Department of Electrical Engineering
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UG Scheme-2023 (NEP-2020)
B. Tech.in Electrical Engineering
With Multidisciplinary Minor

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-V													
23BTEEL301 23BTEE P301	AC Machines	PCC6	2	-	2	4	3	10	15	50	25	25	125
23BTEEL302 23BTEEP302	Power Electronics	PCC7	3	-	2	5	4	10	15	50	25	-	100
23BTEEL303	Basic Power System Analysis	PCC8	3		-	3	3	10	15	50	-	-	75
23BTEEL307 23BTEEP307	Program Elective - I (Energy Storage)	PEC1	3	-	2	5	4	10	15	50	25	-	75
23BTEELXXX 23BTEEPXXX	(Industrial Electrical Systems) Multidisciplinary Minor-III	MDM3	3	-	2	3	4	10	15	50	25	-	100
23BTEEL3XX	Open Elective-III	OE3	2			2	2	10	15	50			75
23BTSHP301	Research Methodology	RM			4	4	2	-	-	-	25	-	25
TOTAL			**16**	**0**	**12**	**24**	**22**	**60**	**90**	**300**	**125**	**25**	**600**

Course Title: AC Machines											
Semester	V	Teaching Scheme				Evaluation Scheme					
						Theory			Practical		
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT	

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Course Category	PCC6	2 Hrs.	-	2 Hrs	3	10	15	50	25	25
Course Code	23BTEEL301 23BTEEP301									
Teaching Mode	Offline	4Hrs			Total	75			50	
Duration of ESE	2 Hrs.					125				

Course Objectives	1. To develop familiarity with 1 ph. & 3 ph. Induction machines and synchronous machines.
	2. To study starting, breaking & reversal of AC Machines.
	3. To study various characteristics and Speed control for AC motors.
Course Outcomes	CO1: Understand the basics of 3-phase induction motors
	CO2: Demonstrate the control of 3 ph Induction motor
	CO3:Acquaintance with different motors
	CO4:Summarizing the behavior and performance of 3-ph. synchronous Generator
	CO5:Interpret the behavior and performance of synchronous motor

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	1	0	0	0	0	0	0	0	0	0	2	3
CO2	2	2	3	1	0	0	0	0	0	0	0	0	0	2	3
CO3	2	2	3	1	0	0	0	0	0	0	0	0	0	2	3
CO4	2	2	3	1	0	0	0	0	0	0	0	0	0	2	3
CO5	2	2	3	1	0	0	0	0	0	0	0	0	0	2	3

Course Contents:

Unit	Contents	Hours

I	**Three Phase Induction Motor:** Constructional details, Types of rotors, Principle of operation, Equivalent circuit, Slip, cogging and crawling, Torque-Slip characteristics, Condition for maximum torque, Loses and efficiency, Load test, Double cage induction motors, Induction generators, Synchronous induction motor, No load and blocked rotor tests	7
II	**Starting and Speed Control of Three Phase Induction Motor:** Need for starting, Types of starters, DOL, Rotor resistance, Autotransformer and Star, delta starters, Speed control, Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking	6
III	**Single Phase Induction Motors** Constructional details of single phase induction motor, Double field revolving theory and operation, Equivalent circuit, Starting methods of single-phase induction motors, Capacitor-start capacitor run Induction motor, Shaded pole induction motor, Linear induction motor,Introduction to magnetic levitation systems.	5
IV	**SYNCHRONOUS GENERATOR:-** Constructional details – Types of rotors –winding factors- emf equation – Synchronous reactance – Armature reaction – Phasor diagrams of non-salient pole synchronous generator connected to infinite bus-Synchronizing and parallel operation – Synchronizing torque - Voltage regulation – EMF, MMF, ZPF and A.S.A methods - Two reaction theory –slip test	6
V	**SYNCHRONOUS MOTOR and Special Machines :-** Principle of operation – Torque equation – Operation on infinite bus bars – V and Inverted V curves – Hunting – natural frequency of oscillations – damper windings- synchronous condenser.- Starting methods Repulsion motor, Hysteresis motor, AC series motor, Servo motors, Stepper motors.	6

Text Books	1	A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
	2	I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

	3	P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
	4	P.C. Sen, “Principles of Electric Machines ”, John Wiley & Sons, 3rd Edition 2021
E--Books	1	https://nptel.ac.in/content/storage2/courses/108105053/pdf/L-30(NKD)(ET)%20((EE)NPTEL).pdf
	2	https://nptel.ac.in/courses/108/106/108106072/
Reference Books	1.	A. S. Leinsdorf, “Alternating current machines”, McGraw Hill Education, 1984.
On line TL Material	1.	https://www.youtube.com/watch?v=dZyO5gcWP-o
	2.	https://www.youtube.com/watch?v=b24jORRoxEc

