CURRICULUM

FOR THE ACADEMIC YEAR 2022-23

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VII AND VIII SEMESTER B.E.

POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING
(An Autonomous College Under VTU)
KALABURAGI

VISION AND MISSION OF INSTITUTE

VISION

To be an institute of excellence in technical education and research to serve the needs of the industry and society at local and global levels

MISSION

To provide a high-quality educational experience for students with values and ethics that enables them to become leaders in their chosen professions.

To explore, create and develop innovations in engineering and science through research and development activities.

To provide beneficial service to the national and multinational industries and communities through educational, technical and professional activities.

VISION AND MISSION OF DEPARTMENT

VISION

To be a premier department known for its quality education and research in the field of Electrical & Electronics Engineering, inculcating professional ethics in students to serve the needs of society and industry.

MISSION

To impart quality education that transforms students through coursework and by providing an understanding of the needs of society and industry.

To develop professional competency and technical expertise for providing sustainable and ethical solutions.

To facilitate research and development in the thrust areas of Electrical and Electronics Engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO-1 To apply the knowledge of basic sciences, electrical and electronics engineering to excel in professional career.

PEO-2 To capacitate for employment in reputed organizations, pursue higher studies, entrepreneurs and to take up research for developing sustainable solutions to engineering problems.

PEO-3 To design and develop projects individually or in a team that also hone leadership qualities and communication skills.

PEO-4 To equip with knowledge and skills of recent practices to identify and solve engineering problems ethically.

PROGRAM OUTCOME (PO)

PO-01 – The Electrical and Electronics Engineering graduate possess knowledge of mathematics, science, engineering fundamentals, and Program specific knowledge has ability to solve Engineering Problems.

PO-02 - The Electrical and Electronics Engineering graduate not only possess ability to solve Engineering Problem but also has the ability to identify, formulate and make an analysis of Engineering Problem and its solution to take valid decisions /conclusions.

PO-03 - The Electrical and Electronics Engineering graduate has the ability to design solutions for problems and also design component or processes for System, to satisfy specified/ desired needs by taking into account, the considerations related to public health, safety, the cultural, societal and environment.

PO -04 - The Electrical and Electronics Engineering graduate possess capabilities to Conduct Experiments which are relevant to his specialization, compile & understand data generated during experimental work and interpret data to take suitable conclusions / decisions.

PO-05 - The Electrical and Electronics Engineering graduate has the knowledge and ability to select and apply modern tools and techniques to engineering activities related to the program.

PO-06 - The Electrical and Electronics Engineering graduate possess ability to assess societal, health, safety, legal and cultural issues with respect to his profession and recognize resulting responsibilities.

PO-07 - The Electrical and Electronics Engineering graduate possess ability to understand the impact of engineering solutions on society and environment and also ability to understand the need of developing sustainable solutions.

PO-08 - The Graduate has an understanding of and also committed to Professional Ethics, norms and Responsibilities.

PO-09 -The Electrical and Electronics Engineering graduate possesses potential to work efficiently individually and also as a member or Leader of Multidisciplinary Team.

PO-10-The Electrical and Electronics Engineering graduate possess effective Communication Skills, both oral and written to communicate any information about engineering activities of his / her specialization to any type of audience.

PO- 11 - The Electrical and Electronics Engineering graduate possess ability to work as a member or leader of a team working on projects in multidisciplinary environments.

PO-12 - The Electrical and Electronics Engineering graduate possess self study capabilities and involve in Life Long Learning.

PROGRAM SPECIFIC OUTCOME (PSO)

PSO-1 Apply the logical knowledge to model, simulate and analyze electrical components and systems.

PSO-2 Integrate the knowledge of fundamentals of electrical and electronics, power electronics & energy systems for the controllability, reliability and sustainability of electrical systems.

PSO-3 Evaluation of an electrical problem in a team, communicate and develop an ethical attitude and concern for society and environment.

Poojya Doddappa Appa College of Engineering, Kalaburagi
B.E.in Electrical and Electronics Engineering
Scheme of Teaching and Examination 2022-23
Outcome Based Education (OBE) and Choice Based Credit System (CBSE)
(Effective from the academic year 2022-23)

VII Semester

Sl.No	Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PC	19EE71	Computer Application To Power Systems	EE	3	-	--	1	03	50	50	100	3
2.	PC	19EE72	High Voltage Engineering	EE	3	--	--		03	50	50	100	3
3.	PE	19EE73X	Professional Elective- II	EE	3	-	--		03	50	50	100	3
4.	PE	19EE74X	Professional Elective-III	EE	3	--	--		03	50	50	100	3
5.	OE	19EE7OEX	Open Elective- II	EE	3	-	--		03	50	50	100	3
6.	PC	19EES72	Seminar	EE	-	-	2		03	50	50	100	1
7.	PC	19EEL71	Power System Simulation Lab	EE	-	-	2		03	50	50	100	1
8.	PROJ	19EEP73	Project Work Phase – 1	EE	-		2		03	50	50	100	4
9.	INT	19EEIN74	Industrial Visit	EE	(To be carried out during the intervening vacations of VI and VII semesters)				-	-	-	-	1
		Total			**16**	**-**	**06**	**1**	**24**	**400**	**400**	**800**	**22**

ELECTIVES GROUP -II (Professional)									
19EE731	Electrical Drives and Applications								
19EE732	Programmable Logic Controller and SCADA								
19EE733	Distributed Generation								
ELECTIVES GROUP -III (Professional)									
19EE741	Power System Dynamics and Control								
19EE742	Introduction to Restructured Power System								

19EE743	MEMS							
	ELECTIVES GROUP -II (Open Elective)							
19EE7OE1	Wind and Solar Energy System							
19EE7OE2	Electrical Power Quality							
19EE7OE3	HVDC Transmission							

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VIII Semester

Sl.No	Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PC	19EE81	Power System Operation & Control	EE	3	2	--		03	50	50	100	4
2.	PE	19EE82X	Professional Elective- IV	EE	3	-	--		03	50	50	100	3
3.	OE	19EE83X	Open Elective- III	EE	3	-	--		03	50	50	100	3
4.	MOOC	19EE8XX	Certification Course	--	--	--	--		--	--	--	--	1
5.	PROJ	19EEP84	Project Work Phase - 2	-	-		2		03	50	50	100	14
6.	INT	19EEI78	Internship	(Completed during the intervening vacations of VI and VII semesters and /or VII and VIII semesters.)									1
		Total			09	**-**	**04**		**19**	**240**	**360**	**600**	**26**

ELECTIVES GROUP -II (Professional)									
19EE821	Power Electronic Converters								
19EE822	Testing and Commissioning of Electrical Equipment's								
19EE823	Smart Grid Technology								
	ELECTIVES GROUP -II (Open Elective)								
19OE831	OOPs/Python								
19OE832	Internet of Things								
19OE833	Energy Conservation and Audit								

Course Title: **COMPUTER APPLICTIONS TO POWER SYSTEM**		
Course Code	**19EE71**	CIE: 50
Number of Lecture Hours/Week	**03hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite: Electrical Power Transmission and Distribution System.
Power System Stability and Analysis.

Course Objectives:

1. To study the different methods of Admittance bus of power system networks.
2. To understand different types of buses and its analysis using load flow study.
3. To study and analysis of transient stability systems.
4. To understand economic concept of power systems.
5. To study of different voltage control method for power systems.

Modules	**Teaching Hours**
Module I **Formation of Y-Bus of a power system network by direct inspection method incidence matrices:** Element node incidence matrix, Bus incidence matrix, Primitive network in impedance & admittance form, primitive {y} matrix. Formation of Y-bus by singular transformation method, Algorithm for formation of bus impedance matrix [z] on single phase basis.	**08hrs**
Module II **Load flow studies:** Types of buses, operating constraints, Classification of system variables load flow equations, solution of load flow equations by Gauss-Seidel method, and Newton Raphson method, Acceleration of convergence LF solution by Fast-decoupled method. Comparison of LF methods, Representation of tap changing & phase shifting transformer.	**09hrs**
Module III **Transient Stability Study:** Swing equation representation of synchronous machine for transient stability studies, load representation network performance equation, solution techniques with flow charts. Transient stability solution by numerical solution of differential equations, modified Euler's method, Runge-Kutta 4th order method.	**08hrs**
Module IV **Economic Operation of Power Systems.** Performance curves, load sharing between the units within plants, load sharing between plants including transmission losses. Penalty factor, Derivation of	**08hrs**

transmission loss formula and loss coefficient.	
Module V **Automatic Generation & Voltage control:** Automatic load frequency control (ALFC) and Automatic voltage regulator (AVR), loop diagrams Automatic load frequency control for fly ball governing system Generator model. Load model, turbine model. governor model complete ALFC Block diagrams steady state and dynamic response of ALFC loops single area and two area block diagram representation.	**09hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1. Stag and EI-Abiad, "computer methods in power system Analysis", McGraw Hill International Edition 1968.
2. M.A. Pai " Computer Techniques in power system", Tata McGraw Hill, 2nd Edition 2006.
3. Nagrath & Kothari, "Modern Power System Analysis", Tata McGraw Hill, 2nd Edition 2003.
4. Uma Rao, "Computer Techniques", Tata McGraw Hill.
5. L.P. Singh, "Advanced Power System and Dynamics", New Age International Pvt.Ltd, New Age International Pvt.Ltd, New Delhi 2001.
6. R.N. Dhar, "computer Aided Power System Operations & Analysis", TMH 1984.
7. Hadi sadat, "Power system Analysis", TMH, 2nd Edition, 12th Reprint 2007.
8. Elgerd, "Electric Energy Systems Theory", TMH, 1983.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Describing the Y-bus formation in power system network through matrices and inspection method.
	CO2	Calculation of Voltage magnitude and power in a power system network.
	CO3	Relate various load flow method in power system network.
	CO4	Analyse the transient stability and Economic operation of power systems.
	CO5	Construct the various model in power system network.

