic Systems", SAE International publications. 3.Junwei Lu & Jahangir Hossain, "Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid" et al (eds), IET Digital Library.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment1(Based on Units I and II) (Deadline: before Insem)	5
2	Assignment2(Based on Units III and IV) (Deadline: before Endsem)	5
3	LMS Tests (Best 5 out of Minimum10)	5
4	Class Test (Before Endsem on Units III,IV,V)	5

T.Y.B.Tech. Pattern:2022 Semester: V (Electrical Engineering) ELE233007A: High Voltage Engineering lab		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 2 hrs/week	**PR: 1**	**Termwork: 25 Marks** **Oral: 25 Marks**
Prerequisite Courses: Fundamentals of Electrical Engineering, Electrical Engineering Materials Lab		
Course Outcomes: On completion of the course, students will be able to–		

	Course Outcomes	Bloom's Level
CO1	Select a proper insulating medium suitable for high-voltage systems	2-Understand
CO2	Generate and measure a high DC, AC voltage and currents in the lab	3 -Apply
CO3	Use various standards to carry out HV tests on various equipment	3 -Apply
CO4	Test gases, liquid and solid materials in the high-voltage laboratory	3 -Apply

List of Laboratory Experiments
(Any eight experiments from Sr. No. 01 to 09 and Industrial Visit is compulsory)

Sr. No.	Laboratory Experiments	COs Mapped
1	To study the use of Sphere gap as a Voltmeter for measurement of High Voltages.	CO1
2	To measure the Dielectric strength of air.	CO1, CO2
3	To study the breakdown under Uniform and non-uniform fields.	CO1, CO2
4	To measure the breakdown strength of Liquid dielectrics as per I. S	CO1, CO2
5	To study the effect of gap-length on B. D. strength of Liquid dielectrics	CO1, CO2, CO3
6	To measure the breakdown strength of various solid dielectrics	CO1, CO2, CO3
7	To simulate Corona discharge	CO1, CO3, CO4
8	To study the Impulse generator	CO1, CO3, CO4
9	Visit to Substation / Special purpose high voltage laboratory	CO1

Guidelines for Laboratory Conduction

1. The teacher will brief the given experiment to students for its procedure, observations, calculations, and outcome.
2. Apparatus and equipment required for the allotted experiment will be provided by the lab technician using SOP.
3. Students will perform the allotted experiment in a group (2-3 students in each group) under the supervision of faculty and lab technician.
4. After performing the experiment students will check their readings and calculations from the teacher.
5. After checking they have to write the conclusion on the final results.
6. Minimum 4 sets of the experiment should be made ready for the conduction of a batch for hardware experiments

Guidelines for Student's Lab Journal

The write-up should include a title, aim and apparatus, circuit or block diagram, waveforms, brief theory, procedure, observations, graphs, calculations, conclusion, and questions, if any.
Guidelines for Term Work Assessment
Each experiment from the lab journal is assessed for thirty marks based on three rubrics. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech. Pattern:2022 Semester: V (Electrical Engineering) EL223007B: Electrical Mobility Lab		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical:2 Hrs/Week	**PR:1**	**Term Work:25 Marks** **Practical: 25 Mark**

Prerequisite Courses, if any: Fundamentals of Electrical Engineering, Electrical Motors, Power Electronics

Course Objectives: The objectives of the course are to

1. Develop a deeper understanding of Electric Vehicles.
2. Connect theoretical engineering knowledge to physical applications Provide exposure to
3. Experimental skills like system modeling, simulation, analysis, observation, design, and use of equipment hardware setup in a step-by-step manner

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Understand the basics of Electric vehicles and hybrid vehicles and considerations for startup and subsidies planning by the government.	1-Remember
CO2	Select the components for an electric vehicle	2-Understand
CO3	Execute various performance and issues related to Electric Vehicle	3-Apply
CO4	Compare the theoretical content with practical analysis	4-Analyze

List of Laboratory Experiments

Sr.No.	Laboratory Experiments	Cos Mapped
1	Study of Start-ups of Electric Vehicle	CO1
2	Study of Battery Design for Electric Vehicle	CO2, CO4
3	Study of EV subsidies and EV policies in different states	CO1
4	Study of Wireless charging for Electric Vehicle and related students.	CO1
5	Study of Harmonics issues of EV charging using PQ analyzer.	CO3
6	Speed Control of Induction motor/BLDC motor	CO2, CO4
7	Study of Various strategies for improving vehicle energy/fuel efficiency regenerating braking	CO1, CO4
8	Study of various Battery Recycling Methods	CO1
9	Simulation of EV using MATLAB and analysis of the behavior	CO1
10	Visit to Industry / Charging Infrastructure of Electric Vehicle	

Guidelines for Laboratory Conduction
1. The teacher will brief the given experiment to students for its procedure, observations, calculations, and outcome. 2. Apparatus and equipment required for the allotted experiment will be provided by the lab technician using SOP. 3. Students will perform the allotted experiment in a group (2-3 students in each group) under the supervision of faculty and lab technician. 4. After performing the experiment students will check their readings and calculations from the teacher. 5. After checking they have to write the conclusion on the final results. 6. Minimum 4 sets of the experiment should be made ready for the conduction of a batch for hardware experiments
Guidelines for Student's Lab Journal
The write-up should include a title, aim and apparatus, circuit or block diagram, waveforms, brief theory, procedure, observations, graphs, calculations, conclusion, and questions, if any.
Guidelines for Term Work Assessment
Each experiment from the lab journal is assessed for thirty marks based on three rubrics. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech.
Pattern:2022 Semester: V (Electrical Engineering)
ELE223009: Digital Signal Processing

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :3 hrs/week	**TH-3**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses: Advanced Calculus and Transform Techniques

Course Objectives: The objectives of the course are to
1. Introduce discrete signals and systems.
2Enable students to analyse DT signals with Z transform, DTFT and DFT.
3. Introduce Digital filters and analyze the response.
4. Explore DSP Applications in electrical engineering.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	State and prove the properties of different transform	2-Understand
CO2	Classify and mathematical operation on the discrete time signal and systems with its Z-transform	3. Apply
CO3	Construct and analyse the frequency response of the LTI system using Fourier Transform.	4-Analyze
CO4	Design and realize IIR and FIR filters.	6-Create

COURSE CONTENTS

Unit I	**Discrete-Time System and Z-transform**	**10 hrs**	**CO1, CO2**

Analog, Discrete-time and Digital signals, Basic sequences and sequence operations, Discrete-time systems, Properties of D. T. Systems and Classification, Linear Time Invariant Systems, impulse response, linear convolution and its properties, properties of LTI systems: stability, causality, Periodic Sampling, Sampling Theorem, Frequency Domain representation of sampling, reconstruction of a band-limited Signal, A to D Conversion Process: Sampling, quantization and encoding.
Revision of Z-transform, Numerical of Z transform, Inverse Z transforms using partial fraction and power series method, Linear constant coefficient difference equations, solution of difference equation, stability and causality using ROC of Z-transform.

Unit II	**Discrete-Time Fourier Transform**	**08hrs**	**CO1, CO3**

Representation of Sequences by Fourier Transform, Symmetry properties of D. T., F. T. theorems: Linearity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, Frequency response analysis of first and second order system, steady state and transient response.

Unit III	**Discrete Fourier Transform**	**08hrs**	**CO1, CO3**

Sampling in the frequency domain, The Discrete Fourier Transform, Relation with z transform Properties of DFT: Linearity, circular shift, duality, symmetry, Circular Convolution, Linear Convolution using DFT, Effective computation of DFT and FFT, DIT FFT, DIF FFT.

Unit IV	**IIR Filter Design**	**10 hrs**	**CO4**

Ideal frequency selective filters, Concept of filtering, specifications of filter, IIR filter design from continuous time filters: Characteristics of Butterworth and Chebyshev, impulse invariant and bilinear transformation techniques, Design examples (Butterworth low pass filter), Basic structures for IIR Systems: direct form, cascade form

Unit V	FIR Filter Design	09hrs	CO4
Specifications of properties of commonly used windows, Design Examples using rectangular and hanning windows. Basic Structures for FIR Systems: direct form. Comparison of IIR and FIR Filters.			