S. N.	Name of Experiments / Mini Projects/ Case Studies
1	Rotor-resistance based speed control for slip ring induction motor.
2	No load and blocked rotor test on 3-phase induction motor.
3	To perform forward and reversal of Induction motor
4	Electrical braking system for induction motor.
5	To study star and delta starting on Induction Motor.
6	Effect of field excitation on the generation of voltage of an alternator.
7	Determination of voltage regulation of alternator by direct loading.
8	To draw open circuit characteristics of an alternator.
9	To draw short circuit characteristics of an alternator.
10	Determination of voltage regulation of alternator by EMF method.
11	Determination of Xq / Xd ratio of alternator by performing slip test.
12	Determination of pettier reactance and voltage regulation of alternator by zero power factor method.
Open Ended Experiments / New Experiments	
1	Different starting methods for synchronous motors.
2	To plot V and Inverted V curve of a synchronous motor.
3	Synchronization of alternator with infinite bus by Dark lamp method
4	Synchronization of alternator with infinite bus by Bright lamp method.
Details of on line Laboratory Resource Material Instruction / Operating Manuals	

1.	http://vp-dei.vlabs.ac.in/Dreamweaver/list.html

Course Title: Power Electronics										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC7	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL302 23BTEEP302									
Teaching Mode	Offline	5Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	1. To introduce different power electronic switches and other devices etc along with their performance characteristics and applications.
	2. To introduce different types of power electronic convertors, their control and performance aspects for various applications.
	3. To study single phase and three phase bridge inverters.
Course Outcomes	CO1: Understand different solid state power electronics devices.
	CO2: Compare different static controllable switches
	CO3: Analyze the circuitry for power convertors.
	CO4:Design Single phase and Three phase Inverter
	CO5: Examine topologies of DC-DC converter.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	3	2	0	0	0	2	2	2	2	3	2	2
CO2	1	2	1	3	2	0	0	0	2	2	2	2	3	2	2
CO3	1	2	1	3	2	0	0	0	2	2	2	2	3	2	2
CO4	1	2	1	3	2	0	0	0	2	2	2	2	3	2	2
CO5	1	2	1	3	2	0	0	0	2	2	2	2	3	2	2

Course Contents:

Unit	Contents	Hours
I	**Thyristor characteristics and application:** Characteristic and basic principle of SCR, SCR turn on & turn off times, ratings, series and parallel connections of SCRs, Triggering circuits, protection of SCR gate circuit protection, over voltage and over current protection, Snubber circuit design	9
II	**Transistor Based Semiconductor Devices:** TRIAC, GTO, BJT, MOSFET, IGBT- Characteristics, working, selection and protection, Basic Driving Circuits. Introduction to SiC and GaN, Line commutated AC voltage regulators based on TRIAC.	9
III	**DC-DC Converters:** Buck, Boost, Buck-Boost, Cuk Converters, Continuous and discontinuous mode of operation, Fly back, Forward, and Push Pull Converters, classification of chopper circuits (A, B, C, D, E). Advanced Topics.	9
IV	**Inverters:** Single phase and three phase bridge inverters (voltage source inverter), Six step operation, PWM, SPWM, and SVPWM Techniques, Determination of Harmonic content, THD, current source inverter,.Unity Power Factor AC to DC Converter. Basic series resonant inverter	8
V	**Converters:** Working principle of single phase and three phase line commutated converters (SCR Based) (fully controlled and half controlled converters and determination of performance parameters like THD, TUF, etc), input output waveforms for different loads, Effect of source inductance, principle operation of dual converters and cycloconverter,	10

Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	Introduction to Power Electronic devices.
2	Simulation of Single Phase Bridge Rectifier with R-Load
3	Generation of PWM pulses on MATLAB.
4	Hardware Implementation of How SCR works as a switch.
5	Hardware Implementation of Full-wave Bridge Rectifier.
6	Simulation of Buck and Boost Converter on MATLAB Simulink.
7	Simulation of Dual Converter on MATLAB

8	Hardware Implementation of Mini Inverter 12V DC to 220V AC.
9	Hardware Implementation of Speed Control of DC motor using MOSFET.
10	Simulation of Single Phase Inverter with R-Load using SPWM technique.
11	Introduction to power electronics switches
12	To plot the characteristic of SCR
13	To study SCR as DC Circuit Breaker
14	To study step down voltage commutated thyristor chopper
15	To plot V-I characteristics of UJT
16	To design a Single phase fully controlled bridge rectifier using MATLAB
17	To design a Three phase Inverter in MATLAB
Open Ended Experiments / New Experiments	
1	Simulation of Single Phase Bridge Rectifier with R-L Load
Details of on line Laboratory Resource Material Instruction / Operating Manuals	
1.	http://www.ee.iitkgp.ac.in/faci_pe.php