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3		2	1							1	3	1	1
2	CO2	3	3		2	1							1	3	2	1
3	CO3	3	3		2	1							1	3	2	1
4	CO4	3	3		2	1							1	3	2	1
5	CO5	3	3		2	1							1	3	2	1
		3	**3**		**2**	**1**							**1**	**3**	**2**	**1**

Course Title: **High Voltage Engineering**		
Course Code	**19EE72**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite: Study of Electrical Power Transmission and Distribution, Power Electronics

Course Objectives:

1- To understand the principles of theory of high voltage generation and measurements.
2- To study the operation of high voltage power supplies for ac, dc and impulse voltages
3- To get familiar with various applications where high voltage field is used.
4- To understand breakdown 0f HV insulation (solid, Liquid and Gas).
5- To know lightning phenomena and HV Insulation Environmental pollution.

Modules	**Teaching Hours**
Module I **Breakdown Phenomenon:** **Gaseous Dielectrics :** Ionization, primary and secondary ionization process, Townsend's criterion for gaseous insulation breakdown, time lag in breakdown, Streamer theory, breakdown in Non-Uniform fields, Paschen's law and its significance, breakdown in Electronegative gases. **Breakdown in Liquid Dielectrics:** Suspended Particle theory, Cavitations and Bubble mechanism, thermal mechanism, stressed oil volume theory.	09 Hours
Module II **Breakdown in Solid Dielectrics:** Intrinsic breakdown, Avalanche breakdown, Thermal breakdown and Electromechanical breakdown. **Generation of High Voltages :** **HVAC:** Need for high AC voltage generation, Cascade connection of transformer, series resonant circuit-Tesla coil, High frequency AC voltages. HVDC : Rectifier circuits, Voltage doubler circuit, Cockroft-walton voltage multiplier circuit, Electrostatic generator.	09 Hours
Module III **Impulse Voltage :** Introduction to lightning and switching impulse voltage, Concept of standard impulse wave, front and tail times, derivation of output voltage of impulse generator(Single stage) in terms of input voltage and circuit components, Marx circuit, modified Marx circuit, components of multistage impulse generator, tripping of impulse generator by three electrode gap , trigatron gap, Generation of switching impulse voltages, generation of impulse current.	08 Hours
Module IV **Measurement of High Voltages :** **HVDC:** Series Resistance micro ammeter method, resistance potential divider	

method, Generating voltmeter method. **HVAC:** Series capacitance method, Electrostatic voltmeter method, peak reading AC voltmeters, Chubb and Fortescue method. **Impulse Voltage:** Potential divider method (Resistive, capacitive and Mixed), factors affecting the spark over voltage. Surge Current Measurement: Klydonograph and magnetic links.	08 Hours
Module V **Over Voltage Phenomenon:** Concept of Lightning, Mechanism of Lightning stroke, Travelling wave, behavior of travelling wave (Unit step function) at transition points. **Non-destructive Insulation Testing Techniques:** Dielectric loss and loss measurement by using Schering bridge, Transformer ratio Arm bridge, Need for Partial Discharge detection and detection methods(Straight and Balance)	08 Hours
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Text books / Reference Books: 1. E. Kuffel and W.S. Zaengil, "High Voltage Engineering Fundamentals", 2nd Edition, Elsvier Press-2005. 2. M.S. Naidu and V. Kamaraju," High Voltage Engineering, 5th Edition, McGraw Hill Education (India) Publication,2014 3. C.L.Wadhwa, "High Voltage Engineering, "New Age International Publishers.2008 4. Abdul Salam, H. Anis, Roshdy Radwan, "High Voltage Engineering theory and Practice", 2nd edition, Special Indian Edition by BSP books Publishers.	

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)	
	CO1	Analyze breakdown phenomenon in solids, liquids, and gaseous dielectrics for practical applications.	
	CO2	Identify different methods of generating HVAC,HVDC,	
	CO3	Outline Impulse Voltage and Current Generators.	
	CO4	Analyze travelling wave at different transition points.	
	CO5	Illustrate different Non destructive insulation testing techniques for various electrical applications.	

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3										1	3	2	1
2	CO2	3											1	3	2	1
3	CO3	3											1	3	2	1
4	CO4	3	3										1	3	2	1
5	CO5	3											1	3	2	1
		3	**3**										**1**	**3**	**2**	**1**

Course Title: **ELECTRICAL DRIVES & APPLICATIONS**		
Course Code	**19EE731**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite: Electrical machine – I and Electrical machine – II, Power Electronics.		
Course Objectives: 1. To understand the concept of Electrical Drives and their dynamics. 2. To study the characteristics of AC and DC drives. 3. To select the drives for electrical traction and industrial applications.		
Modules		**Teaching Hours**
Module I **Introduction:** Concept, classification and advantages of electric drives, Block diagram of typical electric drives. Components of electric drive, choice of electric Drives. Comparison of dc electric drives with ac electric drives.		03 hrs
Dynamics of Electric drives: Fundamental torque equation, speed torque conventions and multiquadrant operation. Equivalent values of drive parameters, components of torques, nature and classification of load torques, calculation of time and energy loss in transient operations, steady state stability, load equalization.		08 hrs
Module II **Characteristics of DC drives:** Starting, braking, transient analysis, single phase half and fully controlled rectifiers, control of separately excited dc motor.		08 hrs
Module III **Characteristics of AC drives:** Speed torque Characteristics, modified speed –torque Characteristics of 3-phase Induction Motor. Types of braking, energy lost during braking and starting. Speed control of 3-phase Induction Motor: Methods, stator voltage, slip power recovery schemes & voltage/frequency control.		08 hrs
Module IV **Selection of motor power rating:** Classes of motor duty, determination of power rating, Continuous duty, short time duty and intermittent periodic duty.		08 hrs
Module V **Industrial drives:** Rolling mill drives, cement mill drives, paper mill drives and textile mill drives.		08 hrs

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text books:

G.K. Dubey, "Fundamentals of Elect. Drives", Second edition 2002 Narosa publishing house.

Reference Books:

1. S.K.Pillai, "A first course and Elect. Drives", Wiley Estern Ltd 1990.
2. N.K.Dey & P.K.Sen, "Electrical Drives", -PHI Publication. New Delhi 2009.
3. R.Krishnan, "Electrical Motor drives, Modeling, Analysis and Control", PHI-2008.

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Definition and Explanation of drive components, classification and comparison of AC &DC Drives.
	CO2	Derive Dynamic torque equation, Drive parameters and stability of drive.
	CO3	Explanation of speed torque characteristics, modified characteristics, transient operations such as starting, braking, acceleration & deceleration. Energy relations of both AC & DC drives
	CO4	Selection of motor Power ratings.
	CO5	Industrial drive applications in cement Rolling mills, paper mills and textile mills.

