



# NEW HORIZON COLLEGE OF ENGINEERING

New Horizon Knowledge Park, Ring Road, Marathalli  
Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC  
Accredited by NAAC with 'A' Grade. Accredited by NBA



**Department of Electrical and Electronics Engineering**

Academic Year 2020-2021

Seventh and Eighth Semester

Scheme and Syllabus

**Department of Electrical & Electronics Engineering**

**Academic Year 2020-21**

**Seventh and Eighth Semesters B.E**

**Scheme and Syllabus**

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## **VISION**

To evolve into a centre of excellence in Electrical and Electronics Engineering for bringing out contemporary Engineers, Innovators, Researchers and Entrepreneurs for serving nation and society.

## **MISSION**

- To provide suitable forums to enhance the teaching-learning, research and development activities.
- Framing and continuously updating the curriculum to bridge the gap between industry and academia in the contemporary world and serve society.
- To inculcate awareness and responsibility towards the environment and ethical values.

## **PROGRAM EDUCATIONAL OBJECTIVES (PEO's):**

**PEO1:** To provide good learning environment to develop entrepreneurship capabilities in various areas of Electrical and Electronics Engineering with enhanced efficiency, productivity, cost effectiveness and technological empowerment of human resource.

**PEO2:** To inculcate research capabilities in the areas of Electrical and Electronics Engineering to identify, comprehend and solve problems and adopt themselves to rapidly evolving technology.

**PEO 3:** To create high standards of moral and ethical values among the graduates to transform them as responsible citizens of the nation.

## **PROGRAM SPECIFIC OUTCOMES (PSO's):**

**PSO 1:** Graduates will be able to solve real life problems of power system and power Electronics using MiPower, PSPICE and MATLAB software tools and hardware.

**PSO 2:** Graduates will be able to Develop & support systems based on Renewable and sustainable Energy sources.

### **PEOs to Mission statement mapping**

PEO'S	MISSION OF THE DEPARTMENT		
	M1	M2	M3
PEO1	3	3	1
PEO2	2	3	2
PEO3	1	2	3

### **Program Outcomes (PO) with Graduate Attributes**

S.No	Graduate Attributes	Program Outcomes (POs)
1	Engineering Knowledge	PO1: Able to understand the fundamentals of mathematics, science, Electrical and Electronics Engineering and apply them to the solution of complex engineering problems.
2	Problem Analysis	PO2: Ability to identify, formulate and analyze real time problems in Electrical and Electronics Engineering.
3	Design and Development of Solutions	PO3: Design solutions for complex engineering problems, that meet the specified needs and to interpret the data.
4	Investigation of Problem	PO4: Use research based knowledge and research methods to provide valid solutions for complex problems in Electrical and Electronics Engineering.
5	Modern Tool usage	PO5: Apply appropriate tools techniques for modeling, analyzing and solving Electrical and Electronics Engineering devices & systems.
6	Engineer and society	PO6: To give basic knowledge of social, economical, safety and cultural issues relevant to professional engineering.
7	Environment and sustainability	PO7: To impart knowledge related to the design and development of modern systems which are environmentally sensitive and to understand the importance of sustainable development.

8	Ethics	PO8: Apply ethical principles and professional responsibilities in engineering practice.
9	Individual & team work	PO9: Ability to visualize and function as an individual and as a member in a team of a multi-disciplinary environment.
10	Communication	PO10: Ability to communicate effectively complex engineering ideas to the engineering community & the society at large.
11	Lifelong learning	PO11: To impart education to learn and to engage in independent and life – long learning in the technological change.
12	Project management and finance	PO12: Ability to handle administrative responsibilities, manage projects & handle finance related issues in a multi-disciplinary environment.

**New Horizon College of Engineering**  
**Department of Electrical and Electronics Engineering**  
**Scheme of Seventh Semester B.E Program**

S. No	Course Code	Course	Credit Distribution				Overall Credits	Contact Hours Weekly (Theory)	Contact Hours Weekly (Lab)	Marks		
			L	T	P	S				CIE	SEE	Total
1	EEE71	Computer Aided Power System Analysis	3	0	2	0	5	4	3	75	75	150
2	EEE72	Advanced Industrial and Building Automation	3	0	2	0	5	4	3	75	75	150
3	EEE73X	Professional Elective -III	3	0	0	0	3	4	0	50	50	100
4	EEE74X	Professional Elective –IV	3	0	0	0	3	4	0	50	50	100
5	20NHOP X	Open Elective II	3	0	0	1	4	3	0	50	50	100
6	EEE75	Project Phase I	0	0	2	0	2	--	--	50	50	100
<b>TOTAL</b>							<b>22</b>	<b>19</b>	<b>06</b>	<b>350</b>	<b>350</b>	<b>700</b>

Professional Elective III		
SI No	Course Code	Course
1	EEE731	Electrical vehicles and Drives
2	EEE732	FACTS and HVDC transmission
3	EEE733	Testing and Commissioning of electrical equipment
4	EEE734	Energy Auditing and Demand side Management

Professional Elective IV		
SI No	Course Code	Course
1	EEE741	Utilization of Electrical Energy
2	EEE742	Power System Operation and Control
3	EEE 743	Solar Electric Systems
4	EEE 744	Artificial Neural network and Fuzzy logic

**New Horizon College of Engineering**  
**Department of Electrical and Electronics Engineering**  
**Scheme of Eighth Semester B.E Program**

S. No	Course Code	Course	Credit Distribution				Overall Credits	Contact Hours Weekly (Theory)	Contact Hours Weekly (Lab)	Marks		
			L	T	P	S				CIE	SEE	Total
1	EEE81XA	Professional Elective –V	3	0	0	1	4	4	0	50	50	100
2	EEE82X	Professional Elective –VI	3	0	0	1	4	4	0	50	50	100
3	EEE83	Internship	0	0	4	0	4	-	-	50	50	100
4	EEE84	Project Phase II	0	0	10	0	10	--	--	50	50	100
<b>TOTAL</b>							<b>22</b>	<b>8</b>	<b>0</b>	<b>200</b>	<b>200</b>	<b>400</b>

<b>Professional Elective V</b>		
SI No	Course Code	Course
1	EEE811A	Estimation and Costing of electrical systems
2	EEE812A	Smart Grid Technologies
3	EEE813A	Power Quality
4	EEE814A	Integration of distributed generation
<b>Professional Elective VI</b>		
SI No	Course Code	Course
1	EEE821	Solar Photo voltaic Fundamentals, Technologies and Applications
2	EEE822	Simulation of Power Electronics
3	EEE823	Biomedical Instrumentation
4	EEE824	Applications of IoT in Electrical Engineering

### INDUSTRIAL OPEN ELECTIVE

S.NO	INDUSTRIAL OPEN ELECTIVE	OFFERING DEPARTMENT
1	Big-Data Analytics using HP Vertica-1	CSE
2	VMWARE Virtualization Essentials -1	ISE
3	Big-Data Analytics using HP Vertica-2	ISE
4	SAP	ME
5	Schneider - Industrial Automation	EEE
6	Routing and Switching -1	ECE
7	Data Analytics	CSE
8	Machine learning	ME
9	Industrial IOT-Embedded systems	ECE
10	Block Chain	CSE

**Seventh Semesters B.E  
Syllabus**

## COMPUTER AIDED POWER SYSTEM ANALYSIS

Course Code : EEE71  
 L:T:P:S : 3:0:2:0  
 Exam Hours : 03

Credits : 03+02  
 CIE Marks : 50+25  
 SEE Marks : 50+25

**Course Outcomes: At the end of the Course, the Student will be able:**

<b>CO1</b>	Get introduced to various network topology and compare the same with practical power system network
<b>CO2</b>	Evaluate network matrices for power system using prevailing methods
<b>CO3</b>	Conduct the load flow analysis of typical power system network using conventional algorithms
<b>CO4</b>	Understand importance of economic operation of the power system
<b>CO5</b>	Develop mathematical models for power system using dedicated software tools and thus analyze power system stability.
<b>CO6</b>	Apply numerical techniques for power system stability studies using dedicated software tools.