Text Books	1	M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.
	2	N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
	3	L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.
E--Books	1	Power Electronics by M. D. Singh, Tata Mcgraw-Hill Publishing Company Limited, 1998https://books.google.co.in/books?id=WZi6AAAACAAJ&dq=power+electronics&hl=en&sa=X&ved=0ahUKEwihzZ-5g-rpAhXGbX0KHTXiCpUQ6AEIODAC
	2	Fundamentals of Power Electronics Robert W. Erickson, Dragan Maksimovic Springer Science & Business Media, 2007 https://books.google.co.in/books?id=B4XhBwAAQBAJ&dq=power+electronics

Reference Books	1	R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.
on line TL Material	1	https://nptel.ac.in/courses/108/102/108102145/
	2	https://nptel.ac.in/courses/108/101/108101038/
	3	https://cusp.umn.edu/power-electronics/introduction-power-electronics

Course Title: Basic Power System Analysis										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC8	3 Hrs.	-	-	3	10	15	50	-	-
Course Code	23BTEEL303									
Teaching Mode	Offline	3 Hrs			Total	75			-	
Duration of ESE	2 Hrs.					75				

Course Objectives	1. To introduce per unit system. Cables, distribution system, transmission systems and different models to represent them to represent Load flow studies.
	2.To introduce elementary distribution schemes
	3.To study concept of real and reactive power control
Course Outcomes	Up on successful completion of this course, student will be able to:
	CO 1. Represent the power systems which may include generation/distribution/ transmission using different models and compare them
	CO 2. Understand the model of Transmission line ,reactance, pi & T
	CO 3. Understand feeders, distributors used in elementary distribution schemes & Cables, insulator in transmission system
	CO 4. Determine the active and reactive power flow at different locations in a multi bus system using load flow analysis.
	CO 5. Understand the speed governor model of turbine generator unit.

Mapping of Course Outcomes with Program Outcomes:

Department of Electrical Engineering

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Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	3	2	1	1	2	2	2	2	2	3	2	2
CO2	1	2	1	3	2	1	1	2	2	2	2	2	3	2	2
CO3	1	2	1	3	2	1	1	2	2	2	2	2	3	2	2
CO4	1	2	1	3	2	1	1	2	2	2	2	2	3	2	2
CO5	1	2	1	3	2	1	1	2	2	2	2	2	3	2	2

Course Contents:

Unit	Contents	Hours
I	Structure of electrical power system, brief exposure of generation, transmission and distribution aspects, elementary consideration of economic bulk power supply system, use of high voltage, general system consideration, idea about substation, concept of real, reactive and complex power, Load and their characteristics, voltage and frequency dependence of loads. Representation of power system elements, models and parameters of generator, transformer and transmission lines, per unit system representation.	8

II	**Design Aspects of Overhead Transmission lines And cables:** A) Mechanical Design: Main components of overhead lines, conductor materials, line supports, insulators, types of insulators, potential distribution over suspension insulators, string efficiency, methods of improving string efficiency, Underground cables, construction of cables, classification of cables, cables for three phase services, insulation resistance of a single core cable B) Electrical Design of Overhead line: Conductors, types of conductors in use, bundled conductor, spacing of conductors, symmetrical and unsymmetrical spacing, equivalent spacing, transposition, transmission line constants, calculation of resistance, inductance and capacitance for simple arrangements and multi-circuit lines, symmetrical and unsymmetrical spacing, concept of self GMD, mutual GMD and their uses in calculations of parameters of overhead lines, skin and proximity effects.	10
III	**Characteristics and Performance of Transmission line**: Short and medium transmission lines, Line performance, effect of capacitance, charging currents, short and medium lines, calculation by nominal-T, nominal-π and end-condenser method, regulation and efficiency, Concept of ABCD constants, the long transmission line- rigorous solution, evaluation of ABCD constants, interpretation of long line equation, surge impedance and surge impedance loading, the equivalent circuit of a long transmission line, power flow through a transmission line,Ferranti effect.	10
IV	Interconnection of system elements to form two bus systems, Illustration of active and reactive power transmission. Introduction to load flow studies in multi bus system (Methods of solution not expected). Introduction of frequency and voltage as system state indicators	9
V	**Economic Aspects of power System:** Cost of Generation and Tariff, Power factor and its effect on system economy, Methods and need of Power factor improvement.	8