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											1	2	2	1
2	CO2	3	1										1	2	2	1
3	CO3	3	2										1	2	2	1
4	CO4	3											1	2	2	1
5	CO5	3											1	2	2	1
		3	**1.5**										**1**	**2**	**2**	1

Course Title: Programmable Logic Controllers and SCADA

Course Code	**19EE732**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite:		
Course Objectives:		

Modules	**Teaching Hours**
1. **Programmable Logic Controller(PLC) Basics:** Definition and History, advantages and disadvantages, Types of PLC systems – CPU's and programmer/ Monitors, PLC input and output models, printing PLC Information, programming procedures, programming Formats, proper construction of PLC Diagrams, Devices to which PLC input and output modules are connected, input on/ off devices and output analog devices	07 hours
2. **Basic PLC Programming and Basic PLC Functions:** Programming on/ off input to produce on / off out puts , PLC input instructions, outputs operational procedures , contact and coil input / Out put programming examples, Relation to digital gate logic contact/ coil logic, PLC programming and conversion examples, creating ladder diagrams form process control descriptions, sequence listing sarge process ladder diagram constructions.	08 hours
3. **General Characteristics of Registers:** Modules addressing, holding registers, input registers, output registers, PLC timer functions, examples of timer functions. Industrial applications, PLC counter functions.	**06 hours**
4. **Intermediate functions:** PLC Arithmetic functions, PLC additions and subtractions, the PLC repetitive clock,PLC multiplications, Division and square Root, PLC trigonometric and log functions, other PLC arithmetic Functions, PLC basic comparison functions applications, numbering systems and number conversion functions, PLC conversion between decimal and BCD Hexadecimal numbering systems.	12 hours
5. **Data Handling Functions:** The PLC skip and master control relay functions, Jump functions, jump with non return with return, PLC data move systems, PLC functions and applications, PLC functions working with bits, PLC digital bit functions and applications, PLC sequencer functions PLC matrix functions.	09 hours

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.		
Text books: 1. John W. Weff. Ronald A Rise. Programmable logic controllers , prentice Hall of India private Limited, Fifth edition, 2003.		
Reference Books:		
E books and online course materials:		
Course outcomes: **On completion of the course, the student will have the ability to:**		
Course Code	**CO #**	**Course Outcome (CO)**
	CO1	Understand the concept of PLC architecture & hardware, develop fundamental PLC wiring diagrams
	CO2	Develop the PLC program using ladder diagram.
	CO3	Illustrate various registers
	CO4	Study of intermediate functions in PLC
	CO5	Study of data handling functions

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2	2	1	1							2	3	3	
2	CO2	3	2	3	1	1							1	3	3	
3	CO3	3	2	3	1	1							1	3	3	
4	CO4	3	2	3	1	1							1	3	3	
5	CO5	3	2	3	1	1							2	3	3	
		3	**2**	**2.8**	**1**	**1**							**1.4**	**3**	**3**	

Course Title: **DISTRIBUTED GENERATION**			
Course Code	19EE733	Credits:3	CIE: 50

Number of Lecture Hours/Week	3hrs (Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite: Basics of Mechanical Engineering, Basic Electrical Engineering

Course Objectives:

1. Knowledge of renewable energy sources
2. Introduce different DG Technologies

Modules	Teaching Hours
Module I **DG**: An introduction: Electricity production, DG Technologies, Economic consideration, Environmental issues. **IC Engine - Generator sets**: IC Engine overview, past and present trends in engine development, Utilizing existing systems, Utility interaction, IC Stirling engine.	**9 hrs**
Module II **Gas turbines:** Basic types, recuperated Brayton cycle, modified gas turbine cycles, turbine performance, future developments of fuels. **PV system:** Semiconductor types, PV system efficiency and design, Technical developments and barriers, PV System Capacity, Credit.	**9 hrs**
Module III **Micro turbines:** Some features of single shaft MT, twin shaft MT, applications, performance improvements, Rankine cycle MT, challenges. **Fuel Cells:** Principles of operation, Types, Comparison, operating parameters, interconnection and control, Technology development and barriers.	**9 hrs**
Module IV **Principles of control of DG systems:** Control techniques, threshold control, Buy back priority, cooling / heating priority control, optional control, complete optimization, system modeling.	**8 hrs**
Module V **Economic & Financial Aspects of DG:** Comparing present and future costs, the life cycle cost, economic evaluation criteria, optimization.	**8 hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1.Annie-Marie Borbely and Jan F. Kreider (editors), "Distributed Generation: the power

paradigm for new millennium", CRC Press, Boca Raton, 2001.
2.Willis H.Lee, Scott, Walter G, " Distributed Power Gneration: Planning and Evaluation", Marcal Dekker, New York, 2000.
3.Thomas Ackermann, Goran Anderson, Lennart Soder, "Distributed Generation: a definition", Electric Power Systems Research", Vol 57,195-204, pp,2001.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	
19EE723	CO1	Define the DG technologies.	
	CO2	Illustrate and review different DG technologies.	
	CO3	Choose suitable DG technology based on economical and environmental consideration.	
	CO4	Appraise the principles of control of DG systems.	
	CO5	Evaluate suitable DG technologies based on cost analysis	

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3					2						1	3		1
2	CO2	3					2						1	3		1
3	CO3	3					2						1	3	1	1
4	CO4	3					2						1	3	1	1
5	CO5	3					2						1	3	1	1
		3					2						1	3	1	1

Course Title: **POWER SYSTEM DYANAMICS AND CONTROL**		
Course Code	**19EE741**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of	42	SEE Hours: 03

Lecture Hours		
Prerequisite: Electrical machine – I and Electrical machine – II, Power System Analysis and Stability.		
Course Objectives: 4. To understand the concept of Excitation, Prime Movers, Transmission Lines, Load Dynamics and Control. 5. To study the concepts of System Modelling and Dynamics of Synchronous Generators. 6. To understand the analysis of Single Machine and Multimachine Systems.		
Modules		**Teaching Hours**
Module I **Basic Concepts of Power System:** Introduction, States of Operation and System Security, System Dynamic Problems and Control.		02 hrs
System Modeling and Dynamics of Synchronous Generator: Basic concepts, Review of classical methods. Modeling of synchronous machine, Swing equation, Park's transformation – Park's voltage equation, Park's mechanical equation (torque). Applications – (a) voltage build up in synchronous machine, and (b) Symmetrical short circuit of generator. Solution for transient analysis, Operational Impedance.		08 hrs
Module II **Excitation and Prime Mover Controllers:** Introduction, Excitation System, Excitation System Modelling, Types of excitation, AVR with and without ESS, TGR, Amplifier, PSS, Static exciters.		08 hrs
Module III **Transmission Lines, SVC and Loads:** Transmission Lines, D-Q Transformation using alpha and beta Variables), Static Var compensators, Loads. **Dynamics of a Synchronous Generator Connected to Infinite Bus:** System Model, Synchronous Machine Model, Application of Model 1.1, Calculation of Initial Conditions, System Simulation, Consideration of other Machine Models. Inclusion of SVC Model		08 hrs
Module IV **Load Modeling and Application of Power System Stabilizers:** Introduction, Two approaches-polynomial model and Exponential model. Small Signal Stability, Angle stability with SMIB system, detailed model of SMIB. Introduction, Basic concepts in applying PSS, Control Signals, Structure and tuning of PSS, Field implementation and operating experience, Examples of PSS Design and Application.		08 hrs
Module V **Analysis of Single Machine System:** Small Signal Analysis with Block Diagram Representation, Characteristic Equation		08 hrs

and Application of Routh-Hurwitz Criterion, Synchronizing and Damping Torques Analysis, Small Signal Model: State Equations, Nonlinear Oscillations - Hopf Bifurcation. **Analysis of Multimachine System:** A Simplified System Model, Detailed Models: Case I and Case II, Inclusion of Load and SVC Dynamics, Modal Analysis of Large Power Systems, Case Studies.	

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text books:

Reference Books:

4. "Power System Dynamics, Stability and Control"-Padiyar K.R, Interline Publications.
5. "Power System STABILITY And Control"- Prabha Kundur Mcgraw-Hill Publishing Company, NY.
6. "Dynamics and control of Large Electric power Systems"-Marija Ilic; john Zaborszky, IEE press and John Wiley & Sons, Inc.
7. "Power System Control and Stability" –Paul M.Anderson and A.A.Fouad, IEEE press and John Wiley & Sons, Inc.
8. Selected topics from IEEE Transaction and Conference Proceedings.
9. Sauer and Pai, "Power System Dynamics and Stability".

E books and online course materials:

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)	
	CO1	Understanding the basic concepts of power system, system modelling and dynamics of synchronous generator.	
	CO2	Outline the concept of excitation and prime mover control.	
	CO3	Analyse the transmission lines, loads and dynamics of a synchronous generator connected to infinite bus.	
	CO4	Illustrate load modeling and application of power system stabilizers	
	CO5	Analyse Single and multimachine system in power system	

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2			1								3	1	
2	CO2	3	2			1								3	1	
3	CO3	3	2			1								3	1	
4	CO4	3	2			1								3	1	

5	CO5	3	2			1							3	1	
		3	2			1							3	1	

Course Title: **INTRODUCTION TO RESTRUCTURED POWER SYSTEM**		
Course Code	**19EE742**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite: Electrical Power Transmission and Distribution System. Power System Stability and Analysis.		

Course Objectives:

1. Introductions to deregulation electric industry and their needs.
2. To understand concept of restructuring of electrical power.