Text Books

1. P. Ramesh Babu, "Digital Signal Processing", 4th Edition SciTech Publication.
2. Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, 1998, ISBN 0-07-044705-5

Reference Books

1. Proakis J., Manolakis D., "Digital signal processing", 3rd Edition, Prentice Hall, ISBN 81- 203-0720-8.
2. W. Rebizant, J. Szafran, A. Wiszniewski, "Digital Signal Processing in Power system Protection and Control", Springer 2011 ISBN 978-0-85729-801-0

NPTEL Course:

1. Dr. V. M. Gadre, "Digital Signal Processing and Its Applications" https://nptel.ac.in/courses/108101174

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Unit I and II) (Dead line: before Insem)	5
2	Assignment 2 (Based on Unit III and IV) (Dead line: before Endsem)	5
3.	LMS Test (Best 5 out of Minimum 10)	5
4.	Programming of DSP in MATLAB (One program on each unit)	5

T. Y. B. Tech. Pattern: 2022 Semester: V Electrical Engineering ELE223008: IPR and Patents		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 2 hrs/week	**TH-2**	**Teamwork: 50 Marks**

Prerequisite Courses: NA

Course Objectives: The objectives of the course are to

1. Provide basics of various forms of intellectual property
2. Provide insight into the registration procedure for various forms of intellectual property
3. Enable students to draft patent specifications on their own

Course Outcomes: after successful completion of the course student should be able to

	Course Outcomes	Bloom's Level
CO1	Define various forms of intellectual property and patent	1-Remember
CO2	Explain the registration procedure for various forms of intellectual property	2-Understand
CO3	Draft patent application	3-Apply

Course Content		
Unit I	Introduction to IP, Patent Basic, and Patent filing procedure **(6 hours)**	**CO1, CO2**
Unit II	Copyright basic, Industrial Design, Emerging issue, **(6 hours)**	**CO1, CO2**
Unit III	Trademark basic, GI basic, IC Layout Design, **(6 hours)**	**CO1, CO2**
Unit IV	Trade secret, Comparative analysis, IP Management **(6 hours)**	**CO1, CO2**
Unit V	Invention as a solution to an unsolved problem, Drafting a Claim, Types and Arrangement of Claims, Structure of the Patent Specification**(6 hours)**	**CO1, CO3**
	NPTEL Course	
1	https://archive.nptel.ac.in/courses/109/106/109106128/ NPTEL Course on PATENT DRAFTING FOR BEGINNERS	
2	https://archive.nptel.ac.in/courses/109/105/109105112/ NPTEL Course on INTRODUCTION ON INTELLECTUAL PROPERTY TO ENGINEERS AND TECHNOLOGISTS	

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	The course Teacher Defined Assignment 1 at the start of the academic session	25
2	Course Teacher Defined Assignment 2 at the start of the academic session	25

T. Y. B. Tech. Pattern: 2022 Semester: V Electrical Engineering ELE223010: Education and Energy Awareness Program		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Tutorial: 1hrs/week **Practical: 2 hrs/week**	**TU-1** **PR-1**	**Termwork: 25 Marks** **Tutorial: 25 Marks**
Prerequisite Courses: NA		
Course Objectives: The objectives of the course are to 1. Develop technological literacy in sustainable and renewable energy. 2. Promote ethical considerations and global perspectives on energy challenges. **3.** Equip students with communication skills for advocating sustainable practices.		
Course Outcomes: After successful completion of the course student should be able to		

	Course Outcomes	Bloom's Level
CO1	Select appropriate strategies to promote sustainable and efficient energy, safety practices and literacy in society	Understand
CO2	Function effectively as an individual, and as a member or leader to give or receive clear instructions to the team for helping society.	Apply
CO3	Communicate effectively as an individual or team, write reports, design documentation and give effective presentations.	Create

Guidelines for Tutorial

The tutorial consists of pre-preparation of Experiments. Students have to select innovative ideas for demonstrating experiments, prepare a Demo/PPT/Poster for each practical and after completion of the experiment write a detailed report on the activity/experiment completed.

Guidelines for Tutorial Assessment

Each tutorial will carry 25 marks based on
1. Demo/Poster/PPT for 10 marks
2. Innovative Idea during Preparation for 10 Marks
3. Report Writing-5Marks

Activity	Experiments Title	COs Mapped
1	Creating Electrical Energy Conversation awareness in schools and villages.	CO1,CO2,CO3,CO4
2	Creating Electrical Safety awareness in schools and villages.	CO2,CO3,CO4
3	Creating awareness about solar-operated water pumps for agricultural farms and its advantages to farmers.	CO1,CO2,CO3,CO4
4	Creating awareness about Solar roof top and its advantages for residential buildings.	CO1,CO2,CO3,CO4
5	Creating computer literacy awareness for village school children.	CO1,CO2,CO3,CO4

List of Laboratory Experiments (Perform any 4 of the following)		
Activity	**Experiments Title**	**COs Mapped**
1	Creating Electrical Energy Conversation awareness in schools and villages.	CO1,CO2,CO3,CO4
2	Creating Electrical Safety awareness in schools and villages.	CO2,CO3,CO4

3	Creating awareness about solar-operated water pumps for agricultural farms and its advantages to farmers.	CO1,CO2,CO3,CO4
4	Creating awareness about Solar roof top and its advantages for residential buildings.	CO1,CO2,CO3,CO4
5	Creating computer literacy awareness for village school children.	CO1,CO2,CO3,CO4

Guidelines for Laboratory Conduction

- A group of 10 students will be assigned to a faculty member called a mentor.
- The mentor has to guide to conduct activities and plan the work schedule.
- Here, the expected outcomes of the activity must be noted. The complete work plan should be divided into the form of individual tasks to be accomplished with targets.
- Weekly review of the completed task should be taken and further guidelines are to be given to a group.
- After each activity, students have to present the work completed and submit the report.
- Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize, and present their learning.

Guidelines for Termwork Assessment

Each activity will carry thirty marks based on their report writing and feedback analysis of external stakeholders. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech.
Pattern:2022 Semester: VI (Electrical Engineering)
ELE223011: Computer Aided Machine Design

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 3 hrs/week	**TH – 3**	**Continuous Comprehensive Evaluation: 20 Marks** **In-Sem Exam: 20 Marks** **End-Sem Exam: 60 Marks**

Prerequisite Courses: Transformer and Induction Machines, Synchronous and Special Purpose Machines

Course Objectives: The objectives of the course are to

1. Enable students to determine the performance parameters of the transformer and then design it.
2. Empower students to calculate the performance parameters of Induction motors and then design it.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Understand transformer and induction motor specifications from the design point of view.	2- Understand
CO2	Apply engineering fundamentals for the design of the transformer and induction motor.	3-Apply
CO3	Determine performance based on the parameters of the transformer and induction motor.	4-Analyze
CO4	Evaluate transformer and induction motor performance using computer-aided design techniques	5-Evaluate

COURSE CONTENTS

Unit I	**Transformer Design: Part-I**	**09 hrs**	**CO1**

Modes of heat dissipation. Heating and cooling curves. Methods of cooling of the transformer. Types and constructional features of core and windings used in transformer. Transformer auxiliaries such as tap changer, pressure release valve, breather and conservator. Specifications of three-phase transformers as per IS 2026 (Part I). Introduction to computer-aided design.

Unit II	**Transformer Design: Part-II**	**09 hrs**	**CO1, CO2, CO3**

Transformer core constructions, windings, Cooling, Insulating oil and materials, various parts of transformers, Output equation, the equation for voltage per turn, optimum design of transformer for minimum cost and loss. Design of core, estimation of overall dimensions of frame and windings of transformer. Design of tank with cooling tubes.

Unit III	**Transformer Performance Evaluation**	**09 hrs**	**CO1, CO2, CO3, CO4**

Estimation of resistance and leakage reactance of transformer. Estimation of no-load current, losses, efficiency and regulation of transformer. Calculation of mechanical forces developed under short circuit conditions, measures to overcome this effect. Computer-aided design of the transformer, generalized flow chart for design of the transformer.

Unit IV	**Three phase Induction Motor Design: Part1**	**09 hrs**	**CO1, CO2, CO3**

Specifications and constructional features. Types of ac windings. Specific loadings, Output equation with usual notations. Calculations for main dimensions turns per phase and the number of stator slots. estimation of axial lengths, air gap diameter, slot dimension for stator and rotor, cage rotor and wound

rotor design.

Unit V	Three-phase Induction Motor Design: PartII	09 hrs	CO1, CO2, CO3, CO4

Calculation of no-load current, Leakage flux and leakage reactance: Slot, tooth top, zig-zag, overhang. Leakage reactance calculation for three-phase machines. MMF Calculation for the air gap, stator teeth, stator core, rotor teeth and rotor core, the effect of saturation, effects of ducts on calculations of magnetizing current, and calculations of no-load current. Calculations of losses and efficiency. Computer-aided design of induction motor, generalized flow chart for design of induction motor.