Text Books	1.	Nagrath& Kothari, Modern Power system analysis, 3rd Edition, Tata McGraw Hill, 1989
	2.	Elegard, Electric Energy System Theory, 2nd Edition, Tata McGraw Hill, 1996

	3.	John Grainger & W.Stevenson, Power system analysis, 4th Edition, McGraw Hill, 2016
Referenc e Books	1.	C.L.Wadhwa, Electrical Power System, 4rd Edition, CBS, 2005
	2.	AshfaqHussain, Electrical Power System, 5th Edition, CBS Publishers, 2007
	3.	P. Kundur power system stability and control mcgraw-hill 1994
E-Book		Bergen, Arthur R. *Power systems analysis*. Pearson Education India, 2009.
NPTEL		https://www.youtube.com/watch?v=fBm1dr_gRBk

Course Title: Program Elective – I (Energy Storage)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC1	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL307									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	To impart knowledge of recent and advanced developments in energy storage Systems.
	To study the advanced application of SMES.
	To study the application of super capacitors.
Course Outcomes	CO1: Understand energy storage system.
	CO2: Compare different techniques for energy storage.
	CO3: Apply different techniques for energy storage.
	CO4: Identify role of renewable energy for grid.
	CO5: Manage energy efficiency.

Mapping of Course Outcomes with Program Outcomes:

Department of Electrical Engineering

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Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3
CO2	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3
CO3	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3
CO4	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3
CO5	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3

Course Contents:

Unit	Contents	Hours
I	**Introduction to energy storage:** Role of energy storage systems, applications. Overview of energy storage technologies: Thermal, Mechanical, Chemical, Electrochemical, Electrical. Efficiency of energy storage systems.	9
II	**Electrical energy storage**: Batteries Battery parameters: C-rating - SoC- DoD- Specific Energy-Specific power (numerical examples), Super capacitors, Superconducting Magnetic Energy Storage (SMES), charging methodologies, SoC, SoH estimation techniques. Environmental impacts of different technologies.	9
III	**Application of Energy Storage:** Hydrogen production and storage, fuel cells. Mobile storage system: electric vehicle, G2V, V2G. Hybrid Energy storage systems: configurations and applications.	9
IV	**Renewable energy systems:** Solar energy, Wind energy, Pumped hydro energy, fuel cells. Energy storage in Micro grid and Smart grid	9
V	**Battery Energy Management:** with storage systems, Battery SCADA, Increase of energy conversion efficiencies by introducing energy storage.	9

Sr. No.	Name of Experiments
1	To study the role of electrical energy storage systems capacitors and superconductors.
2	To study a flywheel energy storage system.
3	To study the characteristics of batteries.
4	To study charging methodologies of batteries.
5	To simulate the SoC and DoD of a lithium-ion battery under varying load conditions.

6	To study the working principles and configurations of fuel cells.
7	To study energy storage integration in solar energy systems.
8	To study wind energy systems with storage integration.
9	To study the role of energy storage in micro grids.
10	To study the role of battery management systems in energy management
Open Ended Experiments / New Experiments	
1	To study multiport converters.

Text Books	1	S. N. Bhadra, D.Kastha, S.Banerjee, “Wind Electrical Systems”, Oxford University Press, 2005.
	2	B.H. Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi,2009.
E--Books	1	Gobal K.Dubey, “Fundamentals of Electrical Drives”, Narosal Publishing House, New Delhi, Second Edition ,2009
	2	Buxbaum, A.Schierau, K.and Staughen, "A Design of control System for DC Drives”, Springer-Verlag, berlins, 1990
Reference Books	1.	Rashid .M. H “power electronics Hand book”, Academic press, 2001.
NPTEL		https://archive.nptel.ac.in/courses/113/105/113105102/

Course Title: Program Elective – I (Advanced Electrical Machines)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC1	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL308									

Teaching Mode	Offline	5 Hrs	Total	75	25
Duration of ESE	2 Hrs.			100	

Course Objectives	1. To introduce the concepts of ideal synchronous machines and poly-phase Induction machines.
	2. Applications which will be utilized in the electrical machines with its Performance and theory of operation.
	3.Study of special machines
Course Outcomes	CO1: Introduce hybrid and linear motors
	CO2: Understand special motors
	CO3: Apply the knowledge of special motors.
	CO4: Practical consideration of machines.
	CO5: Simulate different motor characteristics.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3
CO2	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3
CO3	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3
CO4	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3
CO5	1	1	2	3	3	1	2	1	0	0	0	1	3	2	3

Course Contents:

Unit	Contents	Hours
I	**Introduction To Advanced Electrical Machines:** Need for advanced electrical machines, Recent advances in electrical machines with reference to construction, application, and new technology, Brief introduction to some special machines like: Synchronous Reluctance Machines, Hybrid Motors, and Linear Motors, Superconducting Machines, PCB Motors, Micro motors, Written Pole Machines.	8

II	**Characteristics of Advanced Electrical Machines:** Constructional differences, performance comparison and control of advanced electrical machines like: Synchronous Reluctance Machines, Hybrid Motors, and Linear Motors, Superconducting Machines, PCB Motors, Micro motors, Written Pole Machines.	8
III	**Reluctance Motor: Switched and Synchronous Reluctance motor** Construction, Operating performance, Type of converter and speed control, Applications ,	8
IV	**Application Of Advanced Motor:** Robotics, Automation , Electric Vehicles, pumping , aerospace, etc.	8
V	**Case Study :** Other Advanced machines, Case Studies, Computer Aided Simulation of Electrical Machines.	8

Text Books	1	"Electrical machines", Fitzerald and Kingseley, 2nd edition, McGraw Hill.2013
	2	"Performance and design of AC commutator machines", E. O. Taylor 1971
	3	"Generalized theory of electrical machines", Bimbhra, Khanna Pub 7th Edition 2021
E--Books	1	Janardanan, E. G. Special electrical machines. PHI Learning Pvt. Ltd., 2014.
	2	Burman, Simi P. Special Electrical Machines. SK Kat aria & Sons, 2013.
Reference Books	1	"General theory of AC machines", Bernard Adkins 1975.
on line TL Material	1	https://nptel.ac.in/courses/108/106/108106023/

Sr. No.	Name of Experiments
1	Study and Analysis of Synchronous Reluctance Machine
2	To study the torque-speed characteristics of a Hybrid Motor
3	To study the construction and working principle of a Linear Induction Motor
4	To study the speed control methods for a PCB Motor
5	To study the converter topologies for controlling a Switched Reluctance Motor

6	Speed Control of Switched Reluctance Motor
7	To study the performance of a Superconducting Machine
8	Implementation of Electric Drives for EVs
9	To study the application of advanced electrical machines in electric vehicle propulsion systems
10	To study the role of advanced electrical machines in robotic systems
Open Ended Experiments / New Experiments	
1	Using software like MATLAB/Simulink or ANSYS, simulate an advanced machine

Course Title: Program Elective – I (Modern Instrumentation)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC1	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL 309									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	1. To make the students review the instruments used for measurement of basic process parameters like level, flow, pressure and temperature.
	2. To explore the various types of analyzers used in industrial applications.
	3.To make the students to understand the requirement of safety instrumented system, standards and risk analysis techniques
Course Outcomes	CO1 : Understand optical transducer for measurement of level, temperature and pressure
	CO2: Acquire basic knowledge of Atmospheric Instrumentation systems
	CO3: Use instrumentation in medical and biomedical industry
	CO4: Implement modern Sensors and Actuator in various industrial fields
	CO5:Design, develop Virtual and graphical techniques in the instrumentation

Mapping of Course Outcomes with Program Outcomes:

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Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	3	1	1	0	0	0	0	0	0	0	2	3	2
CO2	1	2	3	1	2	0	0	0	0	0	0	0	2	3	2
CO3	1	2	3	1	2	0	0	0	0	0	0	1	2	3	2
CO4	1	2	3	1	1	0	0	0	0	0	0	0	2	3	2
CO5	1	2	3	1	1	0	0	0	0	0	0	0	2	3	2

Course Contents:

Unit	Contents	Hours
I	**Optical Transducer and Signal Conditioning Design**: Optical transducer, signal conditioning (Transmitters and Converters) (LDR, Photo-diode, and photo-transistor) photo-diode with photo-conducting and photovoltaic modes, photo-transistor and photomultiplier tube. Optical encoder signal conditioning for linear displacement, velocity and angular displacement applications Construction and working of Radiation and optical pyrometers and its Applications. Comparative study for Temperature Transducers	9
II	**Atmospheric Instrumentation:** leak detector, flame detector, smoke detector, measurement of pressure static, average, dynamic, impact pressure and total pressure. Measurement of temperature - total temperature of flowing gas, temperature of oxygen, temperature of solid objects. Measurement of atmospheric density and conductivity, electrostatic flux meter. Measurement of pollutants by laser optical method, measurement of NO and ozone.	9
III	**General Introduction of Medical Instrumentation:** Sensing devices for biomedical instruments: Equipment standards and patient safety. Diagnostic equipment: vector cardiograph, echocardiograph, comparison of ECG, VCG and ECHO, monitoring and transmission of ECG, IR imaging and its diagnostic criteria,	9
IV	**MEMS Sensors and Actuators Design:** Methodology of MEMS Design- Flow chart. Components – Modeling, Design, Fabrication, packaging, material characterization. Application Sensors: Inertial sensors, acoustic devices, RF MEMS, pressure sensors, chemical sensors, biochemical sensors, Smart sensors, Nano sensors, Semiconductor sensors, Optical fiber sensors **Actuators**: Electrostatic, thermal, electromechanical with applications.	9