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3	2	2	2	2	1	1	1	1	2	2
<b>CO2</b>	3	3	2	2	2	2	1	1	1	1	2	2
<b>CO3</b>	3	3	2	2	2	2	1	1	1	1	2	2
<b>CO4</b>	3	3	2	2	2	2	1	1	1	1	2	2
<b>CO5</b>	3	3	2	2	2	2	1	1	1	1	2	2
<b>CO6</b>	3	2	2	2	2	2	1	1	1	1	2	2

### SYLLABUS

Module.	Contents of Module	Hrs	Cos
<b>1</b>	<p><b>NETWORK TOPOLOGY:</b> Introduction, Elementary graph theory – oriented graph, tree, co-tree, basic cut-sets, basic loops; Incidence matrices – Element-node, Bus incidence, Tree-branch path, Basic cut-set, Augmented cut-set, Basic loop and Augmented loop, Primitive network – impedance form and admittance form</p> <p><b>NETWORK MATRICES:</b> Introduction, Formation of YBUS by method of inspection (including transformer off-nominal tap setting) and method of singular transformation (<math>YBUS = A^T yA</math>), Formation of</p>	9	CO1 CO2 CO5

	Bus Impedance matrix by step by step building algorithm (without mutual coupling elements).		
	<p><b>List of Experiments</b></p> <ol style="list-style-type: none"> <li>1. Y Bus formation for power systems with and without mutual coupling, by singular transformation and inspection method.</li> <li>2. Determination of bus currents, bus power and line flow for a specified system voltage (Bus) Profile.</li> <li>3. Formation of Z-bus(without mutual coupling) using Z-bus building Algorithm .</li> </ol>	9	
2	<p><b>LOAD FLOW STUDIES:</b> Introduction, Power flow equations, Classification of buses, Operating constraints, Data for load flow-modeling of power system components (Load, Shunt elements, Transformer, Generator).</p> <p><b>LOAD FLOW TECHNIQUES:</b> Gauss-Seidal Method – Algorithm and flow chart for PQ and PV buses (numerical problem for one iteration only), Acceleration of convergence; Newton Raphson’s Method-Algorithm and flow chart for NR method in polar coordinates (numerical problem for one iteration only). Algorithm for Fast Decoupled load flow method, Comparison of Load Flow Methods.</p>	9	C03 C05
	<p><b>List of Experiments</b></p> <ol style="list-style-type: none"> <li>1. Write a program to perform load flow analysis using Gauss-Seidel method (both PQ and PV bus).</li> <li>2. Formation of Jacobian for a system not exceeding 4 buses (no PV buses) in polar coordinates.</li> <li>3. Load flow analysis using Gauss Siedel method, NR method, Fast decoupled method for both pq and pv buses using MiPower.</li> </ol>	9	
3	<p><b>ECONOMIC OPERATION OF POWER SYSTEM:</b> Introduction(Performance curves), Economic generation scheduling neglecting losses and generator limits, Economic generation scheduling including generator limits and neglecting losses; Iterative techniques; Economic Dispatch including transmission losses- iterative technique for solution of economic dispatch with losses; Derivation of transmission loss formula- along with Problems.</p> <p><b>HYDROTHERMALCOORDINATION:</b> Indroduction, Optimal scheduling for Hydrothermal plants – problem formulation, solution procedure and algorithm (excluding problems).</p>	9	C03 C04

	<b>List of Experiments</b> <b>1.</b> Optimal Generation Scheduling for Thermal power plants.	6	
4	<b>TRANSIENT STABILITY STUDIES.A:</b> Dynamics of synchronous machine-Swing Equation, Numerical Techniques for solving Swing Equation – Point-by-point method, Modified Euler’s method, Runge-Kutta method, Milne’s predictor corrector method.  <b>TRANSIENT STABILITY STUDIES.B:</b> Representation of power system for transient stability studies – load representation, network performance equations. Solution techniques with flow charts, numerical on Modified Euler’s method, Runge-Kutta method, Milne’s predictor corrector method.	9	C04 C05 CO6
	<b>List of Experiments</b> <b>1.</b> To obtain swing curve and to determine critical clearing time and regulation for a single machine connected to infinity bus through a pair of identical transmission lines under 3-phase fault on one of the lines for variation of inertia constant/line parameters /fault location/clearing time/pre-fault electrical output using Point by Point method. <b>2.</b> To obtain swing curve and to determine critical clearing time and regulation for a single machine connected to infinity bus through a pair of identical transmission lines under 3-phase fault on one of the lines for variation of inertia constant/line parameters /fault location/clearing time/pre-fault electrical output using Runge-Kutta method.	9	
5	<b>CASE STUDY:</b> Simulation of standard systems and thus conduct load flow analysis, performance analysis(with respect to transmission efficiency, voltage regulation),Stability analysis( both Steady state, transient analysis) using specific tools	9	C03 C05 CO6
	<b>List of Experiments</b> <b>1.</b> ABCD parameters: Formation for symmetric $\pi$ /T configuration. Verification of $AD-BC=1$ Determination of efficiency and regulation <b>2.</b> Determination of power angle diagrams, reluctance power, excitation, emf and regulation for salient and non-salient pole synchronous machines.	9	

**Text books**

1. Modern Power System Analysis- I J Nagarath and D P Kothari, TMH, 3rd Edition, 2015.
2. Computer Methods in Power System Analysis, Stag and El-Abiad, McGraw Hill International, 2<sup>nd</sup> edition ,2014.
3. Computer Techniques in Power System, M.A.Pai, Tata McGraw Hill,2<sup>nd</sup> edition,2014.

**Reference Books:**

1. Power system Analysis & Design, Glover Sarma, Thomson Learning,3<sup>rd</sup> edition,2013
2. Advanced Power System and Dynamics, L.P.Singh, Wiley Eastern, 2015.
3. Computer Techniques in Power System Operation &Control, R.N.Dhar, McGraw Hill Companies,1<sup>st</sup> edition, 2012.

**Assessment Pattern****Implementation of Bloom's Taxonomy in CIE- Theory (50 Marks) and Lab (25 Marks)**

Blooms levels	CIE – Theory (50 Marks)			Lab (25 Marks)
	Test = 25	Assignment = 15	Quiz = 10	Examination = 25
Remember	3	-	2	5
Understand	6	5	2	-
Apply	7	5	2	5
Analyze	3	5	2	10
Evaluate	6		2	5
Create	-	-		-

**SEE - Theory (50 Marks) and Lab (25 Marks)**

Blooms levels	SEE - Theory	Lab
	Examination = 50	Examination = 25
Remember	10	2
Understand	5	5
Apply	10	8
Analyze	10	4
Evaluate	15	6
Create	-	-

## ADVANCED INDUSTRIAL AUTOMATION AND BUILDING AUTOMATION

Course Code : EEE72  
 L:T:P:S : 3:0:2:0  
 Exam Hours : 03

Credits : 03+02  
 CIE Marks : 50+25  
 SEE Marks : 50+25

**Course Outcomes: At the end of the Course, the Student will be able to:**

<b>CO1</b>	Understand the architecture of an advanced industrial automation system and SCADA
<b>CO2</b>	Analyse and configure connections between elements of an advanced or a building automation system.
<b>CO3</b>	Analyse and configure the fire alarm system the components
<b>CO4</b>	Analyse and configure connections of CCTV and access control system
<b>CO5</b>	Understand the various security system for home automation
<b>CO6</b>	Design and Develop a basic CBUS application for building application management.