Text Books

1. M. G. Say–Theory and Performance and Design of A.C. Machines,3rd Edition, ELBS London.
2. A.K. Sawhney–A Course in Electrical Machine Design, -DhanpatRai and Sons New Delhi
3. K. G. Upadhyay- Design of Electrical Machines, New Age publication
4. R. K. Agarwal–Principles of Electrical Machine Design, S. K. Katariya and Sons.

Reference Books

1. Vishnu Murti, “Computer Aided Design for Electrical Machines”, B. S. Publications.A Shanmuga
2. sundaram,G. Gangadharan, R. Palani,-Electrical Machine Design Data Book,3rd Edition, 3 rd Reprint 1988- Wiely Eastern Ltd.,- New Delhi.
3. Bharat Heavy Electricals Limited, Transformers - TMH.
4. M.V. Deshpande, “Electrical Machine Design” Third Edition, 2009, PHI Learning Pvt Ltd.
5. J Pyrhonen, T. Jokinen and V.Hrabovcova, “Design of Rotating Electrical Machines”, Wiley,2009.

NPTEL Course:

2. NPTEL Course on Three-phase Transformer Design/Three-phase Induction Motor Design.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Unit I and II) (Dead line: before In-sem)	5
2	Assignment 2 (Based on Unit III and IV) (Dead line: before End-sem)	5
3.	LMS Test (Best 5 out of Minimum 10)	5
4.	Teacher-Defined Evaluation Tool (Do be declared at the time of commencement of classes)	5

T.Y.B.Tech.
Pattern:2022 Semester: VI (Electrical Engineering)
ELE223012: Computer-Aided Machine Design Lab

Teaching Scheme:	**Credit Scheme: 1**	**Examination Scheme:**
Practical: 2 hrs/week	**PR: 1**	**Oral- 25 Marks** **TW – 25 Marks**

Prerequisite Courses: Transformer and Induction machines, Synchronous and Special Purpose machines

Course Objectives: The objectives of the course are to
1) Develop analytical/logical skills to design Electrical Machines.
2) Enable students to analyze the performance of three-phase transformers and three-phase induction motors for various design constraints.

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	**Bloom's Level**
CO1	Understand the heating and loss-dissipated modes of electrical machines.	2-Understand
CO2	Understand the procedure of design of three-phase transformers and three-phase induction motors.	2-Understand
CO3	Apply the engineering fundamentals to design the three-phase transformers and three-phase induction motors for the given data.	3-Apply
CO4	Analyze the three-phase transformers and three-phase induction motors to evaluate the performance.	4-Analyze, 5-Evaluate

List of Laboratory Experiments
All the sheets on the design of electrical machines given are compulsory

Sr. No.	**Laboratory Experiments**	**COs Mapped**
1	Details and assembly of transformer with design report. (Sheet in CAD)	CO1, CO2, CO3, CO4
2	Details and layout of single layer three phase winding with design report. (Sheet in CAD)	CO2, CO3
3	Details and layout of double layer three phase winding with design report. (Sheet in CAD)	CO2, CO3
4	Details and layout of three phase mush winding with design report. (Sheet in CAD)	CO2, CO3
5	Assembly of three phase induction motor. (Sheet in CAD)	CO1, CO2, CO3, CO4
6	**Industrial Visit:** Industrial visit to a transformer and Induction motor manufacturing / repairing unit.	CO1, CO2, CO3, CO4

Guidelines for Laboratory Conduction

1. All the sheets are to be prepared using Auto-CAD software.
2. NPTEL course on either three-phase transformer design/three-phase Induction Motor Design is compulsory.

Guidelines for Student's Lab Journal

The student's Lab Journal should contain:

- Five sheets plotted using Auto-CAD software
- Sheet reports on the design of three phase transformer.
- Sheet reports on the design of three phase induction motor stator windings.
- **Industrial Visit Report:**

Industrial visit to a transformer OR Induction motor manufacturing / repairing unit.
Guidelines for Termwork Assessment
Each experiment from the lab journal is assessed for thirty marks based on three rubrics. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech.
Pattern:2022 Semester: VI (Electrical Engineering)
ELE223013: Electrical Installation, Maintenance and Testing

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 3 Hrs/week	TH: 3	Continuous Comprehensive Evaluation: 20 Marks In Sem Exam: 20 Marks End Sem Exam: 60Marks

Prerequisite Courses: Fundamental of Electrical Engineering, Transformer and Induction Machines, Synchronous and Special Purpose machines

Course Objectives: The objectives of the course are to

1. Introduce electrical safety procedures.
2. Explain the comparison and classification of various earthing systems
3. Highlight the importance and necessity of maintenance.
4. Introduced different condition monitoring methods.
5. Enable students to classify different types of distribution supply systems and determine the economics of distribution systems.
6. Empower students to carry out estimation and costing of internal wiring for residential and commercial installations.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Apply electrical safety procedures	1-Remember
CO2	Compare and classify Earthing systems.	2-Understand
CO3	Classify different types of distribution supply systems and determine the economics of the distribution system.	3-Apply 4-Analyze
CO4	Analyze and test different condition monitoring methods.	3-Apply
CO5	Carry out estimates and costing of internal wiring for residential and commercial installations	5-Evaluate

COURSE CONTENTS

Unit I	**Electrical Safety** Contents of first aid box, treatment for cuts, burns and electrical shock. Procedures for first aid (e.g. removing casualty from contact with live wire and administering artificial respiration). Various statutory regulations (Electricity supply regulations, factory acts and Indian electricity rules of Central Electricity Authority (CEA), Classification of hazardous areas. (Introduction to OSHA) Safety regulations & measures, Indian Electricity Supply Act 1948-1956, Factory Act 1948, Fire extinguishers – types & its operations, fixed installation & portable devices.	**(08 hrs)**	**CO1**
Unit II	**Earthing** Necessity of earthing, system earthing: advantage of neutral earthing of generator in power station, equipment earthing: objective, types of earth electrodes, earthing in extra high voltage & underground cable, earthing resistance – factors affecting, determination of maximum permissible resistance of earthing system, measurement of earth resistance: voltmeter-	**(08 hrs)**	**CO2**

	ammeter method, earth tester method, ohm meter method & earth loop tester method, comparison between equipment earthing& system grounding, earthing procedure – building installation, domestic appliances, industrial premises, earthing of substation, generating station & overhead lines. Tolerable step and touch voltages, Steps involved in the design of substation Earthing grid as per IEEE standard 80-2013.		
Unit III	**Maintenance, Condition Monitoring and Testing** **Maintenance:** Importance and necessity of maintenance, different maintenance strategies like breakdown maintenance, planned/preventive maintenance and condition-based maintenance. Planned and preventive maintenance of transformer, Induction motor and Alternators. Condition Monitoring: Advanced tools and techniques of condition monitoring and thermography. dissolved gas analysis, Induction motor fault diagnostic methods – Vibration Signature Analysis, Motor Current Signature Analysis. Hot Line Maintenance - Meaning and advantages, special types of non-conducting Materials used for tools for hotline maintenance Testing: Understanding CAT Ratings & Using CAT rated Instrument, Electrical Installation Testing Procedures- Insulation resistance test between installation and earth, Insulation resistance test between conductors (use of GUARD Terminal in IR test & Application) (methods used for IR Testing) Testing of polarity, Testing of earth continuity paths (Applications of PAT Tester "Portable Appliance Tester" in commercial like hotels, hospital & Industry also) and Earth resistance test (methods for earth testing 2-pole, 3-pole new methods clamp on type where we can perform test in Live)	**(10 hrs)**	**CO4**
Unit IV	**Economics of Distribution Systems:** Classification of supply systems (State Only) (i) DC, 2-wire system, (ii) Single phase two wire ac system, (iii) Three phase three wire ac supply system, iv) Three phase four wire ac supply system. Comparison between overhead and underground systems (For the above-mentioned systems) based on volume requirement for the conductor. AC Distribution System: Types of primary and secondary distribution systems, calculation of voltage drops in ac distributors (Uniform and Non Uniform Loading) (Numerical). Economics of power transmission: Economic choice of conductor (Kelvin's law) (Derivation and Numerical). Distribution Feeders: Design considerations of distribution feeders; radial and ring types of primary feeder's voltage levels, energy losses in feeders.	**(09 hrs)**	**CO3**
UnitV	**Installation and estimation of the distribution system** Electrical installations, domestic, industrial, Wiring Systems, Internal distribution of Electrical Energy. Methods of wiring, systems of wiring, wire and cable, conductor materials used in cables, insulating materials mechanical protection. Types of cables used in internal wiring, multi-stranded cables, voltage grinding of cables, and general specifications of cables. **ACCESSORIES:** Main switch and distribution boards, conduits, conduit accessories and fittings, lighting accessories and fittings, fuses, important definitions, determination of the size of fuse–-wire, fuse units. Earthing conductor, earthing, IS specifications regarding earthing of electrical installations, points to be earthed. Determination of the size of earth wire	**(10 hrs)**	**CO5**

	and earth plate for domestic and industrial installations. Material required for GI pipe earthing. **LIGHTING SCHEME:** Aspects of good lighting services. Types of lighting schemes, design of lighting schemes, factory lighting, public lighting installations, street lighting, general rules for wiring, determination of number of points (light, fan, socket, outlets), determination of total load, determination of Number of subcircuits		