Modules	Teaching Hours
Module I **The Electric Utility Industry:** Introduction, Electric utilities characterized by function. **Need for Deregulation:** Reasons for regulating electric utility industry, Summary of regulated utility structure and functions, merits and demerits of utility regulated system: Need for regulation as perceived by business and government, Conditions and reasons to deregulation.	09 hrs
Module II **Overview of the deregulated electric industry:** a. Unbundling, Open access, Deregulation and Competition. b. Four paradigms creating different amounts of competition. c. Disaggregation of traditional utility. Different perceptions and incentives under deregulation.	09 hrs
Module III **Key concepts of Restructuring:** Restructuring models; Independent System Operator (ISO), power exchange. Market operation; Day and hour ahead markets	08 hrs
Module IV Elastic and in-elastic markets, market power, stranded costs, transmission pricing, congestion pricing.	08 hrs
Module V Special features of Electricity Act 2003, Power exchange India Limited (PXIL), Indian energy exchange (IEX), Hindustan power exchange (HPX), Working of restructured power systems: PJM, NORDPOOL.	08 hrs

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text books/Reference Books:

1. Lorrin philipson, H.Lee Willis: "Understanding electric utilities and deregulation",Marcel Dekker publications, 1998.
2. Mohammad Shahidepour, Muwaffaq Alomoush: "Restructured electrical power system ", Marcel Dekker publications, 2001.
3. Nils Flatato, Gerard Doorman, O.S. Grande, Hans Randen, Ivar Wangensteen; Experience with Nordpool Design and Implementation' IEEE Transactions on power sustems, Vol. 18, No.2, May 2003, pp541-547.
4. Andrew L. Ott, Experience with PJM Market operation, System Design and Implementation' IEEE Transactions on power systems, Vol. 19, No.2, May 2003, pp528-534.
5. Sangamesh Sakri, et al, "Power sector reforms in Karnataka" IEEE power India Conference 2006,

New Delhi, 10-12, April 2006, 1-6 pp.
E books and online course materials: http://www.iexindia.com www.powerexindia.com.
Course outcomes: **On completion of the course, the student will have the ability to:**

Course Code	CO #	Course Outcome (CO)	
	CO1	Outline the reasons for restructuring the power system.	
	CO2	Describe the designated power industry.	
	CO3	Distinguish different restructuring models of power markets.	
	CO4	Examine market power congestion in the transmission.	
	CO5	Appraise different restructured power systems, Electricity Act 2003.	

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											3			
2	CO2	3											3			
3	CO3	3					2						3			
4	CO4	3	3	2			2						3	3		
5	CO5	3					2		2				3			3
		3	**3**	**2**			**2**		**2**				**3**	**3**		**3**

Course Title: MICRO ELECTRO MECHANICAL SYSTEMS & MICRO SYSTEM DESIGN		
Course Code	**19EE743**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite: Basic sciences, Measurement and Instrumentation, Material science		
Course Objectives: • Have a concept on the scope and recent development of the science and technology of MEMS • Gain the physical knowledge underlying the operation principles and design of MEMS • Learn some typical or potentially applicable micro- and nano-systems at the frontier of the development of the field		
Modules		**Teaching Hours**
Module-I Overview of Micro Electro Mechanical Systems (MEMS): MEMS as micro sensor and Micro actuators, components of Microsystems, Evolution of Micro fabrication, comparison of Micro –electronics and Micro system. Application of Micro system in Health care industries, Aerospace industry & Industrial products,		09 hrs
Module-II Working Principles of Microsystems : Introduction, Microsensesrs- Acoustic wave sensors. Bio-medical sensors & biosensors, chemical sensors, optical sensors, Pressure sensors, Thermal sensors. Microactuation: Actuation using Thermal forces, shape memory albys		09hrs

piezoelectric crystals and electrostatic forces MEMS,with Microactutors: Micro grippers, Micromotors, Microvalves Micropumps. Microaccelerometrs Microfleudies.	
Module-III Engineering Mechanics for Microsystem design: Introduction, Static Berding Thin plates, Mechanical vibration, Thin filter Mechanics over viaw of finite– Element stress analysis.	08 hrs
Module-IV Scaling Laws in miniaturization: Introduction to scaling, scaling in Geometry, scaling in rigid body dynamics, scaling in Electrostatic forces, scaling in Electromagnetic forces, scaling in Electricity. Scaling in Heat transfor.	**08 hrs**
Module-V Materials for MEMS & Microsystems: Introduction, Substrates and wafers, Active substrate materials, silicon as substrate materials. Silicon comounds, Silicon piegoresistors, piezoelectric crystals.	08 hrs

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1) MEMS & Microsystems design by Tai-Ran, HSU-MC Graw Hill
2) RF MEMS- VK Varadan, A Laktakia and K J Vinoy, Wiley, 2003 Reprint.
3) RF MEMS Circuit Design De Los Santos, Artech House,2002
4) Transaction Level Modeling with Systems TLM Concepts and Application for Embedded Systems,
5) By Frank Ghenassia, Springer, 2005.
6) Networks on Chips: Technology and Tools, by Lica and Giovanni De micheli,

Reference Books:

E books and online course materials:

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	**Understand the operation of micro devices, micro systems and their applications**
	CO2	**Design the micro devices, microsystems using the MEMS fabrication process**
	CO3	**Gain a knowledge of basic approaches for various sensor design**
	CO4	**Gain s knowledge of basic approaches for various actuator design**

	CO5	**Gain the technical knowledge required for computer-aided design, fabrication.**

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	2												1		
2	CO2	2		3										1		
3	CO3	2												1		
4	CO4	2												1		
5	CO5	2												1		
		2												**1**		

Course Title: **Wind and Solar Energy System**		
Course Code	**19OE751**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite:		
Course Objectives:		

Modules	**Teaching Hours**
Module-I **Fundamentals of Energy Science and Technology:** Introduction, Energy, Economy and Social Development, Classification of Energy Sources, Importance of Non -conventional Energy Sources, Salient features of Non-conventional Energy Sources, World Energy Status, Energy Status in India. **Energy Storage:** Introduction, Necessity of Energy Storage, Specifications of Energy Storage Devices. **Solar Energy-Basic Concepts:** Introduction, The Sun as Source of Energy, The Earth, Sun, Earth Radiation Spectrum, Extraterrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar	08 hrs

Radiation.	09hrs
Module-II **Solar Energy-Basic Concepts (continued):** Measurement of Solar Radiation, Solar Radiation Data, Solar Time, Solar Radiation Geometry, Solar Day Length, Extraterrestrial Radiation on Horizontal Surface, Empirical Equations for Estimating Terrestrial Solar Radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface. **Solar Thermal Systems:** Introduction, Solar Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers.	
Module - III **Solar Photovoltaic Systems:** Introduction, Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell Technologies, Solar Cell, Module, and Array Construction, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications.	08 hrs
Module –IV **Wind Energy:** Introduction, Basic Principles of Wind Energy Conversion, History of Wind Energy, Wind Energy Scenario – World and India. The Nature of the Wind, The Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations. **Wind energy systems:** Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis.	**08 hrs**
Module-V **Basic Components of a Wind Energy Conversion(WEC) System:** Classification of WEC systems, Advantages and Disadvantages of WECS, Types of Wind Machines (Wind Energy Collectors), Analysis of Aerodynamic Forces Acting on the Blade, Performance of Wind- machines, Generating Systems, Energy Storage, Applications of Wind Energy,	09 hrs

Environmental Aspects.	

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text books:

01. Non-Conventional Sources of Energy Rai, G. D Khanna Publishers 4th Edition, 2009

02. Renewable Energy Sources And Emerging Technologies, D.P. Kothari, K. C. Singal, Rakesh Ranjan, PHI Learning Pvt. Ltd., Nov-2011, 456 pages

Reference Books:

1. Non-Conventional Energy Resources ShobhNath Singh Pearson 1st Edition, 2015
2. Solar Energy – Principles of Thermal Collections and Storage, S.P. Sukhatme, J.K.Nayak, McGraw Hill 3rd Edition, 2008
3. Wind Turbine Technology, Ahmad Hemami, Cengage 1st Edition, 2012

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	Discuss the importance of energy in human life, relationship among economy and environment with energy use and the increasing role of renewable energy.
	CO2	Explain the concept of energy storage and the principles of energy storage devices.
	CO3	Discuss solar radiation on surfaces, its characteristics, measurement and analysis of radiation data.
	CO4	Describe the process of harnessing solar energy and its applications in heating and cooling. Operation of solar cell, solar PV systems and their applications.
	CO5	Explain basic Principles of Wind Energy Conversion, collection of wind data, energy estimation and site selection along with the performance of Wind-machines.