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2	2	3	3	2	1	-	2	2	2	3
<b>CO2</b>	3	3	3	3	3	2	2	1	1	3	3	3
<b>CO3</b>	3	3	3	3	3	2	2	1	2	3	3	3
<b>CO4</b>	3	3	3	3	3	2	2	1	2	3	3	3
<b>CO5</b>	3	2	2	3	3	2	1	-	1	3	2	3
<b>CO6</b>	3	3	3	3	3	3	2	1	2	2	3	3

Module	Contents of the Module	Hours	COs
1	<p><b>Introduction to Advanced PLC and SCADA:</b> Need of SCADA systems, features of SCADA, Block diagram of SCADA, Function of SCADA, Network Protocols, Protocol standards, Serial Communication – Device Net – Control Net – EthernetRS232, RS48, Modbus – Fieldbus – Probus – Subnetting – Subnet mask - File transfer protocol.</p>	9	CO1
	<p><b>List of Experiments</b> 1.PLC interface to SCADA using communication links RS232, RS48s and protocols (Modbus ASCII RTU), 2.Advanced PLC applications, 3. SCADA Applications using energy management system (drives..,) Application with Citect SCADA.</p>		
2	<p><b>Introduction to Building management system and energy management systems:</b> Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.-Functions of EMS and Block diagram of EMS</p>	9	CO2 , CO6
	<p><b>List of Experiments</b> 1.Design of a EMS and BMS, 2. Configuration of a EMS and BMS, Applications with Schneider Software.</p>		
3	<p><b>Fire alarm systems:</b> Applications, FAS architecture: Types of Architecture and Examples. Fire Alarm System Devices and Standards <b>Practical activities:</b> Fire- Fire Alarm System-The History, Need for Fire Alarm System, Basic Fire Alarm System, Classification of Fire Alarm System, Conventional Fire Alarm System, Addressable Fire Alarm System, Principles of Operations, Panel Components, Its</p>	9	CO3
	<p><b>List of Experiments</b> 1.Design of a fire alarm system, 2. Configuration of a fire alarm system, Applications with Schneider control panel and software tools.</p>		

4	<p><b>CCTV and access control systems:</b>  Access Components, Access control system Design and Standards. CCTV: Camera: Operation &amp; types, Camera Selection Criteria, Camera Applications, DVR Based system, DVM, Network design, Storage design. Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system Standards.</p>	9	CO4
	<p><b>List of Experiments</b>  1.Design of a basic CCTV and access control system,  2.Configuration of a basic CCTV and access control system, Applications with Schneider control panel and software tools</p>		
5	<p><b>Home automation systems:</b>  Home automation system necessity-block diagram of home automation system-Introduction to Security Systems, Concepts-Components, Technology, Advanced Applications. Security Design-Concept of automation in access control system for safety, Physical security system with components, RFID enabled access control with components - Standards for communication: CBUS – KNX.</p>	9	CO5, CO4
	<p><b>List of Experiments</b>  1.Design of a basic CCTV and access control system,  2.Configuration of a basic CCTV and access control system, Applications with Schneider software tools</p>		

**Text Books:**

1. Intelligent Building Systems by Albert Ting-Pat So, WaiLok Chan, Kluwer Academic publisher,3rd ed., 2012
2. PLCs & SCADA: Theory and Practice by Rajesh Mehra, edition2018
3. Design of Special Hazards and Fire Alarm Systems by Robert Gagnon, Thomson Delmar Learning; 2nd edition, 2007.
4. Energy Management Handbook, Turner, W. C, 5 th Edition, 2004
5. Energy Management Systems, Handschin, E., Springer Verlag, 1990.

**Reference books:**

1. The High Performance HMI Handbook, by Bill Hollifield ,Dana Oliver, Ian Nimmo ,Eddie Habibi, 1st Edition
2. Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs) by Reinhold A. Carlson, Robert A. Di Giandomenico, pub. by R.S. Means Company, 1991

**Assessment Pattern**

**Implementation of Bloom's Taxonomy in CIE- Theory (50 Marks) and Lab (25 Marks)**

Blooms levels	CIE – Theory (50 Marks)			Lab (25 Marks)
	Test = 25	Assignment = 15	Quiz = 10	Examination = 25
Remember	5	2	2	-
Understand	6	4	2	5
Apply	5	6	2	5
Analyze	-	3	2	5
Evaluate	-	-	2	5
Create	9	-	-	5

**SEE - Theory (50 Marks) and Lab (25 Marks)**

Blooms levels	SEE - Theory	Lab
	Examination = 50	Examination = 25
Remember	5	-
Understand	10	5
Apply	10	8
Analyze	10	4
Evaluate	5	4
Create	10	4

**PROFESSIONAL ELECTIVE -III**

**ELECTRIC VEHICLES AND DRIVES**

**Course Code : EEE731**

**L: T: P: S : 3:0:0:0**

**Exam Hours : 03**

**Credits: 03**

**CIE Marks: 50**

**SEE Marks: 50**

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Understand to architecture, different configuration of electric vehicles and vehicle dynamics
<b>CO2</b>	Understand various types of motors used in electric vehicles and energy sources that powers them
<b>CO3</b>	Apply mathematical concepts to understand the dynamics of electrical drives
<b>CO4</b>	Analyze load requirement to select the motor power rating
<b>CO5</b>	Analyze various types of electrical drives to meet the requirement of electrical vehicles
<b>CO6</b>	Analyze need of electric vehicle and its environmental impact

**Mapping of Course Outcomes to Program Outcomes:**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	3	1	1	1	1	3	3	2	1	1	2	3
<b>CO2</b>	3	1	1	1	1	3	3	2	1	1	2	3
<b>CO3</b>	3	3	3	1	2	3	2	2	1	1	2	3
<b>CO4</b>	3	3	3	1	2	3	3	2	1	1	2	3
<b>CO5</b>	3	3	3	1	2	3	3	2	1	1	2	3
<b>CO6</b>	3	1	1	1	1	3	3	3	3	1	2	3

Module No	Module Contents	Hours	COs
1	<p><b>INTRODUCTION TO ELECTRIC VEHICLES:</b> History of Electric vehicle, Definition vehicle, Need of electric vehicle, Architecture of Electric Vehicle, Configuration of Electric vehicle</p> <p><b>VEHICLE FUNDAMENTALS:</b> General description of vehicle movement, vehicle resistance, Dynamic equation, Tire ground adhesion and maximum traction effort, Power train tractive effort and vehicle speed, Vehicle performance, Breaking performance, Drive cycle.</p>	09	CO1, CO2
2	<p><b>ELECTRIC VEHICLE ENERGY SOURCES:</b> Electrochemical batteries, Electrochemical reaction, Thermodynamic voltage, Specific energy, specific power, energy efficiency, Battery technology, ultracapacitors, Flywheels.</p> <p><b>ELECTRIC VEHICLE MOTORS (CONSTRUCTIONS AND FEATURES ONLY):</b> Electric vehicle Motor requirements, Induction motor, DC Motors, Permanent Magnet Brushless DC motor, Switched Reluctance Motors, Stator Permanent Magnet Motor.</p>	09	CO3
3	<p><b>DYNAMICS OF ELECTRICAL DRIVES:</b> Fundamental Torque Equation, Speed torque convention and multi-quadrant operation, Equivalent values of Drive parameters, Components of load torque, Nature of classification of load torque, calculation of time and energy-loss in transient operation, Steady state stability.</p> <p><b>SELECTION OF MOTOR POWER RATINGS:</b> Thermal Model of motor for heating and cooling, Classes of Motor duty, Determination of Motor rating.</p>	09	CO4
4	<p><b>DC MOTOR DRIVES:</b> Starting, Braking, Transient Analysis, Speed control, Chopper-Controlled DC drives, Chopper control of separately excited DC motors, Chopper control of series motors, converter ratings and closed loop control.</p> <p><b>INDUCTION MOTOR DRIVES:</b> Starting, Braking, Transient Analysis, Speed Control, Analysis of Induction Motor fed from Non-sinusoidal voltage supply, variable frequency control from voltage source, voltage source inverter control, closed loop speed control of induction motor drives, current source inverter control.</p>	09	CO5
5	<p><b>SYNCHRONOUS MOTOR AND BRUSHLESS DC MOTOR DRIVES:</b> Synchronous Motor variable speed drives, Permanent magnet AC motor drives, Sinusoidal PMAC motor drives, Brushless DC motor drives.</p>	09	CO2, CO4, CO5,

	<b>SWITCHED RELUCTANCE MOTOR DRIVE:</b> Operation and control requirements, converter circuits, modes of operation, Case studies of different EVs.		
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**Text Books:**