Text Books

1. B. R. Gupta- Power System Analysis and Design, 3rd edition, Wheeler's publication.
2. S. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna publishers.
3. S. L. Uppal - Electrical Power - Khanna Publishers Delhi.

ReferenceBooks

1. S. L. Uppal, Electrical Wiring and Costing Estimation, Khanna Publishers, New Delhi.
2. Raina K.B. and Bhattacharya S.K., Electrical Design, Estimating and Costing, Tata McGraw Hill, New Delhi
3. Power Equipment Maintenance and Testing (Power Engineering Book 32) by Paul Gill

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II)(Deadline: before Insem)	5
2	Assignment 2 (Based on Units III and IV)(Deadline: before Endsem)	5
3	LMS Tests (Best 5 out of Minimum 10)	5
4	Class Test (Before End sem on Units III, IV, V)	5

T.Y.B.Tech.
Pattern:2022 Semester: VI (Electrical Engineering)
ELE223014A: PLC and SCADA Automation

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 3 hrs/week	**TH: 3**	**Continuous Comprehensive Evaluation: 20 Marks** **InSem Exam: 20 Marks** **EndSem Exam: 60 Marks**

Prerequisite Courses: Analog and Digital Circuits, Control System Engineering

Course Objectives: The objectives of the course are to

1. To introduce hardware, architecture and software for PLC and SCADA.
2. To ability to develop PLC and SCADA programming for selected industrial processes.
3. To introduce DCS architecture used in industrial automation.
4. To explore various industrial data communication protocols.

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	**Bloom's Level**
CO1	Explain the wiring of PLC with various sensors & devices and execute ladder programs.	2-Understand
CO2	Develop programs for PLC-based processes and their applications as per requirements.	3-Apply
CO3	Utilize SCADA systems effectively in various industrial sectors.	3-Apply
CO4	Analyse PLC, SCADA, and DCS-based industrial applications.	4-Analyze
CO5	Design and construct DCS with required hardware and software for industry use.	6-Create

COURSE CONTENTS

Unit I	**Programmable Logic Controller (PLC)**	**10 hrs**	**CO1, CO2**

Role of automation in Industries, benefits of automation, Necessity of PLC, Definition, Historical background, Parts of a PLC, Block diagram of PLC, Principles of operation, PLC size & application, PLC hardware components, selection criterion, advantages and disadvantages, specifications, Electromagnetic control relays, Contactors, Manually & Mechanically operated switches, Sensors, Output control devices, Seal-in circuits, Electrical interlocking circuits, Converting relay schematics into PLC ladder programs, Ladder Logic Program from a narrative description.

Unit II	**PLC Programming**	**10 hrs**	**CO1, CO2, CO4**

Introduction, IEC 61131-3 Standard, Types of PLC languages, Ladder diagram format, Ladder relay instructions, Ladder relay programming, Timers and counters, Program/Flow control instructions, Math instructions, Data manipulation, Data transfer instructions & special function instructions, PLC Installation Practices, Editing, and Troubleshooting: PLC enclosures, Electrical noise, Leaky inputs and outputs, Grounding, Voltage variations & surges, Program editing and commissioning, Preventive maintenance, Troubleshooting.

Unit III	**Advanced Functions and Applications of PLC**	**09 hrs**	**CO1, CO2, CO4**

PID Tuning methods, PID Module, AC Motor starters, Overload protection, VFD, DC Motor Controllers. Interfacing PLC to Motor Drives, Need and Advantages of using HMI, PLC-HMI interface, Developing ladder logic for Sequencing of motors, Car parking, Tank level control, Temperature control, Elevator, Bottle filling plant, Traffic light controller

Unit IV	SCADA System	09 hrs	CO3, CO4
Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, important definitions HMI, MTU, RTU, communication means Desirable Properties of SCADA system, advantages, disadvantages and applications of SCADA; SCADA Protocols: Open systems interconnection (OSI) Model, TCP/IP protocol, Modbus model, Device Net, Control Net, Ether Net/IP, Process Field bus (Profibus).			
Unit V	**Distributed Control Systems (DCS)**	**07 hrs**	**CO4, CO5**
Introduction, History of DCS, DCS concept, Communication in DCS, Modes of DCS, DCS hardware & software, DCS structure, Architectural feature of DCS, DCS design considerations, Manual and redundant backup designs, Advantages & disadvantages.			

Text Books

1. Frank Petruzzula, “Programmable Logic Controllers”, McGraw Hill, New York, 5th Edition, 2016
2. Stuart A. Boyer, “SCADA: Supervisory Control and Data Acquisition”, Fourth Edition, ISA- The Instrumentation, Systems, and Automation Society, 2010
3. Lukcas M. P, “Distributed Control Systems”, Van Nostrand Reinhold Co., New York, 1986
4. Curtis D. Johnson, “Process Control Instrumentation Technology”, Pearson New International, 8th Edition, 2013

Reference Books

1. Gary Dunning, “Introduction to Programmable Logic Controllers”, Thomson Delmar Ceneage Learning, 3rd Edition, 2005
2. Ronald L. Krutz, “Securing SCADA Systems”, Wiley, 1st Edition, 2005
3. D. Popovic and V. P. Bhatkar, “Distributed Computer Control for Industrial Automation”, Marcel Dekker, Inc., New York, 1990
4. Katariya Sanjay B., “Industrial Automation Solutions for PLC, SCADA, Drive and Field Instruments: Easy to Learn Industrial Automation”, Notion Press; 1st Edition, 2020

NPTEL Course:

1. https://nptel.ac.in/courses/108105062 [Industrial Automation and Control, IIT Kharagpur, Prof. S. Mukhopadhyay, Prof. S. Sen]
2. https://nptel.ac.in/courses/108106022 [Energy Management Systems and SCADA, IIT Madras, Dr. K. Shanti Swarup]
3. https://www.youtube.com/@realpars
4. https://ial-coep.vlabs.ac.in/List%20of%20experiments.html
5. https://plc-coep.vlabs.ac.in/List%20of%20experiments.html
6. https://sa-nitk.vlabs.ac.in/List%20of%20experiments.html

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II) (Deadline: before Insem)	5
2	Assignment 2 (Based on Units III and IV) (Deadline: before Endsem)	5
3.	LMS Tests (Best 5 sessions out of Minimum 10 sessions)	5
4.	Teacher-defined Evaluation Tool	5

T.Y.B.Tech.
Pattern:2022 Semester: VI (Electrical Engineering)
ELE223014B: Application of Power Electronics in Power Systems

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory:3 hrs/week	TH-3	Continuous Comprehensive Evaluation: 20 Marks InSem Exam: 20Marks EndSem Exam: 60Marks

Prerequisite Courses: Power Electronics, Power System Engineering, Power System Analysis

Course Objectives: The objectives of the course are to

1. Introduce operation and control of SVC and TCSC
2. Introduce concepts of IGBT-based FACTS controllers
3. Explain operation Line Commutated Converter(LCC) based HVDC links
4. Introduce features of voltage source converter-based HVDC link.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Identify and understand the problems in AC transmission systems and understand the need for Flexible AC transmission systems and HVDC Transmission	1-Remember
CO2	Understand the operation and control of FACTs devices and their applications to enhance the stability and damping	2-Understand
CO3	Analyze basic operation and control of voltage source converter-based FACTS and HVDC controllers	4-Analyze
CO4	Evaluate the performance of FACTs devices and HVDC lines.	5-Evaluate

COURSE CONTENTS

Unit I	Introduction	09 hrs	CO2

Reactive power control in electrical power transmission lines–load & system compensation, Uncompensated transmission line–shunt and series compensation. Need for HVDC Transmission, Comparison between AC & DC Transmission, Types of HVDC Transmission Systems

Unit II	Static Var Compensator (SVC) and Thyristor Controlled Series Compensator (TCSC)	09 hrs	CO1, CO3

VI characteristics of FC+TSR, TSC+TSR, Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator, Thyristor Controlled Series Compensator (TCSC), Concept of TCSC, Operation of the TCSC–Different modes of operation and applications:

Unit III	Voltage Source Converter-Based Facts Controllers	09 hrs	CO1, CO3

Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability-prevention of voltage instability. SSSC-operation of SSSC VI characteristics, Enhancement in Power transfer capability –, UPSC – Operation Principle Applications.