V	**Virtual Instrumentation:** Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs, Structures: Case, Sequence & Formula nodes, Need of software based instruments for industrial automation using Labview.	9

Sr. No.	**Name of Experiments**
1	Overview of lab equipments
2	Measurement of temperature using thermocouple
3	Measurement of humidity using humidity sensors
4	Study of smoke detections system using smoke sensor
5	Measurement of pressure using piezoelectric sensors
6	Design a system of Temperature measurement using Lab View software
7	Design of object detection system with ultrasonic senors and Ardiuno software
8	Measurement of resistance of LDR with respect to variation of flux
9	Measurement of lux level using Lux meter
10	Measurement of temperature using Tinkewr cad and Ardiuno software
Open Ended Experiments / New Experiments	
1	Virtual lab

Text Books	1	Introduction to Modern Instrumentation: For HydraulicsDardo Oscar Guaraglia, Jorge Lorenzo Pousa · 2014
	2	Modern Instrumentation for Scientists and Engineers, James A. Blackburn · 2012
E--Books	1	https://nptel.ac.in/content/storage2/courses/downloads_new/LectureNotes/103108100/103108100.zip
Reference Books	1	Instrumentation and Control Systems, William Bolton · 2004
on line TL Material	1	https://nptel.ac.in/courses/103/108/103108100/

Course Title: Program Elective – I (Electrical Machine Design)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC1	3 Hrs.	-	2 Hrs	4	10	15	50	25	-

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Course Code	23BTEEL 310									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	Design of transformer based on specifications.
	Determine performance based on the parameters of transformer.
	Design of Induction motor based on specifications.
Course Outcomes	Identify and analyze the design constraints of different electrical machines.
	Design, analyze torque equation and control techniques of permanent magnet synchronous motor.
	Derive and apply the output equations for single-phase and three-phase transformers.
	Design overall dimensions of three phase Induction motor
	Analyze and determine the design specification of synchronous motor

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	3	2	1	0	0	0	0	0	0	0	2	1	3
CO2	1	2	3	2	1	0	0	0	0	0	0	0	2	1	3
CO3	1	2	3	2	1	0	0	0	0	0	0	0	2	1	3
CO4	1	2	3	2	1	0	0	0	0	0	0	0	2	1	3
CO5	1	2	3	2	1	0	0	0	0	0	0	0	2	1	3

Course Contents:

Unit	Contents	Hours
I	**PRINCIPLES OF ELECTRICAL MACHINE DESIGN**: Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines. Inductor Design	9

II	**DESIGN PERMANENT MAGNET SYNCHRONOUS MOTOR:** Construction, Principle of Operation, EMF and Torque equations, Phasor Diagram, Comparison of Conventional Synchronous Motor and PMSM, Control of PMSM, Applications.	9
III	**DESIGN OF TRANSFORMERS** (Single phase and three phase): Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and conductor cross sectional area of Primary and secondary windings, estimation of no load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular)	9
IV	**DESIGN OF INDUCTION MOTORS**: Output equation, Choice of specific loadings, main dimensions of three phase induction motor, Stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of Rotor bars and end ring, design of Slip ring induction motor, estimation of No load current and leakage reactance,	9
V	**DESIGN OF SYNCHRONOUS MACHINES**: Output equation, Choice of specific loadings, short circuit ratio, design of main dimensions, armature slots and windings, slot details for the stator of salient and non salient pole synchronous machines. Design of rotor of salient pole synchronous machines, magnetic circuits, dimensions of the pole body, design of the field winding, and design of rotor of non-salient pole machine.	9

Sr. No	Name of Experiments / Mini Projects/ Case Studies
1	Details and assembly of three phase transformer with design report. (Sheet in CAD)
2	Details and layout of AC winding with design report. (Sheet in CAD)
3	Assembly of 3- phases induction motor. (Sheet optional CAD or Drawing)
4	Use of Finite Element Analysis (FEA) software for analysis of electrical machines, the report should include: a. Schematic diagram (Diagram/FEA model/Layout) b. Current/Flux/Force distribution. c. Analysis by variation of design parameters.
5	Report based on Industrial visit to a manufacturing unit. (Transformer or Induction motor).
Open Ended Experiments / New Experiments	