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC, Press, 2010.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

**Reference Books:**

1. Power Electronics, M.H.Rashid, , Pearson, 3<sup>rd</sup> Edition, 2017.
2. Power Electronics – Converters, Applications and Design, Ned Mohan, Tore M. Undeland, and William P. Robins, Third Edition, John Wiley and Sons, 2011.
3. Power Electronics, Devices, Circuits and Industrial Applications, V.R. Moorthi, Oxford University Press, 2005

**Assessment Pattern**

**Implementation of Bloom’s Taxonomy in CIE (50 Marks)**

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10
Remember	4	-	-	-
Understand	4	-	1	-
Apply	9	5	1	10
Analyze	4	5	1	-
Evaluate	4	-	1	-
Create	-	-	1	-

**SEE - Theory (50 Marks)**

Blooms levels	SEE - Theory
	Examination = 50
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

## FACTS AND HVDC TRANSMISSION

Course Code : EEE732

Credits : 03

L: T: P: S : 3:0:0:0

CIE Marks : 50

Exam Hours : 03

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Learn the concept of power flow control through various power electronic controllers such as FACTS controllers, operational aspects and their capabilities and their integration in power flow analysis
<b>CO2</b>	Learn the method of shunt compensation by using static VAR compensators and their applications
<b>CO3</b>	Understand the working of STATCOM and UPFC.
<b>CO4</b>	Analyze different converter topologies viz. 3, 6 and 12 Pulse converters and understand it's control aspects.
<b>CO5</b>	Analyze different types of DC links and applications of DC transmission.
<b>CO6</b>	Understand the concepts of FACTS controllers and HVDC transmission

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2	3	2	2	2	2	-	-	1	1	2
<b>CO2</b>	3	2	3	2	2	2	2	-	-	1	1	2
<b>CO3</b>	3	2	3	2	2	2	2	-	-	1	1	2
<b>CO4</b>	3	2	3	2	2	2	2	-	-	1	1	2
<b>CO5</b>	3	2	3	2	2	2	2	-	-	1	1	2
<b>CO6</b>	3	2	3	2	2	2	2	-	-	1	1	2

Module No	Module Contents	Hours	COs
1	<p><b>INTRODUCTION:</b></p> <p>Basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.</p>	09	CO1, CO2, CO6

2	<p><b>STATIC VAR COMPENSATOR (SVC):</b></p> <p>Configuration of SVC- voltage regulation by SVC- Modelling of SVC for load flow analysis- Modelling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.</p>	09	CO1,C O2, CO6
3	<p><b>VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS:</b></p> <p>Static synchronous compensator (STATCOM) - Static synchronous series compensator(SSSC) - Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modelling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers(UPFC and IPFC)- Modelling of UPFC and IPFC for load flow and transient stability studies Applications.</p>	09	CO3, CO6
4	<p><b>GENERAL ASPECTS OF DC TRANSMISSION AND COMPARISON OF IT WITH AC TRANSMISSION :</b></p> <p>Comparison of AC and DC Transmission-Economics of power transmission-Technical performance-Reliability, Application of DC transmission, Description of DC transmission system-Types of DC links-Converter station, planning for HVDC transmission, Modern trends in HVDC technology, Some operating problem, HVDC transmission based on Voltage Source Inverter.</p>	09	CO5, CO6
5	<p><b>STATIC POWER CONVERTERS:</b></p> <p>3-pulse, 6-pulse, and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters. VSC based HVDC and Hybrid HVDC systems. Back to back thyristor converter system.</p>	09	CO4, CO6

**Text Books:**

1. Thyristor – Based Facts Controllers for Electrical Transmission Systems, R.Mohan Mathur, Rajiv K.Varma, IEEE press and John Wiley & Sons, Inc, 2011.
2. Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems, Narain G. Hingorani, Standard Publishers Distributors,2011
3. HVDC Power Transmission System, K.R. Padiyar, 2nd Edition, New Age International Publishers, 2012.
4. Power Transmission by Direct Current, Erich Uhlmann, Fourth Indian Reprint Springer International Edition, 2012.

### Reference Books:

1. Introduction to FACTS Controllers: Theory, Modeling, and Applications, Kalyan K sen, Mey Ling Sen, Wiley & sons Ltd., 2016
2. Flexible AC Transmission System: Modelling and Control, Xiao – Ping Zang, Christian Rehtan and Bikash Pal, Springer, 2012
3. High Voltage Direct Current Transmission: Converters, Systems and DC Grids, Dragan Jovcic , Khaled Ahmed, John Wiley & sons Ltd., 2015
4. H.V.D.C Transmission, J Arrillaga , Peter Peregrinus Ltd , London UK 1998.

### Assessment Pattern

#### Implementation of Bloom's Taxonomy in CIE (50 Marks)

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10
Remember	5	-	2	-
Understand	5	-	1	-
Apply	5	5	1	10
Analyze	10	5	1	-
Evaluate		-	-	-
Create	-	-	-	-

#### SEE - Theory (50 Marks)

Blooms levels	SEE - Theory
	Examination = 50
Remember	15
Understand	15
Apply	10
Analyze	10
Evaluate	-

## TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENT

Course Code : EEE733

Credits : 03

L: T: P: S : 3:0:0:0

CIE Marks : 50

Exam Hours : 03

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Describe the method of procurement process and state-of-the art global practices in maintenance of electrical equipment.
<b>CO2</b>	Analyze and explaining of the requirement common to all equipment.
<b>CO3</b>	Understand the specifications Installation and testing of transformers
<b>CO4</b>	Analyze and explain the Installation and testing of induction motors.
<b>CO5</b>	Understand and explain about the Installation of synchronous machines.
<b>CO6</b>	Explain about specification, precommissioning test, commissioning test and routine test of synchronous machines

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2	2	1	2	3	2	-	-	1	2	2
<b>CO2</b>	3	2	2	1	2	3	2	-	-	1	2	2
<b>CO3</b>	3	2	2	1	2	3	2	-	-	1	2	2
<b>CO4</b>	3	2	2	1	2	3	2	-	-	1	2	2
<b>CO5</b>	3	2	2	1	2	3	2	-	-	1	2	2
<b>CO6</b>	3	2	2	1	2	3	2	-	-	1	2	2

Module No	Module Contents	Hours	COs
1	<p><b>PROCUREMENT PROCESS:</b> Tender specifications based on requirement and national, international codes and standards, compiling tender documents &amp; vendor assessment, inviting tenders, scrutiny and evaluation of bids (technical and financial) acceptance and award of contract with necessary safety and security classes.</p>	6	CO1
2	<p><b>REQUIREMENTS COMMON TO ALL EQUIPMENT:</b> Types of construction, design details and dimensional layout. Types of enclosure (IP code) and cooling system, Insulation class, Physical inspection, handling and storage, Foundation details f) Tests- factory, site and stage wise-inspection and certification. Name plates-code of practice ,Duty cycle and cyclic duration factor, Vibration and noise levels control, Tips for trouble shooting ,Maintenance schedules and assessment of their effectiveness, Documentation of all factory and field test results with equipment and instruction manuals for operation and maintenance.</p>	8	CO2
3	<p><b>TRANSFORMERS:</b> Specification: Power&amp; distribution transformers as per BIS standard. Acceptance Tests: Type, routine and special tests applicable. Installation: Location, foundation details, conductor/cable termination boxes, bushings, polarity and phase sequence, oil tank and radiators, nitrogen and oil filled trafos, drying of windings and general inspection. Commissioning Tests: Pre-commissioning, tests as per relevant BIS or IEC standards, ratio and polarity, insulation resistance, oil dielectric strength, tap changing gear, fans and pumps for cooling, neutral earthing resistance, buchholz relay, load tests and temperature rise, hot and cold IR value.</p>	12	CO2, CO3
4	<p><b>INDUCTION MOTORS:</b> Specifications: For different types of induction motors as per BIS including duty and IP protection. Acceptance Tests: Type, routine and special tests as specified by BIS codes of testing. Installation: Location and details of mounting and foundation, control gear, alignment with driven equipment with coupling, fitting of pulleys, bearings, drying of windings. Commissioning Tests: Pre-commissioning tests, physical examination, alignment and airgap, bearing, balancing and vibration, insulation resistance, no-load run, frame earthing and bearing pedestal insulation, load test and temperature rise, hot and cold IR values.</p>	10	CO2, CO4
5	<p><b>SYNCHRONOUS MACHINES:</b> Specifications: As per BIS Standards. Acceptance Tests: Type, routine-and special tests applicable as per BIS. Installation: Location and details of mounting and foundations, control gear,</p>	9	CO2, CO5, CO6

	excitation system and cooling arrangements. Commissioning Tests: Pre-Commissioning tests, physical examination, alignment and air gap, armature and field winding insulation resistance, balancing and vibration, no load run and frame earthing, pedestal insulation, load test and temperature rise, hot and cold IR values.		
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**Text Books:**

1. Testing & Commissioning of Electrical Equipment, Ramesh. L. Chakrasali, Elite Publishers, Mangalore.
2. Testing & commissioning of Electrical Equipment, S.Rao, Khanna Publishers.