Unit IV	Line Commutated HVDC Transmission	09 hrs	CO1, CO4

Operation of Gratz bridge - Effect of delay in Firing Angle – Effect of commutation overlap - Equivalent circuit, Basic concept of HVDC transmission. Model of operations and control of power flow CC and CIA mode of operation

Unit V	VSC-Based HVDC Transmission	08 hrs	CO1, CO4

Basic 2-level IGBT inverter operation- 4 Quadrant operation- phase angle control- dq control- Control of power flow in VSC-based HVDC Transmission, Topologies of MTDC system.

Text Books

1. R. D. Begamudre, "Extra High Voltage AC Transmission Engineering" New Age Publishers, 2009
2. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Reactions" New Age International, 3rd edition, 2017

Reference Books

1. Understanding of FACTs, Hingorani, N. G.; IEEE Press 1996.
2. Heydt G.T. Power Quality; Stars in a Circle Publications, Indiana, 1991.
3. Miller T.J.E.Static Reactive Power Compensation.; John Wiley & Sons, New York, 1982
4. Flexible AC Transmission System. (FACTs).; Yong Hua Song.; IEE 1999.

NPTEL Course:

3. "High Voltage DC Transmission" https://nptel.ac.in/courses/108104013
4. "Facts Devices" "https://onlinecourses.nptel.ac.in/noc23_ee58/preview

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Unit I and II) (Dead line: before Insem)	5
2	Assignment 2 (Based on Unit III and IV) (Dead line: before Endsem)	5
3.	LMS Tests (Best 5 out of Minimum 10)	5
4.	Simulation of IEEE paper to demonstrate FACTs or HVDC Technologies.	5

T.Y.B.Tech. Pattern:2022 Semester: VI (Electrical Engineering) ELE223015A: PLC and SCADA Automation Lab		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 02 hrs/week	**PR: 01**	**Term Work: 25 Marks** **Oral: 25 Marks**

Prerequisite Courses: Analog and Digital Circuits, Control System Engineering

Course Objectives: The objectives of the course are to

1. Develop a deeper understanding of concepts in industrial automation.
2. Connect theoretical PLC, SCADA, and DCS knowledge to physical applications
3. Provide exposure to experimental skills like the use of programming software, design of a ladder program, design of SCADA screens, hardware interfacing in a step-by-step manner, observation, analysis, etc.

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	Bloom's Level
CO1	Select components/equipment for industrial automation.	2-Understand
CO2	Interface the PLC with hardware devices to develop the ladder program for industrial applications.	3-Apply
CO3	Design and apply the SCADA and DCS systems for industrial applications.	6-Create

List of Laboratory Experiments

At least 8 experiments are to be performed out of the following list:
a) Experiments No. 1, 9, 10, 12 and 13 are compulsory.
b) Any 3 experiments should be conducted from experiment number 2 to 8, 10, 14, 15.

Sr. No.	Laboratory Experiments	COs Mapped
1	Understand the PLC and various components. Interfacing of discrete input and output devices with PLC for ON and OFF operation. Verify all logic gates.	CO1, CO2
2	Set/Reset (Latch/Unlatch) operation: many push buttons for ON (set/latch) and one push button for OFF (reset/unlatch) operation.	CO1, CO2
3	Application using a combination of counter and timer for lamp ON/OFF operation.	CO1, CO2
4	DOL starter and star delta starter operation by using PLC.	CO1, CO2
5	PLC-based thermal (temperature) ON/OFF control using an analog input device.	CO1, CO2
6	Tank level control by using PLC.	CO1, CO2
7	PLC-based speed, position, flow, level, and pressure measurement system. (Any one or two applications)	CO1, CO2
8	To study the operation of single-acting cylinders, double-acting cylinders with 3-2 valve & 5-2 valve	CO1
9	PLC interfaced with SCADA and status read/command transfer operation.	CO1, CO2, CO3
10	Parameter reading of PLC in SCADA, for thermal (temperature) control performed in PLC.	CO1, CO2, CO3

11	Reporting and trending in the SCADA system.	CO1, CO2, CO3
12	To interface VFD with PLC and monitoring and control by using SCADA.	CO1, CO2, CO3
13	To understand hardware and software platforms for DCS	CO1, CO3
14	Study of Alarm Management System in DCS.	CO1, CO3
15	Tune PID controller for heat exchanger using DCS. (Virtual Lab).	CO1, CO3
16	Industrial Visit (Compulsory for all students).	CO1, CO2, CO3

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.

Guidelines for Laboratory Conduction

1. There will be groups of 3 to 4 students in each lab. These groups will be fixed for the whole semester.
2. Each experiment will have a pre-lab, lab, and post-lab.
3. Pre-lab will have a theoretical problem statement that students have to solve before coming to the lab.
4. During the lab, the problem will be programmed using a ladder, SCADA, and DCS software and answers will be verified.
5. Post-lab will have further analysis of the problem in the form of an extension of the problem to the physical system, more extensive simulation and observation of results, hardware implementations, etc.
6. Assessment will be based on pre-lab, lab, and post-lab.
7. An industrial visit is compulsory.

Guidelines for Student's Lab Journal

1. Students should write the journal in their own handwriting using A4 size on both sides of the ruled paper.
2. Circuit / Ladder diagram or construction diagram must be drawn either manually or using software on A4 size blank/graph paper.
3. Handwriting must be neat and clean.
4. The journal must contain a certificate indicating the name of the institute, student, department, subject, class/ year, number of experiments completed, signature of staff, Head of the department and the Principal.
5. The index must contain sr. number, title of the experiment, page number, and the signature of staff along with the date.
6. Use a black or blue ink pen for writing.

Guidelines for Term Work Assessment

1. Each experiment from the lab journal is assessed for thirty marks based on three rubrics.
2. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech. Pattern:2022 Semester: VI (Electrical Engineering) ELE223015B: Application of Power Electronics in Power System Lab		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 2 hrs/week	**PR: 1**	**Term Work:** **Oral:**

Prerequisite Courses: Power Electronics, Power System Engineering, Power System Analysis

Course Objectives: The objectives of the course are to

1. Provide knowledge about modern trends in Power Transmission Technology
2. Make students understand the applications of power electronics in the control of power transmission
3. Educate students on the utilization of software such as PSCAD, and MATLAB for power transmission and control

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	Bloom's Level
CO1	Perform experiments in the group, write a lab report, and present it effectively	3-Apply
CO2	Model the FACTs controller and HVDC transmission lines with different control strategies.	4-Analyze
CO3	Interpret the results obtained from simulations and evaluate the performance of the device	5-Evaluate
CO4	Design various FACTs controller/HVDC lines and simulate them using MATLAB/PSCAD.	6-Create

List of Laboratory Experiments

At least 6 experiments are to be performed out of the following list:

Sr. No.	Laboratory Experiments	Cos Mapped
1	Simulation of abc-dq0 and dq0 transformation using power variance and invariance method	CO1, CO2, CO3, CO4
2	Simulation and analysis of the performance of 6 pulse converter	
3	Simulation and analysis of the performance of the FC-TCR scheme for the given power system.	CO1, CO2, CO3, CO4
4	Simulation and analysis of the performance of the STATCOM scheme for the given power system.	CO1, CO2, CO3, CO4
5	Simulation and analysis of the performance of the TCSC scheme for the given power system.	CO1, CO2, CO3, CO4
6	Simulation and analysis of the performance of the SSSC scheme for the given power system.	CO1, CO2, CO3, CO4
7	Simulation and analysis of the performance of active power filter scheme for the given power system.	CO1, CO2, CO3, CO4
8	Simulation and analysis of the performance of the DVR scheme for the given power system.	CO1, CO2, CO3, CO4
9	Simulation and analysis of the performance of 12 pulse converter	CO1, CO2, CO3, CO4
10	Simulation and analysis of the performance of HVDC lines for the given power system.	CO1, CO2, CO3, CO4

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.