1	Industrial visit to a manufacturing unit of transformer and Induction motor.
Details of on line Laboratory Resource Material Instruction / Operating Manuals	
1.	https://www.youtube.com/watch?v=krNH7-wDnZk
2.	https://www.youtube.com/watch?v=2zpkI0Uzab4
3.	https://www.youtube.com/watch?v=WgpmOR5jcVQ

Textbooks	1	M.G. Say – Theory and Performance and Design of A.C. Machines, 3rd Edition, ELBS London.2005
	2	A.K.Sawhney – A Course in Electrical Machine Design, 10th Edition, - Dhanpat Rai and sons New Delhi.2016
	3	K. G. Upadhyay- Design of Electrical Machines, New age publication 2018
	4	R. K. Agarwal – Principles of Electrical Machine Design, S. K.Katariya and sons.2014
	5	Indrajit Dasgupta – Design of Transformers – TMH 2017
E books	1	http://www.sasurieengg.com/e-course-material/EEE/III-Year%20Sem%206/EE2355%20%20%20DEM.pdf
Reference Books	1	K.L. Narang , A Text Book of Electrical Engineering Drawings, Reprint Edition : 1993 / 94 – Satya Prakashan, New Delhi.
	2	A Shanmuga sundaram, G. Gangadharan, R. Palani, - Electrical Machine Design Data Book, 3rd Edition, 3rd Reprint 1988 - Wiely Eastern Ltd., - New Delhi
	3	Vishnu Murti, “Computer Aided Design for Electrical Machines”, B.S. Publications.2015
NPTEL		https://onlinecourses.nptel.ac.in/noc24_ee50/preview https://onlinecourses.nptel.ac.in/noc23_ee140/preview

Course Title: Program Elective – I (PLC SCADA)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT

Course Category	PEC1	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL 311									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	1. To know the importance and benefits of automation in an industrial process using PLC.
	2. To understand the instructions of PLC and program PLC using the Ladder diagrams.
	3. To learn applications of timers, counters and effective use of program flow control instructions to manage PLC operations.
Course Outcomes	CO1:Develop and explain the working of PLC with the help of a block diagram
	CO2:Develop ladder programming for different using different PLC instructions
	CO3:Execute, debug and test the programs developed for digital and analog operations
	CO4:Develop architecture of SCADA and explain the importance of SCADA in critical infrastructure
	CO5:Reproduce block diagram representation on industrial applications using PLC and SCADA and applications of protocols

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	0	3	3	2	0	0	0	0	0	0	0	3	3	2
CO2	2	0	3	3	2	0	0	0	0	0	0	0	3	3	2
CO3	2	0	3	3	2	0	0	0	0	0	0	0	3	3	2
CO4	2	0	3	3	2	0	0	0	0	0	0	0	3	3	2
CO5	2	0	3	3	2	0	0	0	0	0	0	0	3	3	2

Course Contents:

Unit	Contents	Hours
I	**Introduction to PLC:** Definition & History of PLC, architecture of PLC system, PLC Input & Output modules, central processing unit, CPUs & programmer/monitors, Solid state memory, the processor, Input and output modules (Interfaces), Power supplies, PLC advantages & disadvantages. Selection criteria for PLC. Types of PLC.	9
II	**Programming of PLC**: Programming software and equipment's, Structure of PLC ladder program and rules. Basics of PLC cycle. Basic input and instruction set–& their symbols in ladder diagram,Basic AND-logic and OR-logic program using PLC ladder programming and its working . Working of latching programs and its application Interfacing of analog and discrete input/output devices to PLC. programming of discrete Inputs to produce discrete outputs. MOV, Jump and interrupt instruction in PLC ladder programing.	8
III	**PLC Function**: Timers(On,Off,retentive) function in PLC and its application for timing control in industrial processes(AC motor based conveyor belt control), counter (Up, Down, Up-Down) function in PLC and its application for industrial processes (DC motor based conveyor belt timing control), Arithmetic and logical function in PLC ladder program and its application for controlling Variable speed (Variable Frequency) AC motor Drive.	8
IV	**SCADA Systems:** Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, Communication requirements, Desirable Properties of SCADA system, features, advantages, disadvantages and applications of SCADA. SCADA Architectures (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture), Remote Terminal Units (RTUs), Programmable Logic Controllers (PLCs), Human Machine Interface (HMI) Power System Automation (Automatic substation control and power distribution), Petroleum Refining Process, Water Purification System, Chemical Plant.	9
V	**SCADA Protocol:** Introduction to different protocol,Open systems interconnection (OSI) models, Modbus RTU, Modbus TCP/IP, , DNP3 protocol IEC61850 layered architecture, Control and Information Protocol (CIP), Control Net, EtherNet/IP, Flexible Function Block process (FFB), Process Field bus (Profibus)). Interfacing of SCADA with PLC	9