**Reference Books:**

1. Power Station and Substation Practice, M.P.Krishan Pillai, Standard Publishers Distributors. BIS Standards
2. Hand Books: Transformers – BHEL Handbook, Switchgear - J&P Handbook.

**Assessment Pattern**

**Implementation of Bloom's Taxonomy in CIE (50 Marks)**

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10
Remember	5	-	1	-
Understand	5	-	1	-
Apply	5	5	1	10
Analyze	10	5	1	-
Evaluate	-	-	1	-
Create	-	-	-	-

**SEE - Theory (50 Marks)**

Blooms levels	SEE - Theory
	Examination = 50
Remember	10
Understand	15
Apply	10
Analyze	15
Evaluate	-
Create	-

## ENERGY AUDITING AND DEMAND SIDE MANAGEMENT

Course Code : EEE734

Credits : 03

L: T: P: S : 3:0:0:0

CIE Marks : 50

Exam Hours : 03

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Understand the energy situation and need for energy economic analysis.
<b>CO2</b>	Analyse the concept of energy auditing.& need for Electrical System Optimization.
<b>CO3</b>	understand the energy audit instruments
<b>CO4</b>	Apply energy auditing for buildings
<b>CO5</b>	understand the concept of the energy conservation
<b>CO6</b>	Understand the concept of Demand Side Management.

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	1	3	1	1	1	-	-	-	-	3	-
<b>CO2</b>	3	1	3	3	3	1	3	-	-	-	3	-
<b>CO3</b>	3	1	1	3	3	1	-	-	-	-	-	-
<b>CO4</b>	3	1	1	3	2	3	3	3	-	-	3	2
<b>CO5</b>	3	2	1	3	2	2	-	-	-	-	1	-
<b>CO6</b>	3	2	1	3	2	2	-	-	-	-	-	-

Module No	Module Contents	Hours	COs
1	<p><b>INTRODUCTION:</b> Energy situation – world and India, energy consumption, conservation. Codes, standards and Legislation.</p> <p><b>ENERGY ECONOMIC ANALYSIS:</b> The time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit – numerical problems.</p>	09	CO1, CO2
2	<p><b>ENERGY AUDITING:</b> Introduction, Elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results</p> <p><b>ELECTRICAL SYSTEM OPTIMIZATION:</b> The power triangle, Motor horsepower, Power flow concept. Electrical Equipment and power factor –correction &amp; location of capacitors.</p>	09	CO3 CO4
3	<p><b>LIGHTING AND ENERGY INSTRUMENTS</b> Good lighting system design and practice, lighting control ,lighting energy audit - Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers ,application of PLC's</p> <p><b>ENERGY EFFICIENT MOTORS</b> Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation- voltage unbalance- over motoring- motor energy audit.</p>	09	CO3 CO5
4	<p><b>ENERGY CONSERVATION:</b> Motivation of energy conservation, Principles of Energy conservation, Energy conservation planning, Energy conservation in industries, EC in SSI, EC in electrical generation, transmission and distribution, EC in household and commercial sectors, EC in transport, EC in agriculture, EC legislation</p> <p><b>ENERGY AUDIT APPLIED TO BUILDINGS:</b> Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings</p>	09	CO4 CO6
5	<p><b>DEMAND SIDE MANAGEMENT – I:</b> Introduction to DSM, concept of DSM, benefits of DSM, different Techniques of DSM – time of day pricing, multi-utility power exchange model, time of day models for planning.</p> <p><b>Demand Side Management -II</b></p>	09	CO2, CO3, CO6,

	Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. Management and Organization of Energy		
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### Text Books:

1. Handbook on Energy Audit, Sonal Desai, McGraw Hill 2014.
2. Generation of Electrical Energy, B R Gupta, S. Chand, 1 st Edition, 1983
3. Electrical distribution, Pabla, 6th edition, TMH, 2012..

### Reference Books

1. Recent Advances in Control and Management of Energy Systems D.P.Sen, K.R.Padiyar, Indrane Sen, M.A.Pai Interline Publisher, Bangalore, 1993.
2. Energy Demand – Analysis, Management and Conservation, Ashok V. Desai, Wiley Eastern Ltd., New Delhi., 1990.
3. Demand Side Management Jyothi Prakash, TMH Publishers.
4. Hand book on energy auditing - TERI (Tata Energy Research Institute)

### Assessment Pattern

#### Implementation of Bloom's Taxonomy in CIE (50 Marks)

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10
Remember	7	-	1	-
Understand	8	-	1	-
Apply	5	5	1	10
Analyze	3	5	1	-
Evaluate	2	-	1	-
Create	-	-	-	-

#### SEE - Theory (50 Marks)

Blooms levels	SEE - Theory
	Examination = 50
Remember	15
Understand	15
Apply	10
Analyze	5
Evaluate	5
Create	-

## PROFESSIONAL ELECTIVE-IV

### UTILIZATION OF ELECTRICAL ENERGY

Course Code : EEE741

L: T: P: S : 3:0:0:0

Exam Hours : 03

Credits : 03

CIE Marks : 50

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Identify the selection of motor depends on its applications
<b>CO2</b>	Design the illumination level for different lighting system
<b>CO3</b>	Understand the basic concept of electric welding & heating and its applications
<b>CO4</b>	Understand the basic principles of refrigeration & air conditioning system
<b>CO5</b>	Identify the power factor necessity and its improvement methods with economic aspects
<b>CO6</b>	compare the public and private supply based on losses, initial cost and efficiency

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2	3	2	1	3	1	-	-	-	1	3
<b>CO2</b>	3	3	3	3	1	2	1	-	-	-	1	3
<b>CO3</b>	3	1	1	1	1	-	2	1	-	-	1	2
<b>CO4</b>	3	1	1	-	1	2	3	1	-	-	-	2
<b>CO5</b>	3	3	3	2	1	2	1	-	-	-	3	3
<b>CO6</b>	3	3	3	3	1	2	1	-	-	-	1	3

Module No	SYLLABUS	Hours	COs
1	<p><b>ELECTRIC DRIVES AND TRACTION</b></p> <p>Fundamentals of electric drive - choice of an electric motor - application of motors for particular services - traction motors - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear.</p>	09	CO1
2	<p><b>ILLUMINATION</b></p> <p>Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED.</p>	09	CO2
3	<p><b>HEATING AND WELDING</b></p> <p>Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating - resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types - resistance welding - arc welding - power supply for arc welding - radiation welding</p>	09	CO3
4	<p><b>REFRIGERATION AND AIR CONDITIONING</b></p> <p>Refrigeration Systems – Refrigerants – Types of Refrigeration Systems – Electrical Circuit of a Domestic Refrigerator – Trouble shooting of Refrigerator. Air Conditioning Systems – Types - Electrical circuit of window and Central Air Conditioning Systems</p>	09	CO4
5	<p><b>ECONOMIC ASPECTS OF UTILISING ELECTRICAL ENERGY</b></p> <p>Power Factor Improvement, Improvement of Load Factor, Off Peak Loads- Use of Exhaust Steam, Waste Heat recovery, Pit Head Generation, Diesel Plant, General Comparison of Private Plant and Public Supply- Initial Cost and Efficiency, Capitalization of Losses, Choice of Voltage</p>	09	CO5

**Text Books:**

1. N.V.Suryanarayana, 'Utilisation of Electric Power : Including Electric Drives and Electric Traction', New Age International Publishers, Second Edition 2014
2. J.B. Gupta, 'Utilization of Electric Power and Electric Traction', S.K.Kataria and Sons, Eleventh Edition 2015.