Guidelines for Laboratory Conduction
1. There will be groups of 3 to 4 students in each lab. These groups will be fixed for the whole semester. 2. Each experiment will have a pre-lab, lab, and post-lab. 3. Pre-lab will have a theoretical problem statement that students have to solve before coming to the lab. 4. Post-lab will have further analysis of the problem in the form of an extension of the problem to the physical system, more extensive simulation and observation of results, hardware implementations, etc. 5. Assessment will be based on pre-lab, lab, and post-lab. 6. An industrial visit is compulsory.
Guidelines for Student's Lab Journal
1. Students should write the journal in their own handwriting using A4 size on both sides of the ruled paper. 2. Circuit / Ladder diagram or construction diagram must be drawn either manually or using software on A4 size blank/graph paper. 3. Handwriting must be neat and clean. 4. The journal must contain a certificate indicating the name of the institute, student, department, subject, class/ year, number of experiments completed, signature of staff, Head of the department and the Principal. 5. The index must contain sr. number, title of the experiment, page number, and the signature of staff along with the date. 6. Use a black or blue ink pen for writing.
Guidelines for Term Work Assessment
1. Each experiment from the lab journal is assessed for thirty marks based on three rubrics. 2. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech. Pattern:2022 Semester: VI (Electrical Engineering) ELE223016A: Renewable Energy Systems		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 3 hrs/week	**Th: 3**	**Continuous Comprehensive Evaluation: 20 Marks** **InSem Exam: 20 Marks** **EndSem Exam: 60 Marks**

Prerequisite Courses: Fundamentals of Electrical Engineering, Applied Physics and Applied Chemistry

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Understand different renewable energy resources	2- Understand
CO2	Describe the working principles of various energy technologies.	1- Remember
CO3	Design solar PV System for different load	6- Create
CO4	Analyze the properties of biogas plant	4- Analyze
CO5	Select electrolyser and Fuel cell for appropriate applications.	3- Apply
CO6	Analysis of V-I characteristics of PV and Fuel cell	4- Analyze

COURSE CONTENTS			COs mapped
Unit I	**Fundamentals of Renewable Energy Technology**	**9 hrs.**	**CO1, CO2**

Concept of Renewable Energy Sources (RES), Review of renewable energy sector MNRE (Ministry of Power and MNRE website) Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Hydrogen, Fuel cells, Comparison of renewable energy sources with non-renewable sources. Energy global scenario Status of energy utilization. Energy consumption pattern & energy resources in India.

Unit II	**Photovoltaic Technology and Systems**	**9 hrs.**	**CO2, CO3**

Solar Photovoltaics: Introduction, p-n junctions. Types of Solar Cells, Wafer based Silicon Cell, Thin film amorphous silicon cell Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell.
Solar Photo Voltaic Module: Solar cell, solar module, solar array, series & parallel connections of cell, mismatch in the cell, fill factor, the effect of solar radiation and temperature on the power output of the module, I-V and power curve of the module.
Application of Solar PV systems, Standalone, Grid-connected, Hybrid Systems, solar lanterns, solar street lights, solar water pumping systems, and Rooftop solar photovoltaic power plants.

Unit III	**Biogas Technology**	**9hrs.**	**CO3, CO4**

Bio-energy: Introduction, Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier.
Biogas: Biogas technology and generation of power from biogas. mechanisms, Conditions for optimum production. Raw material for biogas Mechanical conversion of biogas. Design & use of different commercial-sized Biogs Plant. types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas.

Unit IV	**Hydrogen Technology**	**9 hrs.**	**CO4, CO5**

Introduction to Hydrogen Technology, Significance of H2 in Different Sectors, Hydrogen Production

Processes, Different Types of Electrolizer Acidic, Alkaline and Solid Oxide, Chemical reactions, Storage of hydrogen in solid liquid and gas form. Hydrogen transportation methods.			
Unit V	**Fuel Cell**	**9 hrs.**	CO5, CO6
Definition of a fuel cell, Introduction to Fuel cell technology, type of fuel cells, Working of PEM FC, V-I characteristics of the fuel cell, Comparison of fuel cells, Advantages and disadvantages of fuel cells, Application of FC			

Text Books

1. Renewable Energy, theory and practice, N. S. Rathore, N.C. Panwar, A. K. Kurchania, 2008
2. Garg H.P. and J. Prakash 2000. Solar Energy Fundamentals and Applications. 1St Revised Edition. Tata Mcgraw-Hill, New Delhi
3. Khandelwal, K.C. & S.S. Mandi. 1990. Biogas Technology.
4. Fuel cells: principles and applications. B Viswanathan, M AulicScibioh, Universities Press First Edition (1 January 2006)

Reference Books

1. Bansal N.K., Kleemann M. &Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.
2. Alan L: Farredbruch& R.H. Buse. 1983. Fundamentals of Solar Academic Press, London.
3. S.Rao and B.B.Parulekar.Energy Technology, Third Revised Edition.Khanna Publication, New Delhi

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II) (Deadline: before Insem)	5
2	Assignment 2 (Based on Units III and IV) (Deadline: before Endsem)	5
3.	LearniCo (Best 5 sessions out of Minimum 10 sessions)	5
4.	Class Test (Before Endsem exam on Units III, IV and V)	5

T.Y.B.Tech.
Pattern:2022 Semester: VI (Electrical Engineering)
ELE223016B: Energy Audit and Management

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory:3 hrs./week	TH-3	Continuous Comprehensive Evaluation: 20Marks InSem Exam: 20Marks EndSem Exam: 60Marks

Prerequisite Courses: Power System Engineering, Power System Analysis

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Describe BEE Energy policies and the Energy ACT.	2- Understand
CO2	Explore and use simple data analytic tools for demand-side management measures for managing utility systems.	3- Apply
CO3	Identify appropriate energy conservation methods for electric and thermal utilities.	4- Analyze
CO4	Evaluate the economic feasibility of energy conservation projects.	5- Evaluate

COURSE CONTENTS

Unit I	Energy Scenario and Management	10hrs	CO1

Classification of Energy resources, commercial energy production, and final energy consumption. Energy needs of growing economy, short and long-term policies, energy sector reforms, energy security, importance of energy conservation, energy and environmental impacts, introduction to CDM, UNFCCC, Paristreety, emission check standard, salient features of Energy Conservation Act 2001 and Electricity Act2003. Latest amendments in Energy Conservation and Electricity Act. Indian and Global energy scenario. Introduction to IE Rules. Study of Energy Conservation Building Code (ECBC).
Definition, Objective and Principles of Energy Management, Energy Management Strategy and skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy, Organization setup and energy management. Responsibilities and duties of energy manager under the latest Act. Energy Efficiency Programs and energy monitoring systems.

Unit II	Demand Side Management	09hrs	CO1, CO2

Supply-side management (SSM), Generation system up gradation, constraints on SSM. Demand side management (DSM), advantages and barriers, implementation of DSM. Use of demand-side management in agricultural, domestic and commercial consumers. Demand management through tariffs (TOD). Impact of p.f on Electricity bills. Apparent energy tariffs. Role of renewable energy sources in energy management, direct use (solar thermal, solar air conditioning, biomass) and indirect use (solar, wind etc.) Introduction to ISO 50001- Energy Management.

Unit III	Energy Audit	08 hrs	CO1, CO3

Definition, need of energy audits, types of audit, procedures to follow, data and information analysis, Introduction to Data Analytics, data quality processing, clustering techniques, pattern mining, regression and classification. Relevance of Data Analytics in Audit, energy audit instrumentation, energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit reporting format – Executive Summary, Detailing of the report.

Unit IV	Financial Analysis	08 hrs	CO2, CO3

Financial appraisals; criteria, simple payback period, return on investment, net present value method,

time value of money, break-even analysis, sensitivity analysis and numerical based on it, cost of energy, cost of generation Energy Audits case studies – Sugar Industry, Steel Industry, Paper and Pulp industry.			
Unit V	**Energy Conservation**	**10hrs**	**CO2, CO3, CO4**
Energy Conservation of a) Motive power (motor and drive system). b) Illumination c) Heating systems (boiler and steam systems) d) Ventilation(Fan, Blower and Compressors) and Air Conditioning systems e) Pumping System f) Cogeneration and waste heat recovery systems g) Utility industries (T and D Sector)and Performance Assessments.			