Course Articulation Matrix for the Academic Year 2022-23

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					1	1				1	1
CO2	3					1	1				1	1
CO3	3					1	1				1	1
CO4	3					1	1				1	1
CO5	3					1	1				1	1

Course Title: Electrical Power Quality		
Course Code	**19OE752**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite:		

Course Objectives: To impart knowledge about the following topics

1. Causes, Mitigation techniques of various PQ events.
2. Measuring and Solving PQ problems
3. Custom power devices

Modules	**Teaching Hours**
Module-I **Introduction to Electrical Power Quality :** Introduction, Power Quality Issues, Remedial measures, power quality V/S Equipment immunity, Power Quality concerns, power quality standards and power quality monitoring.	06 Hours 08 Hours

Module-II **Voltage Sags and Interruptions:** Sources of sags & interruptions, estimating voltage sag performance, fundamental principles of protection, motor starting sags and mitigation of voltage sag.	
Module-III **Electrical Transients:** Introduction, Types and causes of transients over voltage mitigation techniques, Transient over voltage in communication circuits, Standards of transient over voltages, Transient measurements, Surge generators, Surge suppressors, Interruption of fault circuits, Power factor correction using capacitors, motor start transient.	08 Hours
Module-IV **Harmonics:** Introduction, Harmonic analysis, Effect of harmonics on power system devices, Harmonic current mitigation, Individual harmonic distortion, Total Harmonic Distortion (THD), causes of voltage & current harmonics, Guide lines for harmonic voltage & current limitation.	08 Hours
Module-V **Measuring and Solving Power Quality Problems:** Introduction, power quality measurements, types of equipment for monitoring of power quality, Analyzing power quality measurement Data, PQA features, CBEMA & ITIC curves. **Custom power Devices:** Introduction, Dynamic Voltage Restorer (DVR), D-Statcom, Unifed power quality conditioner (UPQC), Unifed power quality converter topology, principles and configuration of UPS.	07 Hours 07 Hours
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Text books: 1. J.D. Dixit & Amit Yadav "Electrical Power Quality" University Science Press" First edition 2010. 2. Bhim Sing, Ambrish Chandra, Kamal Al-Haddad, Power Quality Problem & Mitigation Techniques Wiley, 2015. 3. C. Sankaran, "Power Quality".	

4. Simmi P. Butman & Bipin Singh, S.K .Kataria & Sons, 2nd edition, 2016

Reference Books:

1. Math H J Bollen, "Understanding power Quality Problems; voltage Sags and Interruptions", Wiley India.

2. Roger C, Dugan, et.el, "Electrical power System Quality", 2nd Edition, TMH, 2011.

3. G T Heydt, "Electric power Quality", Stars in Circle publications, 1991.

4. Ewald F Fuchs, et.el, "Power Quality in power System and Electrical Machines", Academic press, Elsevier, 2009

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	**Understand various sources, causes & effects of PQ issues & their measures and mitigation.**
	CO2	**Understand the concept of voltage sags and interruptions**
	CO3	**Understand the concept of electrical transients**
	CO4	**Study the effects of harmonics on power system devices**
	CO5	**Study types of equipments for PQ monitoring & different power devices**

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3										1		1	

2	CO2	3	2											1	
3	CO3	3	2											1	
4	CO4	3	3			2	1						1		
5	CO5	2			1								1		

Course Title: **HVDC TRANSMISSION**		
Course Code	**19OE753**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite: Electrical Power Transmission and Distribution System.

Power System Stability and Analysis.

Course Objectives:

1. To introduce students with the concept of HVDC Transmission system.
2. To familiarize the students with the HVDC converters and their control system.
3. To expose the students to the harmonics and faults occur in the system and their prevention.

Modules	**Teaching Hours**
Module I **HVDC Systems:** Introduction, comparison of AC and DC systems, Existence of HVDC, systems in india and abroad, Applications of DC transmission , types of DC links, components of converter station,	

choice of voltage level, modern trends in DC transmission. **Analysis of HVDC Converters:** Simplified analysis of Graetz circuit without overlap and with overlap.	**10hrs**
Module II **Control strategies:** Basic means of control, limitations of manual control, constant voltage verses constant current control, desired features of control, Actual control characteristics firing angle control, and MTDC systems.	**08hrs**
Module III **Harmonics and Filter circuits:** Characteristics and uncharacteristic harmonics, troubles caused by harmonics design of AC and DC filters, means of reducing harmonics, Telephone interference.	**08hrs**
Module IV **Protection:** DC breakers, Dc reactors, Surge Arresters, Over voltage protection, HVDC cables.	**08hrs**
Module V **Simulation of HVDC systems:** Philosophy and Tools, HVDC simulator (Physical model), parity simulator, Digital dynamic simulation, Modeling of HVDC systems for digital dynamic simulation.	**08hrs**
Text books / Reference Books: 1. K.R. Padiyar, "HVDC Power Transmission Systems-Technology and system interaction", NEw Age International (P) Limited publishers, 1992. 2. E.W.Kimbark, "Direct Current Transmission", volume 1, Wiley Future Science, 1971. 3. Arrilga, "High Voltage Direct Current Transmission", Peter Peregrines Limited 1983. 4. Uhlmann, "Power Transmission by Direct current", Springrer Verlag, 1975.	
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	

Course Code	CO #	Course Outcome (CO)	
	CO1	**Review the HVDC system and its trends in DC transmission**	
	CO2	**Analyze the Gratez circuit with and without overlap**	
	CO3	**Examine the control strategies in HVDC system**	
	CO4	**Identify the modes of generation and methods reducing the harmonics**	
	CO5	**Identify the components for HVDC system protection**	
	C06	**Discuss the simulation tools used in HVDC system**	

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											2	3		1
2	CO2	3	3										2	3	3	1
3	CO3	3	2										2	3	3	1
4	CO4	3		3									2	3		1

Course Title: **POWER SYSTEM SIMULATION LAB**		

Course Code	**19EEL71**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Modules	**Teaching Hours**
MATLAB 1. MATLAB fundamentals, matrices, Vectors, matrix and array operations. 2. Using built in functions, saving and loading data, script files. 3. Function files, language specific features much as loops, branches and control flow.	
Power system simulation using MATLAB, software packages and C++ 1. i) Y-Bus formation for systems with and without mutual coupling, by singular transformation and inspection method. ii) Determination of Bus currents, bus power & line flows for a specified system voltage bus profile. 2. ABCD parameters i) Formation for symmetric π/T configuration ii) Verification of AD-BC=1 III) Determination of efficiency and regulation 3. Determination of power angle diagrams for salient and nonsalient pole synchronous machines, reluctance power, excitation emf and regulation. 4. To determine fault currents and voltages in a single transmission line system with star-delta transformers, at a specified location for SLGF, DLGF, and LLF. 5. To determine fault curve i) swing curve ii) critical clearing time for a single machine connected to infinite bus through a pair of identical transmission lines. for a 3-phase on one of the lines for variation of inertia constant/line parameters/fault location/prefault electrical output.	

6. Load flow analysis for a 3 Bus system using Gauss Seidal method for at least 3 iterations (Y-bus to be given as data) 7. Formation of jacobian for a system not exceeding 4 buses (no PV buses) in polar co-ordinates. 8. For a given power system, computation of Jacobian to conduct load flow analysis using Newton Raphson method (no PV Buses) 9. Optimal generator scheduling for thermal power plants.	

Reference Books:

1. Rudrapratap, " Matlab getting started with MATLAB", Oxford University press.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)	
	CO1	**Describe Power System tools of MATLAB, determine Y bus by using inspection and singular transformation.**	
	CO2	**Determination of Bus Currents, Bus power and line flows for a specified power system networks.**	
	CO3	**Determination of power angle diagrams for synchronous machines, find fault currents and voltages in a single transmission line system with star delta transformers.**	
	CO4	**Load flow analysis for a power system network by using Gauss Seidal, Newton Raphson and fast decoupled load flow studies**	
	CO5	**Determine optimal generator scheduling for thermal power plants**	

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	1	1				2			1	3	2	2

2	CO2	3	3	3	1	1				2			1	3	2	2
3	CO3	3	3	3	1	1				2			1	3	2	2
4	CO4	3	3	3	1	1				2			1	3	2	2
5	CO5	3	3	3	1	1				2			1	3	2	2
		3	**3**	**3**	**1**	**1**				**2**			**1**	**3**	**2**	**2**

Course Title: **POWER SYSTEM OPERATION AND CONTROL**		
Course Code	**19EE81**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite : Electrical Power Transmission and Distribution System.

Power System Stability and Analysis and control systems.

Course Objectives:

1. To understand optimal dispatch of generation with and without losses
2. To study the optimal scheduling of hydro thermal systems.
3. To study the optimal unit commitment problem.
4. To study the load frequency control for single area system
5. To understand the reactive power control and compensation of transmission lines.