3. Utilization of Electric Energy, E. Openshaw Taylor and V. V. L. Rao, Universities Press, 2009

**Reference Books:**

1. C.L. Wadhwa, 'Generation, Distribution and Utilization of Electrical Energy', New Age International Pvt. Ltd, Third Edition 2015
2. H. Partab, 'Art and Science of Utilisation of Electrical Energy', Dhanpat Rai and Co, New Delhi, Third Edition 2014.
3. R.K.Rajput, Utilisation of Electric Power, Laxmi publications Private Limited.,2007

**Assessment Pattern**

**Implementation of Bloom's Taxonomy in CIE (50 Marks)**

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10
Remember	4	-	-	-
Understand	4	-	1	-
Apply	9	5	1	10
Analyze	4	5	1	-
Evaluate	4	-	1	-
Create	-	-	1	-

**SEE - Theory (50 Marks)**

Blooms levels	SEE - Theory
	Examination = 50
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

## POWER SYSTEM OPERATION AND CONTROL

Course Code : EEE742

Credits : 03

L: T: P: S : 3:0:0:0

CIE Marks : 50

Exam Hours : 3

SEE Marks : 50

**Course Outcomes: At the end of the course, the student will be able to:**

<b>CO1</b>	Understand the Operating States of Power System and Megawatt-frequency and Megavar-Voltage control loops.
<b>CO2</b>	Model the Generator, Turbine, Governor, Tie-Line and analyze the response of single area and two area systems.
<b>CO3</b>	Analyze the reactive power requirement at a point in system and suggest the compensation.
<b>CO4</b>	Apply Equal Incremental Cost method and allocate optimal generation for generating units in a generating station and apply Unit Commitment Solution Methods and find the Units to be Committed for optimal generation
<b>CO5</b>	Analyze the contingency of a system using Linear Sensitivity Factors and understand the concept of Synchrophasors, Phasor Measurement Unit and Wide Area Monitoring Systems
<b>CO6</b>	Understand the concept of Synchrophasors, Phasor Measurement Unit and Wide Area Monitoring Systems.

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	-	-	-	-	-	-	-	-	-	-	-
<b>CO2</b>	3	3	-	-	-	-	-	-	-	-	-	-
<b>CO3</b>	3	3	1	2	-	-	-	2	-	-	2	3
<b>CO4</b>	3	3	-	2	-	2	2	2	-	-	2	3
<b>CO5</b>	3	3	-	2	-	2	2	-	-	-	-	3
<b>CO6</b>	3	3	-	2	-	2	2	-	-	-	-	3

Module No	Module Contents	Hours	COs
1	<b>INTRODUCTION:</b> Structure of Electric Energy System, Operating States of Power System, Transmission Capacity. Load Characteristics: Voltage and	09	CO1, CO2

	Frequency Load Dependency. The Real Power Balance and its Effect on System Frequency. The Reactive Power Balance and its Effect on System Voltage. Control of Generation: Megawatt-frequency and Megavar-voltage control, Generator Model, Load Model, Prime-Mover Model, Governor Model.		
2	<b>LOAD FREQUENCY CONTROL:</b> Speed-Load characteristics of Governor, Parallel operation of Generators, Concept of Control Area. Megawatt-Frequency Control of Single Area: the uncontrolled and controlled case. The two area system: Block diagram of two area system. Static and Dynamic response of uncontrolled two-area system, Static and Dynamic response of controlled two-area system.	09	CO2
3	<b>REACTIVE POWER AND VOLTAGE CONTROL:</b> Production and absorption of reactive power, Methods of Voltage Control, Shunt reactors Shunt Capacitors, Series Capacitors Synchronous condensers, Static VAR systems, Principles of Transmission system compensation, Modeling of reactive compensating devices, Application of tap changing transformers to transmission systems, Distribution system voltage regulation, Modeling of transformers ULTC control systems.	09	CO3
4	<b>ECONOMIC DISPATCH OF THERMAL UNITS AND UNIT COMMITMENT:</b> Optimal operation of Generators in Thermal Power Stations, - heat rate Curve – Cost Curve – Incrementalfuel and Production costs, input-output characteristics, Optimum generation allocation with line lossesneglected using Lagrangian function.Optimum generation allocation including the effect of transmission line losses – Loss Coefficients, Generaltransmission line loss formula.Unit Commitment:Constraints in Unit Commitment, Spinning Reserve, Thermal Unit Constraints, Hydro-Constraints, Must Run Constraint & Fuel Constraints. Unit Commitment Solution Methods: Priority List, Lagrange Relaxation Solution.	09	CO4
5	<b>POWER SYSTEM SECURITY&amp; MODERN TRENDS IN POWER SYSTEM CONTROL:</b> Factors affecting Power System Security, Linear Sensitivity Factors (LSFs). Contingency Analysis using LSFs,Numerical Problems.Energy Management Systems, SCADA Control of the Indian Power Grid, Role of Load Despatch Centers, ,Synchrophasors, Phasor Measurement Unit (PMU), Wide Area Monitoring System (WAMS), Overview of WAMS in Indian Grid.	09	CO5

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**Text Books:**

1. Power Generation Operation and Control, Allen J.Wood, Bruce.F.Wollenberg, Gerald B. ShebléWiley & Sons,, 2013.
2. Electric Energy Systems Theory, Elgerd.O.I McGraw Hill Education; Second Edition, 2017.
3. Power system operation and control, V.Ramanathan &P.S.Manoharan, Charulatha Publications, Chennai, 2008.

**Reference Books:**

1. Reactive Power Control in Electric Systems, Timothy J. E. Miller, Wiley, First Edition, Reprint 2010.
2. EPRI Power System Dynamics Tutorial, Electric Power Research Institute, Jul 27, 2009
3. Unified Real Time Dynamic StateMeasurement (URTSM), Power Grid Corporation of India, Feb 2012

**Assessment Pattern**

**Implementation of Bloom’s Taxonomy in CIE (50 Marks)**

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10
Remember	5	-	2	-
Understand	5	-	1	-
Apply	5	5	1	10
Analyze	5	5	1	-
Evaluate		-		-
Create	5	-		-

**SEE - Theory (50 Marks)**

Blooms levels	SEE - Theory
	Examination = 50
Remember	5
Understand	5
Apply	15
Analyze	15
Evaluate	-
Create	10

## SOLAR ELECTRIC SYSTEMS

Course Code : EEE743

L: P: T: S : 3:0:0:0

Exam Hours : 03

Credits : 03

CIE Marks : 50

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Define the solar related systems efficiently
<b>CO2</b>	List and generally explain the main sources of energy and their primary applications
<b>CO3</b>	Explain the principles that underlie the ability of various natural phenomena to deliver solar energy
<b>CO4</b>	Evaluate the power electronics devices needed for the solar electric systems
<b>CO5</b>	outline the technologies that are used to harness the power of solar energy
<b>CO6</b>	Identify good sites and evaluate the efficiency for solar planting.