Text Books

1. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities (available online)
3. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities (available online)
4. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4 (available online)

Reference Books

1. Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.
2. Energy Management by W.R. Murphy and Mackay, B.S. Publication.
3. Generation and Utilization of Electrical Energy by B.R. Gupta, S. Chand Publication
4. Energy Auditing is made simple by Balasubramanian, Bala Consultancy Services.
5. A General Introduction to Data Analytics by Andre Carvalho and TomášHorváth Wiley Inc. First Edition 2019.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment1 (Based on Units I and II) (Deadline: before Insem)	5
2	Assignment2 (Based on Units III and IV) (Deadline: before Endsem)	5
3.	Class Test (Before Endsem) Based on Units III to V	5
4.	Energy Audit - Case study as defined by the course teacher.	5

T.Y.B.Tech.
Pattern:2022 Semester: VI (Electrical Engineering)
ELE223017: Communication Systems

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 3hrs/week	**TH: 3**	**Continuous Comprehensive Evaluation: 20 Marks** **InSem Exam: 20 Marks** **EndSem Exam: 60 Marks**

Prerequisite Courses: Digital Signal Processing

Course Objectives: The objective of the course is to make the student aware of the importance of communication in the electricity sector and describe some common analog and digital modulation techniques.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Describe the structure of analog and digital communication system	2-Understand
CO2	Demonstrate the effect of noise and distortion on communication	3- Apply
CO3	Explain the operation of analog and digital modulation techniques	2-Understand
CO4	Select the appropriate communication technique for data transfer	2-Understand

COURSE CONTENTS

Unit I	**Fundamentals of communication system**	**8 hrs**	**CO1**

Importance of communication in electrical systems; Basic structure of any communication system; Overview of analog to digital and digital to analog conversion; Classification of signal; Fourier series; Fourier transform

Unit II	**Noise and distortion**	**10 hrs**	**CO2**

External and internal noise; Types; Noise due to multiple amplifiers in cascade and to the reactive circuit; Noise figure and noise temperature; Signal distortion over a communication channel; Types of distortion; Multipath effect; Fading channels; Signal energy and ESD; Essential bandwidth; Signal power and PSD

Unit III	**Amplitude and angle Modulation**	**12 hrs**	**CO1, CO3, CO4**

Introduction to amplitude modulation; Bandwidth and power of AM wave; AM modulators and demodulators – DSBSC, SSBSC, VSBSC; FDM and OFDM; FM and PM; Single tone FM and classification; WBFM and NBFM; Generation of WBFM- Direct and indirect method; FM demodulation –Frequency and phase discrimination method

Unit IV	**Basics of digital communication**	**10 hrs**	**CO1, CO3, CO4**

Sampling and A/D conversion; Aliasing effect and anti-aliasing filter; Time-division multiplexing (TDM); Synchronous and asynchronous TDM; Uniform and non-uniform quantization; A-law and μ-law; Pulse communication; Analog and digital pulse modulation; PAM; PTM; PCM; Delta and adaptive delta modulation

Unit V	**Digital data modulation**	**5 hrs**	**CO3, CO4**

ASK, OOK, FSK, PSK, QPSK, DPSK, QAM

Text Books

1. B. P. Lathi, Zhi Ding, "Modern Digital And Analog Communication Systems", Oxford University Press, 4th Edition, 2017.
2. S. S. Haykin, M. Moher, "Introduction to Analog and Digital Communications", Thomson learning,

2nd Edition, 2007.
3. J. G. Proakis, M. Salehi, “Fundamentals of Communication Systems”, Pearson Education, 1st Edition, 2014.

Reference Books

1. S. Sharma, "Communication Systems (Analog And Digital)”, S. K. Kataria& Sons, 1st Edition, 2013.
2. R. P. Singh, S. Sapre, “Communication Systems: Analog and Digital”, McGraw Hill Education, 3rd Edition, 2017.
3. K. Sam Shanmugam, “Digital and Analog Communication Systems", Wiley India Pvt Ltd, 2006.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II) (Deadline: before Insem)	5
2	Assignment 2 (Based on Units III and IV) (Deadline: before Endsem)	5
3.	LMS Tests (Best 5 sessions out of Minimum 10 sessions)	5
4.	Course Teacher Defined Evaluation Tool	5

T.Y.B.Tech.
Pattern: 2022 Semester: VI (Electrical Engineering)
ELE223018: Finance for Engineers

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 2 hr/week	**TH:2**	**Continuous Comprehensive Evaluation: 50 Marks**

Course Objectives: The objectives of the course are to
1. Provide exposure to finance-related aspects of engineering
2. Expose to various terminologies in finance

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	**Bloom's Level**
CO1	Define various terminologies in finance	2-Understand
CO2	Interpret various finance sheets	3-Analyze

Course Content

Unit I	Basic Accounting and concepts in finance; Book keeping: definitions, objectives, elements, journal and ledger. Accounting & Concepts in Finance I: definitions, objectives, characteristics, limitations, basic terms; GAAP (Generally Accepted Accounting Principles) Accounting & Concepts in Finance II: Systems of accounting, cash book, bank book, depreciation; provisions, reserves, accounting equation, journal & ledger entries, trial balance, profit & loss; account, balance sheet, cash flow statement)Analysis of financial statements I: Financial leverage, financial ratios **(15 Hours)**	COs Mapped: CO1 and CO2
Unit II	Financial planning including capital budgeting I: Definition, financial planning options and objectives, time value of money Financial planning including capital budgeting II: simple and compound interest, rule of 72, methods of capital budgeting - payback period Financial planning including capital budgeting III: Accounting rate of return (ARR), net present value (NPV), internal rate of return (IRR) Introduction to energy trading and power trading **(15 hours)**	COs Mapped: CO1 and CO2

Text Books and Reference Books

1. Frank Crundwell, "Finance for Engineers Evaluation and Funding of Capital Projects" Springer, 2008
2. Shim, Norman Henteleff, "What every engineer should know about accounting and finance", Taylor & Francis
3. Colin K. Drummond, "Financial Decision-Making for Engineers", Yale University Press 2018

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I) (Deadline: before Insem)	15
2	Assignment 2 (Based on Units II) (Deadline: before Endsem)	15
3.	LMS Tests (Best 2 sessions out of Minimum 4 sessions)	20

T.Y.B.Tech. Pattern: 2022 Semester: VI (Electrical Engineering) ELE223019: Industry Connect Lab		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 1 hr/week **Practical: 2 hrs/week**	**TH: 1** **PR: 1**	**Term Work: 25 Marks** **Oral: 25 Marks**

Prerequisite Courses: All core courses and elective courses studied in the previous semester

Course Objectives: The objectives of the course are to

3. Provide exposure to industrial testing procedures and practices
4. Expose to the latest trends in the industry

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	Bloom's Level
CO1	List out the various jobs and routine activities of the various sections of the industry	2-Understand
CO2	Understand the documentation needed from product design to marketing	2-Understand
CO3	Explain the product testing procedures with respect to standards practices	2-Understand
Course Content		
TH	The theory classes of this course will be delivered by industry professionals from various industries where they will explain the various work completed by the various sections highlighting one particular section in a detailed manner. Industries in all the sectors (core, IT, service, etc.) will be covered. A minimum of 10 industries will be covered.	**COs Mapped:** CO1, CO2, CO3
LAB	The practical sessions will be conducted in the same industries with the demonstration of the particular section including design, prototyping, and manufacturing, testing of the product or service. A minimum of 8 experiments will be conducted in the industry.	**COs Mapped:** CO1, CO2, CO3

Guidelines for Laboratory Conduction
1. All the labs will be conducted in industry by following the guidelines of industry.
Guidelines for Student's Lab Journal
1. Students will be a blank sheet with a Title, Aim, Apparatus, Diagram, Calculation and Conclusion. 2. They will have to write it during the visit and submit it to the course coordinator
Guidelines for Term Work Assessment
1. Each experiment from the lab journal is assessed for thirty marks based on three rubrics. 2. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

T.Y.B.Tech. Pattern: 2022 Semester: VI (Electrical Engineering) ELE223020: Software for Research		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 2 hrs/week	**PR: 1**	**Term Work: 50 Marks**