Modules	**Teaching Hours**
Module I **Control Center Operation Of Power Systems:** Power system control and operating states, Introduction to SCADA, control center, digital computer configuration, automatic generation control, area control error, operation without central computers, expression for tie-line flow and frequency deviation, parallel operation of	

generators, area lumped dynamic model.	08 hrs
Module II **Optimal System Operation And Unit Commitment:** Introduction , Optimal operation of generators on a bus bar, Statement of the Unit Commitment problem, need and importance of unit commitment, Constraint in Unit Commitment, Unit Commitment solution methods-Priority lists method, Forward Dynamic Programming method(excluding problem), Spinning reserve Examples.	08 hrs
Module III **Power System Security:** Introduction, factors affecting power system security, Security analysis, Contingency Selection, Techniques for contingency evaluation-D.C. load flow AC load flow and fast decoupled load flow(with flowcharts excluding problems) detection of network problems, network sensitivity methods.	10 hrs
Module IV **Automatic Generation Control:** Automatic voltage regulator, Automatic Load Frequency Control loops of generators, performance of Voltage Regulator, ALFC of single area system, concept control area, multi area system, POOL operation – two area system, tie-line bias control.	08 hrs
Module V **Control Of Voltage And Reactive Power:** Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, single machine infinite bus systems, methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse. **Power System Reliability:** Introduction, Modes of failures of a system, Reliability index.	08 hrs
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Text books/Reference Books: 1. GL Kusic, “Computer aided power system analysis”, PHI- 2010. 2. I.J. Nagarath and D.P. Kothri, “//modern power system Analysis”, 3rd Edition -2003 3. Allen. J. Wood & Woolenburg “Power Generation , Operation & control”, John Wiley & Sons -2nd Edition -2009.	

4. Power system operation and control Uma Rao K 1st edition -2016
5. O.I.Elgerd, "Electrical Energy Systems Theory", TMH-2008.

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
	CO1	**Illustrate the operation power system with SCADA**
	CO2	**Determine the optimal operation of power system by unit commitment**
	CO3	**Examine the power system security with different methods**
	CO4	**Analyze automatic generation control in power system with different control loops**
	CO5	**Examine voltage and reactive power control in power system**
	C06	**Recognize the modes of failures in power system for reliability assessments**

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											1	3		1
2	CO2	3	2										1	3	2	1
3	CO3	3				2							1	3		1
4	CO4	3	2			2							1	3	2	1
5	CO5	3											1	3	2	1

6	CO6	3										1	3	2	1
		3	2			2						1	2	2	1

Course Title: Power Electronics Converters			
Course Code	19EE821	Credits:3	CIE: 50
Number of Lecture Hours/Week	**3Hrs (Theory)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03
Pre-requisites			

Course Objectives:

- To understand designing concepts of AC-AC voltage controllers.
- To analyze the performance of controlled AC-DC converters.
- To learn the designing of DC-DC chopper circuits.
- To understand and analyze PWM techniques for Inverters.
- To understand different types of resonant converters.

Modules	**Teaching Hours**
Module- I **AC/AC Converters:** Single-Phase AC/AC Voltage Converters - Time Proportional Control Three-Phase Converters, Frequency Converters, Direct Frequency Converters. **Introduction to Multilevel Converters:** Basic Characteristics -Multilevel DC/DC Converters, Time Interval: $nT < t < nT + DT$, $n = 0, 1, 2$,Time Interval: $nT + DT < t < (n + 1)T$, Multilevel Inverters - Cascaded H-Bridge Inverters, Diode-Clamped Multilevel Inverters, Flying Capacitor Multilevel Inverter.	**08 Hrs**
Module-II **AC/DC Converters – Rectifiers**: Half-Wave Single-Phase Rectifiers , Full-Wave Rectifiers - Commutation of Current, Output Filters - Capacitive Filter, L Filter,Voltage Doublers, Three-Phase Rectifiers, Phase	**08 Hrs**

Controlled Rectifiers - Full-Wave Thyristor Rectifiers, Three-Phase Thyristor Bridge Rectifiers, Twelve-Pulse Rectifiers, Rectifiers with Circuit for Power Factor Correction.	
Module-III **D.C. to D.C. Converters:** Analysis of step-down and step-up dc to dc converters with resistive and Resistive-inductive loads - Switched mode regulators - Analysis of Buck Regulators - Boost regulators - buck and boost regulators - Cuk regulators.	**08 Hrs**
Module-IV **Pulse Width Modulated Inverters(single phase):** Principle of operation - performance parameters - single phase bridge inverter -evaluation of output voltage and current with resistive, inductive and Capacitive loads - Voltage control of single phase inverters - single PWM - Multiple PWM - sinusoidal PWM - modified PWM. **Pulse Width Modulated Inverters(three phase):** Three phase inverters - analysis of 180 degree condition for output voltage And current with resistive, inductive loads - analysis of 120 degree Conduction - voltage control of three phase inverters - sinusoidal PWM.	**08 Hrs**
Module-V **Resonant Converters:** Resonant Circuits - Resonant Converters of Class D, Series Resonant Converters, Parallel Resonant Converters, Series – Parallel Resonant Converter, Series Resonant Converters Based on GTO Thyristors, Class E Resonant Converters, DC/DC Converters Based on Resonant Switches - ZCS Quasi-resonant Converters, ZVS Quasi-resonant Converters, Multiresonant Converters, ZVS Resonant DC/AC Converters.	**08 Hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text Books:

1. Mohammed H. Rashid,"Power Electronics" , Pearson Education -3rd Edn - First Indian reprint 2004.
2. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics" John Wiley and Sons, 2nd Edn.
3. Ned Mohan at el Wiley "Power Electronics Converters, Applications, and Design" 3 rd Edition,2014

References:

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)

19EE821	CO1	Analyze AC – AC converters and multilevel converters.
	CO2	Design and analyze AC – DC converters and control their operation using PWM techniques.
	CO3	Apply the knowledge of power electronics in design and analysis of DC – DC PWM converters.
	CO4	Design and analyze PWM Single Phase and Three-Phase Inverters.
	CO5	Design and analyze different resonant converters and their control circuits.

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	1	2									3	3	1
2	CO2	3	3	1	2									3	3	1
3	CO3	3	3	1	2									3	3	1
4	CO4	3	3	1	2									3	3	1
5	CO5	3	3	1	2									3	3	1
		3	**3**	**1**	**2**									**3**	**3**	**1**

Course Title: Testing and Commissioning of Electrical Equipments		
Course Code:19EE822	**Credits:03**	**CIE: 50**
Number ofLecture Hours/Week	**3hrs (Theory)**	**SEE: 50**
Total Number of Lecture Hours	**42 hours**	**SEE Hours: 03**

Prerequisite and Course Objectives:

Prerequisite: Fundamentals of Electrical Machines, Electrical Measurements

Course Objectives:

1. Describe the process to plan, control and implement commissioning of electrical equipment's.
2. Differentiate the performance specifications of transformer and induction motor.
3. Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
4. Identification of tools and equipment's used for installation and maintenance of electrical equipment.
5. Explain the operation of an electrical equipment's such as isolators, circuit breakers, insulators and switchgears.

Rationale: Power Systems and Industrial Plants consist of number of electrical drives, transformers, circuit breakers and other equipments which require installation, commissioning and regular maintenance to prevent permanent break down. It is required to carryout/supervises installation, commissioning and maintenance of various electrical equipments in power stations, substations and industry. This course will enable the students to understand the concepts, principles and acquire basic skills of installation, commissioning and maintenance of electrical equipments in power stations, substations and industry.

Modules	**Teaching Hours**
Module I **Electrical Tools, accessories:** Tools, Accessories and Instruments required for Installation, Maintenance and Repair Work, India Electricity Rules, Safely Codes Causes and Prevention of Accidents, Artificial Respiration, Workmen's Safety Devices. **Transformers:** Installation, Location Site Selection, Foundation Details, Code of Practice for Terminal Plates, Polarity and Phase Sequence, Oil Tanks, Drying of Winding sand General Inspection. Commissioning Tests As Per National and International Standards - Volts Ratio Earth Resistance, Oil Strength, Insulation Tests, Impulse Tests Polarizing Index, Load Temperature Rise Tests. Specific Tests for Determination of Performance Curves like Efficiencies, Regulation Etc., Determination Mechanical Stress Under Normal and Abnormal Conditions.	**8 hrs**