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2	1	2	2	3	3	1	1	2	2	3
<b>CO2</b>	3	2	1	2	2	3	3	1	1	2	2	3
<b>CO3</b>	3	2	1	2	2	3	3	1	1	2	2	3
<b>CO4</b>	3	2	1	2	2	3	3	1	1	2	2	3
<b>CO5</b>	3	2	1	2	2	3	3	1	1	2	2	3
<b>CO6</b>	3	2	1	2	2	3	3	1	1	2	2	3

Module No	Module Contents	Hours	Cos
1	<p><b>ENERGY SOURCES:</b> Introduction, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Classification of Energy Resources; Conventional Energy Resources -Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario.</p> <p><b>SOLAR ENERGY BASICS:</b> Introduction, Solar Constant, Basic Sun-Earth Angles – definitions and their representation, Solar Radiation Geometry (numerical problems), Estimation of Solar Radiation of Horizontal and Tilted Surfaces (numerical problems); Measurement of Solar Radiation Data – Pyranometer and Pyrhelimeter.</p>	09	CO1, CO2
2	<p><b>SOLAR RESOURCE AND RADIATION:</b> Solar resources, Quantifying solar radiation, The effect of the Earth’s atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays.</p> <p><b>PV INDUSTRY AND TECHNOLOGY:</b> Semiconductor devices, Main stream technologies, Mono crystalline silicon, Multi crystalline / polycrystalline silicon, Thin film solar cells, Contacts, Buying solar modules, Standards, Certifications, Warranties, Emerging technologies, Dye-sensitized solar cells, Sliver cells, Hetero junction with intrinsic thin layer (HIT) photovoltaic cells, III-V Semiconductors, Solar concentrators.</p>	09	CO3
3	<p><b>PV CELLS, MODULES AND ARRAYS:</b> Characteristics of PV cells, Graphic representations of PV cell performance, Connecting PV cells to create a module, Specification sheets, Creating a string of modules, Creating an</p>	09	CO4

	<p>array, Photovoltaic array performance, Irradiance, Temperature, Shading.</p> <p><b>SOLAR THERMAL SYSTEMS:</b> Principle of Conversion of Solar Radiation into Heat, Solar Water Heaters (Flat Plate Collectors), Solar Cookers – Box type, concentrating dish type, Solar driers, Solar Still, Solar Furnaces, Solar Green Houses.</p>		
4	<p><b>INVERTERS AND OTHER SYSTEM COMPONENTS:</b></p> <p>Introduction, Inverters, Battery inverters, Grid-interactive inverters, Transformers, Mainstream inverter technologies, String inverters, Multi-string inverter, Central inverter, Modular inverters, Inverter protection systems, Self protection, Grid protection, Balance of system equipment: System equipment excluding the PV array and inverter, Cabling, PV combiner box, Module junction box, Circuit breakers and fuses, PV main disconnects/isolators, Lightning and surge protection, System monitoring, Metering, Net metering, Gross metering.</p>	09	CO5
5	<p><b>MOUNTING SYSTEMS:</b></p> <p>Roof mounting systems, Pitched roof mounts, Pitched roof mounts for tiled roofs, Pitched roof mounts for metal roofs, Rack mounts, Direct mounts, Building-integrated systems, Ground mounting systems, Ground rack mounts, Pole mounts, Sun-tracking systems, Wind loading, Lightning protection.</p> <p><b>SITE ASSESSMENT:</b></p> <p>Location of the PV array, Roof specifications, Is the site shade-free?, Solar Pathfinder, SolmetricSuneye, HORI catcher, iPhone apps, Software packages, Available area, Portrait installation, Landscape installation, Energy efficiency initiatives, Health, safety and environment (HSE) risks, Local environment, Locating balance of system equipment, Site plan.</p>	09	CO2, CO4, CO5,

**Text Books:**

1. Non-Conventional Sources of Energy, Rai, G. D, Khanna Publishers, 4th Edition, Reprint- 2014
2. Grid-connected Solar Electric Systems, The Earthscan Expert Handbook for Planning, Design and Installation, Geoff Stapleton and Susan Neill, Earthscan, 1<sup>st</sup> Edition 2012.

3. Non-Conventional Energy Resources, Khan, B. H., TMH, 2nd Edition, Reprint 2014

### Reference Books:

1. Fundamentals of Renewable Energy Systems, Mukherjee, D and Chakrabarti, S., New Age International Publishers, 2005.
2. Solar Photovoltaics - Fundamentals, Technologies and Applications, Solanki C S, PHI Publications, 3<sup>rd</sup> edition, 2015.

### Assessment Pattern

#### Implementation of Bloom's Taxonomy in CIE (50 Marks)

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10
Remember	5	-	1	-
Understand	7	5	1	-
Apply	5	-	1	10
Analyze	4	5	1	-
Evaluate	4	-	1	-
Create	-	-	-	-

#### SEE - Theory (50 Marks)

Blooms levels	SEE - Theory
	Examination = 50
Remember	10
Understand	14
Apply	10
Analyze	8
Evaluate	8
Create	-

## ARTIFICIAL NEURAL NETWORKS AND FUZZY LOGIC

Course Code : EEE744

Credits : 03

L: P: T: S : 3:0:0:0

CIE Marks : 50

Exam Hours : 03

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Understand the concepts of neural networks and fuzzy logic
<b>CO2</b>	Design and develop artificial and neural network based algorithms
<b>CO3</b>	Evaluate the better algorithms for the successful implementation
<b>CO4</b>	Analyze the operation of neural network and fuzzy based systems
<b>CO5</b>	Use modern tools for understanding and implementation
<b>CO6</b>	Apply fuzzy logic and neural network for application related to design and manufacture

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3	3	2	1	3	1	2	2	1	1	2
<b>CO2</b>	3	3	3	2	2	3	1	2	3	3	3	2
<b>CO3</b>	3	3	3	3	2	3	1	3	3	3	3	2
<b>CO4</b>	3	3	3	2	2	3	1	2	3	3	3	2
<b>CO5</b>	3	3	3	2	3	3	1	2	3	2	2	2
<b>CO6</b>	3	3	3	2	2	3	1	3	3	2	1	2

<b>Module No</b>	<b>Module Contents</b>	<b>Hours</b>	<b>COs</b>
1	<p><b>EVOLUTION OF NEURAL NETWORKS:</b></p> <p>Artificial Neural Network: Basic model, Classification, Feed forward and Recurrent topologies, Activation functions; Learning algorithms: Supervised, Un-supervised and Reinforcement; Fundamentals of connectionist modeling: McCulloch – Pits model, Perceptron, Adaline, Madaline.</p>	09	CO1 CO2
2	<p><b>TOPOLOGY OF MULTI-LAYER PERCEPTRON:</b></p> <p>Back propagation learning algorithm, limitations of Multi-layer perceptron. Radial Basis Function networks: Topology, learning algorithm; Kohenen’s self-organising network: Topology, learning algorithm; Bidirectional associative memory Topology, learning algorithm, Applications.</p>	09	CO2 CO3
3	<p><b>RECURRENT NEURAL NETWORKS:</b></p> <p>Basic concepts, Dynamics, Architecture and training algorithms, Applications; Hopfield network: Topology, learning algorithm, Applications; Industrial and commercial applications of Neural networks: Semiconductor manufacturing processes, Communication, Process monitoring and optimal control, Robotics, Decision fusion and pattern recognition.</p>	09	CO4
4	<p><b>CLASSICAL AND FUZZY SETS:</b></p> <p>Introduction, Operations and Properties, Fuzzy Relations: Cardinality, Operations and Properties, Equivalence and tolerance relation, Value assignment: cosine amplitude and max-min method; Fuzzification: Membership value assignment- Inference, rank ordering, angular fuzzy sets. Defuzzification methods, Fuzzy measures, Fuzzy integrals, Fuzziness and fuzzy resolution; possibility theory and Fuzzy</p>	09	CO4 CO5

	arithmetic; composition and inference; Considerations of fuzzy decision-making		
5	<b>BASIC STRUCTURE AND OPERATION OF FUZZY LOGIC CONTROL SYSTEMS:</b> Design methodology and stability analysis of fuzzy control systems; Applications of Fuzzy controllers. Applications of fuzzy theory.	09	CO4 CO6

**Text Books:**

1. Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications, S. Rajasekaran and G. A. Vijayalakshmi Pai, Prentice Hall India, 2<sup>nd</sup> edition, 2017.
2. Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson Education, India, 1<sup>st</sup> edition, 2015.
3. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Wiley, 3<sup>rd</sup> edition, 2011.