Prerequisite Courses: All core courses and elective courses studied in the previous semester

Course Objectives: The objectives of the course are to

1. Provide exposure to professional software
2. Enable students to use the software for simulation, design and result analysis
3. Empower students to write research studies, understand and write research papers

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	Bloom's Level
CO1	Construct simple circuits and models using various simulation platforms	2-Understand
CO2	Solve the simulation circuit and model and check the values	3-Apply
CO3	Integrate various subsystems to form the whole system	4-Analyze
CO4	Test the performance with respect to standard performance indices	5-Evaluate
Course Content		
LAB	Using the following four simulation platforms experiments are to be completed 1. ETAP, 2. PSCAD, 3. Ansys, 4. MATLAB The experiments are conducted in a such way that the results are documented to write a research paper or it can be a simulation of the published research paper (published in a peer-reviewed journal)	**COs Mapped CO1, CO2, CO3, CO4**

Guidelines for Laboratory Conduction
1. Faculty has to identify the research papers on various simulation platforms' application to electrical engineering problems and explain to the students during lab 2. Design the experiments in a such way that the final result of the three experiments is a simulation of a research paper
Guidelines for Student's Lab Journal
1. Students will mathematically solve the problem and will verify using the simulation platform 2. The write-up will have the solved solution and a printout of the simulation
Guidelines for Term Work Assessment
1. Each experiment from the lab journal is assessed for thirty marks based on three rubrics. 2. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.

B. Tech (Electrical) Hon./minor* degree with MdM
Pattern 2022 Semester: VI
ELE223021: Power Electronic Converter Design

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 04 hrs/week	TH-04	CCE: 20 Marks InSem Exam: 20Marks EndSem Exam: 60Marks

Prerequisite Courses: Introductory course on power electronics

Course Objectives:
1. Design the advanced power electronics converters
2. Make students aware of different power electronics components design topologies

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Analysis of power electronic converters	4-Analyze
CO2	Design of Power semiconductor devices	6-Creating
CO3	Design of Gate Drivers, Snubber	6-Creating
CO4	Design of Electromagnetic interference	6-Creating

COURSE CONTENTS

Unit I	Analysis of power electronic converters	08 hrs	CO2

Introduction, Analysis of Buck Converter, Choosing L and C, Design Example of Buck Converter, Analysis of H Bridge, Bipolar PWM, Unipolar PWM, Bipolar Vs Unipolar PWM.

Unit II	Design of Power semiconductor devices	08 hrs	CO1, CO3

Different types of Power Diode, Diode Characteristics, diode Datasheets, Diode datasheet examples, Switching characteristics of MOSFET, MOSFET Datasheets –I, MOSFET Datasheets –II, MOSFET Datasheets example, IGBT Datasheets –I, IGBT Datasheets –II, IGBT Datasheet Example,

Unit III	Design of Gate Drivers, Snubber	08 hrs	CO1, CO3

Introduction to Gate Drivers, Gate Driver Requirements, Optocouplers based Gate Drivers-I, Optocouplers based Gate Drivers –II, Pulse Transformer based Gate Drivers, Introduction to Snubbers, RC Snubber Analysis – II: Under damped Case, RC Snupper Analysis –III: Overdambed and Critically, Damped Case, RC Snubber Design –I, RC Snubber Design –II, RCD Snubbers –I, RCD Snubbers –II.

Unit IV	Design of Thermal, Magnetics, Transformer	08 hrs	CO1, CO4

Thermal Modelling –I, Thermal Modelling –II, Thermal Modelling –III, choosing Heat Sinks, Magnetic Losses, Conductors, Magnetic Materials, Magnetic Core, Transformer Design, Example of Transformer Design.

Unit V	Design of Electromagnetic interference, and Familiarity and design on power electronic hardware	08 hrs	CO1, CO4

Introduction to EMI, EMI Measurements, EMI in Power electronics, CM and DM noise, design Solutions of EMI, EMI Filter –I, EMI Filter – II, Familiarity with Components –I, Familiarity with Components –II, PCB –I, PCB –II, PCB –III.

Text Books

1. Ned Mohan, T.M Undeland and W. P Robbin, "Power Electronics: converters, Application and design" John Wiley and Sons. Wiley India First Edition, 2006.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004
3. P. S. Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003

Reference Books

4. Abraham I. Pressman, Keith Billings &Taylor Morey: Switching Power Supply Design, McGraw Hill International, Third Edition, 2009.
5. R.W. Erickson and Dragan Maksimonic: Fundamentals of Power Electronics, Springer, Second Edition, 2001.
6. Umanand, L., Power Electronics: Essentials and Applications, John Wiley India, First Edition, 2009

NPTEL Course:

3. Design of Power Electronics Converter" https://archive.nptel.ac.in/courses/117/103/117103148/#

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II) (Dead line: before Insem)	5
2	Assignment 2 (Based on Units III and IV) (Dead line: before Endsem)	5
3.	LMS Tests (Best 5 sessions out of Minimum 10 sessions)	5
4.	Certificate course on ETAP/MATLAB Simulation/DIgSalient Power Factory/PSCAD	5

B. Tech (Electrical) Hon./minor* degree with MdM
Pattern 2022 Semester: VI
ELE223022: Power Electronic Converter Design Lab

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical: 04 hrs/week	PR: 02	Term Work: 50 Oral: 50

Prerequisite Courses: Analog and Digital Circuits, Advanced Calculus and Transform Techniques

Course Objectives: The objectives of the course are to

1. Enable students to develop hands-on experience in analyzing, designing, and carrying out experiments on power electronic circuits.
2. Introduce the switching devices, power converters, and their applications in various systems for power control.

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	Bloom's Level
CO1	Simulate and analyze various power electronic converters with different control techniques	3- Apply
CO2	Evaluate the performance of different power electronic converters	5-Evaluate
CO3	Design the magnetic circuit, power circuit, and control circuit of various power electronic converters.	6-Create

List of Laboratory Experiments

At least 8 experiments are to be performed out of the following list:

Sr. No.	Laboratory Experiments	COs Mapped
1	Design and Simulation/Hardware of Buck Converter; (ii) Boost Converter; and (iii) Buck-Book Converter.	CO1
2	Design and Simulation/Hardware of Boost Converter; and (iii) Buck-Book Converter.	CO1
3	Design and Simulation/Hardware of Buck-Book Converter.	CO1
4	Design and Simulation of three phase controlled rectifier different configurations with R, R-L, R-L-E load.	CO1, CO2
5	Design and Simulation of three phase inverter: (i) 120 degree mode; (ii) 180 degree mode; (iii) Selective harmonic elimination and (iv) sine PWM.	CO1, CO2
6	Design and Simulation of single phase inverter: (i) Square wave; (ii) Quasi square wave; (iii) Selective harmonic elimination and (iv) sine PWM.	CO1, CO2
7	Design and Simulation of Multi-level Inverter: (i) 3-level; and (ii) 5 level.	CO1, CO2
8	Magnetics (inductor & transformer) design & construction.	CO1
9	Wireless charging circuits using low-frequency air-core transformers.	CO1, CO2, CO3
10	Design and Simulation of Resonant Converter Circuits: Series, Parallel.	CO1, CO2, CO3

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.

Guidelines for Laboratory Conduction
1. There will be groups of 3 to 4 students in each lab. These groups will be fixed for the whole semester. 2. Each experiment will have a pre-lab, lab, and post-lab. 3. Pre-lab will have a theoretical problem statement that students have to solve before coming to the lab. 4. Post-lab will have further analysis of the problem in the form of an extension of the problem to the physical system, more extensive simulation and observation of results, hardware implementations, etc. 5. Assessment will be based on pre-lab, lab, and post-lab. 6. An industrial visit is compulsory.
Guidelines for Student's Lab Journal
1. Students should write the journal in their own handwriting using A4 size on both sides ruled paper. 2. Circuit / Ladder diagram or construction diagram must be drawn either manually or using software on A4 size blank/graph paper. 3. Handwriting must be neat and clean. 4. The journal must contain a certificate indicating the name of the institute, student, department, subject, class/ year, number of experiments completed, signature of staff, Head of the department and the Principal. 5. Index must contain sr. number, title of the experiment, page number, and the signature of staff along with the date. 6. Use a black or blue ink pen for writing.
Guidelines for Term Work Assessment
1. Each experiment from the lab journal is assessed for thirty marks based on three rubrics. 2. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing where each rubric carries ten marks.