Module II **Synchronous Machines:** Specifications as per BIS Standards. Installation - Physical Inspection, Foundation Details, Alignments, Excitation Systems, Cooling and Control Gear, Drying Out. Commissioning Tests - Insulation, Resistance Measurement of Armature and Field Windings, Wave Form and Telephone Interference Tests, Line Charging Capacitance. **Performance Tests** -Various Tests to Estimate the Performance of Generator Operations, Slip Test, Maximum Lagging Current, Maximum Reluctance Power Tests, Sudden Short Circuit Tests, Transient Sub Transient Parameters, Measurement of Sequence Impedances, Capacitive Reactance, and Separation Of Losses, Temperature Rise Test, and Retardation Tests. Factory Tests -Gap Length, Magnetic Eccentricity, Balancing Vibrations, Bearing Performance.	**8 hrs** .
Module III **Induction Motor:** Specifications. Installation- Location of Motors and its Control Apparatus, Shaft Alignment for Various Coupling, Fitting of Pulleys and Coupling, Drying of Windings. Commissioning Tests -Mechanical Tests For Alignment, Air Gap Symmetry, Tests for Bearings, Vibrations and Balancing. Specific Tests - Performance and Temperature Raise Tests, Stray Load Losses, Shaft Alignment, Re-Writing and Special Duty Capability, Site Test	**8 hrs**
Module IV **Laying of Underground Cables:** Inspection, Storage, Transportation and Handling of Cables, Cable Handing Equipment, Cable Laying Depths and Clearances from other Services such as Water Sewerage, Gas, Heating and other Mains, Series of Power and Telecommunication Cables and Coordination with these Services, Excavation of Trenches, Cable Jointing and Terminations Testing and Commissioning. Location of Faults using Megger, Effect of Open or Loose Neutral Connections, Provision of Proper Fuses on Service Lines and Their Effect on System, Causes and Dim, and Flickering Light.	**9 hrs** .
Module V **Switchgear and Protective Devices:** Standards, Types, Specification, Installation, Commissioning Tests, Maintenance Schedule, Type and Routine Tests. **Domestic Installation:** Introduction, Testing of Electrical Installation of a Building, Testing of Insulation Resistance to Earth, Testing of Insulation and Resistance between Conductors Continuity or Open Circuit Test, Short Circuit Test, Testing of Earthing Continuity, Location of Faults, IE Rules for Domestic Installation	**9 hrs**
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	

Reference Books:

1. Testing, Commissioning, Operation and Maintenance of Electrical Equipment S. Rao Khanna Publishers 6 th Edition, 19th Reprint, 2015
2. Testing and Commissioning of Electrical Equipment R.L.Chakrasali Prism Books Pvt Ltd 1 st Edition,2014
3. Preventive Maintenance of Electrical Apparatus S.K.Sharotri Katson Publishing House 1st Edition, 1980
4. Handbook of Switchgears BHEL McGraw Hill 1 st Edition, 2005
5. Transformers BHEL McGraw Hill 1 st Edition, 2003
6. The J&P Transformer Book Martin J. Heathcote Newnes 12th Edition, 1998

Course outcomes: **On completion of the course, the student will have the ability to:**		
Course Code	**CO**	**Course Outcome (CO)**
19EE822	CO1	To Describe the process to plan, control and implement commissioning of electrical equipment's.
	CO2	To Differentiate the performance specifications of transformer and induction motor.
	CO3	To Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
	CO4	To Describe corrective and preventive maintenance of electrical equipment's.
	CO5	To Explain the operation of electrical equipment's such as isolators, circuit breakers, induction motor and synchronous machines.

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	1			1		2		1	2	1	1	1	2	
2	CO2	3	1			1		2		1	2	1	1	1	2	
3	CO3	3	1			1		2		1	2	1	1	1	2	
4	CO4	3	1			1		2		1	2	1	1	1	2	
5	CO5	3	1			1		2		1	2	1	1	1	2	
		3	**1**			**1**		**2**		**1**	**2**	**1**	**1**	**1**	**2**	

Course Title: Smart Grid Technology			
Course Code	19EE823	Credits:3	CIE: 50

Number of Lecture Hours/Week	**3Hrs (Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Pre-requisites: Electrical Distribution Systems, Power Systems

Course Objectives:

To understand various aspects of smart grid
- To study various smart transmission and distribution technologies
- To appreciate distribution generation and smart consumption
- To know the regulations and market models for smart grid

Modules	Teaching Hours
Module- I Introduction to Smart Grids: Definition, justification for smart grids, smart grid conceptual model, smart grid architectures, Interoperability, communication technologies, role of smart grids standards, intelligrid initiative, national smart grid mission (NSGM) by Govt. of India.	**07 Hrs**
Module-II Smart Transmission Technologies: Substation automation, Supervisory control and data acquisition (SCADA), energy management system (EMS), phasor measurement units (PMU), Wide area measurement systems (WAMS).	**09 Hrs**
Module-III Smart Distribution Technologies: Distribution automation, outage management systems, automated meter reading (AMR), automated metering infrastructure (AMI), fault location isolation and service restoration (FLISR), Outage Management Systems (OMS), Energy Storage, Renewable Integration.	09 Hrs
Module-IV Distributed Generation and Smart Consumption: Distributed energy resources (DERs), smart appliances, low voltage DC (LVDC) distribution in homes / buildings, home energy management system (HEMS), Net Metering, Building to Grid B2G,	**08 Hrs**

Vehicle to Grid V2G, Solar to Grid, Microgrid.	
Module-V Regulations and Market Models for Smart Grid: Demand Response, Tariff Design, Time of the day pricing (TOD), Time of use pricing (TOU), Consumer privacy and data protection, consumer engagement etc. Cost benefit analysis of smart grid projects.	**09 Hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text Books:

1. Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response"-CRC Press, 2009.
2. Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley-ISTE, IEEE Press, May 2012.

References:

1.Janaka Ekanayake, Kithsiri Liyanage, Jianzhong. Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"-Wiley, 2012.
2. James Momoh, "Smart Grid: Fundamentals of Design and Analysis" - Wiley, IEEE Press,2012.
3. India Smart Grid Knowledge Portal

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	Blooms Level
19EE823	CO1	Understand technologies for smart grid	
	CO2	Appreciate the smart transmission as well distribution systems	
	CO3	Realize the distribution generation and smart consumption	
	CO4	Know the regulations and market models for smart grid	
	CO5		

Course Articulation Matrix for the Academic Year 2022-23

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3					2					

CO2	3						2					
CO3	3	3					2					
CO4	3						2	2				2

Course Title: **Python**			
Course Code	19OE831	Credits:3	CIE: 50
Number of Lecture Hours/Week	3 hrs.(Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:
1. Knowledge of Computer Basics C Language is needed
2. Knowledge of C++ is needed

Course Objectives:

1. To study Python Syntax, semantics and functions.
2. To understand about strings and file handling.
3. To implement the python programs.
4. To study the concept of OOPs used in python.
5. To implement the applications of Python.

Modules	**Teaching Hours**
Module I Why should you learn to write programs, Variables, expressions and statements, Conditional execution, Functions	**08 Hours**
Module II Iteration, Strings, Files	**08 Hours**
Module III Lists, Dictionaries, Tuples, Regular Expressions	**08 Hours**

Module IV Classes and objects, Classes and functions, Classes and methods.	**08 Hours**
Module V Networked programs, Using Web Services, Using databases and SQL	**08 Hours**

Question paper pattern: Two questions from each module will be set. The student has to answer five full questions, selecting at least one full question from each module.

Reference Books:

Reference Books:

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, "Core Python Applications Programming", 3rdEdition,Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, "Data Structures and Algorithms in Python",1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. ReemaThareja, "Python Programming using problem solving approach", Oxford university press, 2017

Text Books:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck. com/pythonlearn/EN_us/pythonlearn.pdf) (Chapters 1 – 13, 15)

2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2ndEdition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 15, 16, 17)(Download pdf files from the above links).

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)
19OE	CO1	Understand Python syntax and semantics and be fluent in the use of Python flow control and functions.
	CO2	Demonstrate proficiency in handling Strings and File Systems.
	CO3	Implement Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions.
	CO4	Interpret the concepts of Object-Oriented Programming as used in Python.

	CO5	Implement exemplary applications related to Network Programming, Web Services and Databases in Python

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											1	3		
2	CO2	3	2										1	3	2	2
3	CO3	3		2									1	3	2	2
4	CO4	3		1									1	3	2	2
5	CO5	3											1	3	2	2

Course Title: **Object Oriented Programming**			
Course Code	19OE831	Credits:3	CIE: 50
Number of Lecture Hours/Week	3 hrs.(Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:
1. Knowledge of Computer Basics C Language is needed
2. Knowledge of C++ is needed

Course Objectives:

1. To study the OOPs programming
2. To understand the Java Pragramming.
3. To implement Classes, inheritance, and exception handling.
4. To study the packages, interfaces and multithreading.
5. To implement the event handling and swings.