Sr. No.	Name of Experiments
1	Study of Architecture and block diagram of PLC
2	Introduction to Ladder Programming, develop and simulate Logic gates and Boolean equations.
3	Develop and Simulate Ladder program for simple on-off applications.
4	Develop and Simulate Ladder program for timer applications.
5	Develop and Simulate Ladder program for counter applications.
6	Creating and Configuring a Project and tags in SCADA
7	Design and Develop SCADA System for application.
8	Develop and Simulate Ladder program for cascading of timers & counters.
9	Develop and Simulate Ladder program for Comparison Instruction/ Logical Instruction.
10	Develop and Simulate Ladder program for MOV instruction
Open Ended Experiments / New Experiments	
1	Interfacing Motion Control systems to PLC.

Text Books	1.	Programmable Logic Controllers: Principles & Applications by John W. Webb, Ronald A. Reis, Prentice Hall of India, 5th ed.2003
	2.	Introduction to Programmable Logic Controllers by Gary Dunning, Delmar Thomson Learning, 3rd ed.1998
	3	Programmable Logic Controllers: Programming methods and applications by John R. Hackworth and Frederick D. Hackworth Jr., Pearson publication 2004
Reference Books	1.	Programmable Logic Controller by Frank D Petruzella, McGraw-Hill Education, 5th ed.2016
	2.	Programmable Logic Controllers by W. Bolton, Elsevier Newness publication, 4th ed.2009
	3.	Programmable Controller by T. A. Huges, ISA publication, 2nd ed. 1997
	4	SCADA by Stuart A. Boyer 2010
e-Book		Hackworth, Frederick D. *Programmable Logic Controllers: Programming Methods and Applications (with CD)*. Pearson Education India, 2011.
NPTEL		https://www.youtube.com/watch?v=MS3qJq2jvu0

(MDM- III to other discipline students)
Course Title: Industrial Electrical Systems

		Teaching Scheme	Evaluation Scheme
Semester	V		

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						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	EE	3Hrs.	.	2Hrs.	02	10	15	50	25	
Course Code	23BTEELXXX									
Teaching Mode	Conventional	5Hrs			Total	75			25	
Duration of ESE	02.30					100				

Course Objectives	1. Understanding of basic concept of Electrical System Components
	2. To understand the various electrical wiring systems for residential, commercial and industrial consumers.
	3. To understand the behavior of industrial & electrical automation system.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Remembers of basic concept of Electrical System Components
	CO2: Understand the electrical wiring systems for residential, commercial and industrial consumers.
	CO3: Understand various components of industrial electrical systems.
	CO4: Understand the behavior of electrical automation system.
	CO5:

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	--	--	--	--	--	--	--	--	--	3	2	1
CO2	3	1	2	1	--	--	--	--	--	--	--	--	3	2	1
CO3	3	1	2	--	--	--	--	--	--	--	--	--	3	2	1
CO4	3	--	1	--	--	--	--	--	--	--	--	--	3	2	1
CO5	3	--	2	--	--	--	--	--	--	--	--	--	3	2	1

Course Contents:

Unit	Contents	Hours
I	**Unit-I:- Electrical System Components** LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.	9
II	**Unit – II:- Residential and Commercial Electrical Systems** Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.	9

III	**Unit III:- Industrial Electrical Systems I** HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction –KVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.	9
IV	**Unit IV Industrial Electrical Systems II** DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.	9
V	**Unit V:- Industrial Electrical System Automation** Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.	9

Text Books	1.	S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating &Costing”, Khanna publishers, 2008.
	2.	K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007
E--Books	1.	
	2.	
Referenc eBooks	1.	S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.
	2.	H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008
	3.	
Online TL Material	1.	
	2.	

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Sr. No.	Name of Experiments
1	Introduction to electrical symbols of electrical wiring.
2	Wire up PVC Conduit wiring to control one lamp from two different places
3	Draw layouts and practice in PVC casing - capping, conduit wiring with minimum to more number of points of minimum 15 metre length
4	Wire up the consumer's main board with I.C.D.P. switch and distribution fuse box
5	Estimate the cost/bill of material for wiring of hostel/residential building and workshop
6	To study pipe earthing and measure earth resistance by earth tester/megger
7	Measure electrical parameters using tong tester in three phase circuit
8	Service and repair of electric iron
9	To study role of automation by using PLC and SCADA
10	
Open Ended Experiments / New Experiments	
1	