Modules	**Teaching Hours**
Module I	

Introduction to Object Oriented Concepts: A Review of structures, Procedure–Oriented Programming system, Object Oriented Programming System, Comparison of Object Oriented Language with C, Console I/O, variables and reference variables, Function Prototyping, Function Overloading. **Class and Objects:** Introduction, member functions and data, objects and functions. Text book 1: Ch 1: 1.1 to 1.9 Ch 2: 2.1 to 2.3 RBT: L1, L2	**08 Hours**
Module II **Class and Objects (contd):** Objects and arrays, Namespaces, Nested classes, Constructors, Destructors. **Introduction to Java:** Java's magic: the Byte code; Java Development Kit (JDK); the Java Buzzwords, Object-oriented programming; Simple Java programs. Data types, variables and arrays, Operators, Control Statements. Text book 1:Ch 2: 2.4 to 2.6Ch 4: 4.1 to 4.2 Text book 2: Ch:1 Ch: 2 Ch:3 Ch:4 Ch:5 RBT: L1, L2	**08 Hours**
Module III **Classes, Inheritance, Exception Handling:** Classes: Classes fundamentals; Declaring objects; Constructors, this keyword, garbage collection. **Inheritance:** inheritance basics, using super, creating multi level hierarchy, method overriding. **Exception handling:**	**08 Hours**

Exception handling in Java. Text book 2: Ch:6 Ch: 8 Ch:10 RBT: L1, L2, L3	
Module IV **Packages and Interfaces:** Packages, Access Protection, Importing Packages. Interfaces. **Multi Threaded Programming:** Multi Threaded Programming: What are threads? How to make the classes threadable ; Extending threads; Implementing runnable; Synchronization; Changing state of the thread; Bounded buffer problems, producer consumer problems. Text book 2: CH: 9 Ch 11: RBT: L1, L2, L3	**08 Hours**
Module V **Event Handling:** Two event handling mechanisms; The delegation event model; Event classes; Sources of events; Event listener interfaces; Using the delegation event model; Adapter classes; Inner classes. **Swings:** Swings: The origins of Swing; Two key Swing features; Components and Containers; The Swing Packages; A simple Swing Application; Create a Swing Applet; Jlabel and ImageIcon; JTextField;The Swing Buttons; JTabbedpane; JScrollPane; JList; JComboBox; JTable. Text book 2: Ch 22: Ch: 29 Ch: 30 RBT: L1, L2, L3	**08 Hours**
Question paper pattern: Two questions from each module will be set. The student has to answer five full questions, selecting at least one full question from each module.	
Textbooks: 1. Sourav Sahay, Object Oriented Programming with C++ , 2nd Ed, Oxford University Press,2006 2. Herbert Schildt, Java The Complete Reference, 7th Edition, Tata McGraw Hill, 2007.	

Reference Books:

1. Mahesh Bhave and Sunil Patekar, "Programming with Java", First Edition, Pearson Education,2008, ISBN:9788131720806

2. Herbert Schildt, The Complete Reference C++, 4th Edition, Tata McGraw Hill, 2003.

3. Stanley B.Lippmann, Josee Lajore, C++ Primer, 4th Edition, Pearson Education, 2005.

4. Rajkumar Buyya,S Thamarasi selvi, xingchen chu, Object oriented Programming with java, Tata McGraw Hill education private limited.

5. Richard A Johnson, Introduction to Java Programming and OOAD, CENGAGE Learning.

6. E Balagurusamy, Programming with Java A primer, Tata McGraw Hill companies.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)
19OE	CO1	Understand the concept of OOPs programing
	CO2	Explain the concept of Java Programming
	CO3	Implement the Classes, inheritance and exception handling.
	CO4	Study the concept of packages, interfaces and multithreading
	CO5	Use event handling and swings.

S.No.	PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3

Course Articulation Matrix for the Academic Year 2022-23

1	CO1	3														
2	CO2	3	2		1											
3	CO3	3	2													
4	CO4	3	1		1											
5	CO5	3														

Course Title: INTERNET OF THINGS			
Course Code	19OE832	Credits:3	CIE: 50
Number of Lecture Hours/Week	**3Hrs (Theory)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03
Pre-requisites: Basic electronics, embedded systems, sensors and networking , C and python programming			

Course Objectives:

1.To Understand State of the Art - IoT Architecture.

2.To classify Real World IoT Design Constraints, Industrial Automation in IoT.

Modules	Teaching Hours
Module - I **What is IoT :** What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures.	**08 Hrs**
Module - II **A Simplified IoT Architecture**: The Core IoT Functional Stack, IoT Data Management and Compute Stack. **Smart Objects:** Sensors, Actuators, and Smart Objects: Sensor, Sensor types, Actuators and classification of actuators, Micro-Electro-Mechanical systems (MEMS), Smart Objects: Trends in smart objects. Sensor Networks, Wireless sensor networks.	**09 Hrs**
Module - III **Connecting Smart Objects**: Communications Criteria: Range, Frequency bands, Powe consumption, Topology, Constrained devices, Constrained-node networks. IoT Access Technologies: 802.16.4, 802.16.4g, 802.16.4e, IEEE1901.2a, IEEE802.11ah, LoRaWAN, NB-IoT and other LTE versions, LTE Cat, LTE-M.	**09 Hrs**
Module - IV **IP as the IoT Network Layer**: The Business Case for IP, Adoption of the internet protocol, The need for Optimization: Constrained nodes, IP Versions, Optimizing IP for IoT. Profiles and compliences. **Application protocols for IoT**: The transport layer, IoT application transport methods.	**08 Hrs**
Module - V **IoT Physical Devices and Endpoints** - Introduction to Arduino, Exploring Arduino UNO Learning board, Installing the Software, Fundamentals of Arduino Programming. Fundamentals of Arduino UNO Programming, Introduction to communications,	**08 Hrs**

Example modules on Arduino.	

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of

   Things", 1 Edition, Pearson. 2017 (Chapters 1 to 6 for Modules 1 to 4).

2. Srinivasa K G, Siddesh G.M. and Hanumantha Raju R. "Internet of Things", CENGAGE Leaning India, 2017 (Chapter 7).

Reference Books:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands -on-Approach)", 1 st Edition, VPT, 2014.

2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1 Edition, McGraw Hill Education, 2017.

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	Blooms Level
19EE832	CO1	Discuss IoT technology, challenges, network architecture, IoT stack and its data management.	**L2**
	CO2	Describe IoT sensors, actuators, smart objects, sensor networks, IoT access technologies.	**L4**
	CO3	Identify and explain need for optimizing IP for IoT, application protocols for IoT and Transport layer.	**L4**
	CO4	Describe Big data Analytics , Machine Learning and IoT security.	**L2**
	CO5	Demonstrate different IoT devices and end points, IoT hardware, IoT programming and constructing IoT applications.	**L4**

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3

	CO															
1	CO1	3											2	3		1
2	CO2	3	3										2	3	3	1
3	CO3	3	2										2	3	3	1
4	CO4	3		3									2	3		1
5	CO5	3											2	3		1
6	CO6	3											2	3		**1**
		3	**2.5**	**3**									**2**	**3**	**3**	**1**

Course Title: Energy Conservation and Audit			
Course Code	19OE833	Credits:3	CIE: 50
Number of Lecture Hours/Week	**3Hrs (Theory)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03
Pre-requisites:			
Course Objectives:			

Modules	**Teaching Hours**
Module- I Introduction to Energy Conservation: Principles, Past and present energy scenario of world, Energy consumption in India, resource availability, Demand supply gap, Environmental aspects, Energy Conservation act, Standards and labeling, designated consumers.	**07 Hrs**

Module-II Energy Conservation in Thermal Systems: Steam systems, Boilers, blow down control, furnaces, thermic fluid eaters, steam traps, insulators and refractories, cooling tower, air pressure control, waste heat recovery, cogeneration.	**09 Hrs**
Module- III Energy Conservation in Electrical Systems: Components of EB billing, types of tariff, HT and LT supply, Transformers, cable selection, power factor improvement, capacitors, harmonics electric motors, efficiency, energy efficient motors, variable speed drives, lighting, types, efficacy, LED.	**09 Hrs**
Module- IV Energy Conservation in Industries: Pumps, fans, blowers, compressed air systems, refrigeration and air conditioning systems, cooling towers, DG sets.	**08 Hrs**
Module-V Energy Audit and Energy Economics: Energy audit, need, types, benefits, methodology and barriers, role of energy managers, instruments for energy auditing; Energy economics, discount rate, depreciation cost, payback period, internal rate of return, net present value, life cycle costing, case study.	**09 Hrs**
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Reference Books: 1. Kennedy, William J., Turner, Wayne C., &Capehart, Barney L., Guide to Energy Management, The Fairmount Press 2. Callaghan, P.W., Design and Management for Energy Conservation", Pergamon Press, Oxford **Reference Books:** 1. Dryden, I.G.C., The Efficient Use of Energy, Butterworths, London 2. Turner, W.C., Energy Management Handbook, Wiley, New York (1982) 3. Energy Manager Training Manual (www.energymanagertraining.com)	

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	Blooms Level
	CO1	Identify the energy demand supply gap in the World & India and understand energy conservation opportunities available	

19EE832			
	CO2	Quantify the energy conservation opportunities in different thermal systems	
	CO3	Quantify the energy conservation opportunities in different electrical systems	
	CO4	Identify and evaluate the common energy conservation opportunities in different energy intensive industrial equipments	
	CO5	Understand the need for energy audit and examine the economic evaluation of energy conservation solutions adopted	

Course Articulation Matrix for the Academic Year 2022-23

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1					3					2
CO2	3	3										2
CO3	3	3										2
CO4	3	3										2
CO5	3	3			1							2