**Reference Books:**

1. Make Your Own Neural Network, Tariq Rashid, CreateSpace Independent Publishing Platform, 1<sup>st</sup> edition, 2016
2. Introduction to Artificial Neural Systems, Jack M. Zurada, PWS Publishing Co., Boston, 2002.
3. Fuzzy sets, Uncertainty and Information, Klir G.J. & Folger T.A., Prentice –Hall of India Pvt. Ltd., New Delhi, 2008.
4. Fuzzy set theory and its Applications, Zimmerman H.J., Kluwer Academic Publishers Dordrecht, 2001

**Assessment Pattern**

**Implementation of Bloom’s Taxonomy in CIE (50 Marks)**

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10
Remember	10	-	5	-
Understand	5	-	-	-
Apply	5	10	-	10
Analyze	5	-	-	-
Evaluate	-	-	-	-

Create	-	-	-	-
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**SEE - Theory (50 Marks)**

Blooms levels	SEE - Theory
	Examination = 50
Remember	15
Understand	10
Apply	15
Analyze	5
Evaluate	5
Create	-

**VIII-SEMESTER**

**SYLLABUS**

## PROFESSIONAL ELECTIVE-V

### ESTIMATION AND COSTING OF ELECTRICAL SYSTEMS

Course Code : EEE811A

L: T: P: S : 3:0:0:1

Exam Hours : 03

Credits : 04

CIE Marks : 50

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Analyze estimation & costing, Necessity and procedures for estimation and costing, major applicable I.E rules and acts, Types and materials used for wiring
<b>CO2</b>	Understand general rules, guidelines for internal wiring, preparation of detailed estimates and costing of internal wiring, Inspection and testing of wiring installations
<b>CO3</b>	Apply the procedure for service connection, design, estimation and costing of underground and overhead service connections.
<b>CO4</b>	Analyze the Important considerations regarding motor installation wiring, Design and Estimation of components required for Motor installation and costing the same
<b>CO5</b>	Design overhead transmission & distribution lines. Typical AC electrical power system, Estimation & costing of transmission & distribution lines
<b>CO6</b>	Design, estimate and costing of the components of substations and substation Earthing, Remote control wiring

Design and Estimation of components required for Motor installation and costing the same

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3	2	1	2	2	1	1	3	3	3	3
<b>CO2</b>	3	3	2	2	2	2	1	1	3	3	3	3
<b>CO3</b>	3	3	2	2	2	2	1	1	3	3	3	3
<b>CO4</b>	3	3	3	2	2	2	1	1	3	3	3	3
<b>CO5</b>	3	3	3	2	2	2	1	1	3	3	3	3
<b>CO6</b>	3	3	3	2	2	2	1	1	3	3	3	3

Module No	Module Contents	Hours	Cos
1	<p><b>PRINCIPLES OF ESTIMATION &amp; COSTING:</b> Introduction to estimation &amp; costing, Electrical Schedule, Catalogues, Market Survey and source selection, Recording of estimates, Determination of required quantity of material, Determination of cost of material and labour, Contingencies, Overhead charges, Profit, Purchase system, Purchase enquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills, Tender form, Indian Electricity Act and major applicable I.E rules.</p> <p><b>WIRING:</b> Introduction, Distribution of energy in a Building, PVC Casing and Capping, Conduit Wiring, Types of cables used in Internal Wiring, Multi Strand Cables, Voltage Grading and Specification of Cables, Main Switch and Distribution Board, Conduits and its accessories and Fittings. Lighting Accessories and Fittings, Types of Fuses, Size of Fuse, Fuse Units, Earthing Conductor.</p>	09	CO1
2	<p><b>INTERNAL WIRING ESTIMATION:</b> General rules for wiring, Determination of number of points, Total load, number of sub-circuits, Size of conductor, Rating of main switch and distribution board, mounting arrangements and positioning of switchboards, distribution boards main switch etc, Sequence to be followed for preparing estimate, Preparation of detailed estimates and costing of residential installation.</p> <p><b>INSPECTION AND TESTING OF INSTALLATIONS:</b> Inspection of internal wiring installations, Inspection of new installations, testing of installations, Testing of wiring installations, Reason for excess recording of energy consumption by energy meter.</p>	09	CO2
3	<p><b>INSTALLATION OF SERVICE CONNECTIONS:</b> Concept of service connection, Types of service connection and their features, Method of installation of service connection, estimation and costing of overhead and underground service connections,</p> <p><b>ELECTRICAL INSTALLATION FOR POWER CIRCUITS :</b> Introduction, Important considerations regarding motor installation wiring, Determination of input power, Determination of input current to motors, Determination of rating of cables, determination of rating of fuse, Determination of size of Conduit, distribution Board main switch and starter.</p>	09	CO3, CO4
4	<p><b>ESTIMATION OF OVERHEAD TRANSMISSION &amp; DISTRIBUTION LINES:</b> Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports, Factors governing</p>	09	CO5

	<p>height of pole, Conductor materials, Determination of size of conductor for overhead transmission line, Cross arms, Pole brackets and clamps, Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Overhead line insulators, Insulator materials, Types of insulators, Lightning Arrestors, Phase plates, Danger plates, Anti climbing devices, Bird guards, Beads of jumpers, Muffs.</p> <p><b>ESTIMATION OF OVERHEAD TRANSMISSION &amp; DISTRIBUTION LINES (CONTINUED):</b></p> <p>Points to be considered at the time of erection of overhead lines, Erection of supports, Setting of stays, Fixing of cross arms, Fixing of insulators, Conductor erection, Repairing and jointing of conductor , Dead end clamps, Positioning of conductors and attachment to insulators, Jumpers, Tee-offs, Earthing of transmission lines, Guarding of overhead lines, Clearances of conductor from ground, Spacing between conductors, Testing and commissioning of overhead distribution lines, Some important specifications.</p>		
5	<p><b>DESIGN AND ESTIMATION OF SUBSTATIONS:</b></p> <p>Introduction, Classification of substation, Indoor substations, Outdoor substations, Selection and location of site for substation, Main Electrical Connections, Graphical symbols for various types of apparatus and circuit elements on substation main connection diagram, Key diagram of typical substations, Equipment for substation and switchgear installations, Substation auxiliaries supply, Substation Earthing.</p> <p><b>REMOTE CONTROL WIRING:</b></p> <p>Remote control Switching, Remote control selection considerations, types of control devices, motor control circuits.</p>	09	CO6

**Text Books:**

1. Electrical Installation Estimating & Costing, J.B.Gupta, S.K. Katria & Sons New Delhi, IX Edition, 2013
2. 1. Electrical Design Estimating and Costing, K.B.Raina S.K.Bhattacharya, New Age International second edition 1<sup>st</sup> Mar 2017.

**Reference Books:**

1. Electrical Wiring Estimating and Costing, Uppal, Khanna Publishers Delhi, 2008
2. Electrical Systems Design, M.K.Giridharan, I K International Publishing House Pvt. Ltd 3rd Revised edition 30th November 2015
3. I.E. Rules and Act Manuals.

### Assessment Pattern

Blooms levels	CIE –Theory (50 Marks)				SEE – Theory(50 Marks)
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10	Examination = 50
Remember	4	-	-	-	5
Understand	4	-	1	-	10
Apply	4	5	1	10	10
Analyze	4	5	1	-	5
Evaluate	4	-	1	-	10
Create	5	-	1	-	10

## SMART GRID TECHNOLOGIES

Course Code : EEE812A

L:T: P: S : 3:0:0:1

Exam Hours : 03

Credits : 04

CIE Marks : 50

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Understand the concept of Smart Grid, compare with conventional grid, and identify its opportunities and barriers.
<b>CO2</b>	Understand the concept of Smart Meter, Smart Appliances, Plug in Hybrid Electric Vehicles, Vehicle to Grid, Smart Sensors.
<b>CO3</b>	Understand the concept of Substation Automation, Feeder Automation, Intelligent Electronic Devices, Smart storage like Battery.
<b>CO4</b>	Understand the concept of micro grid, distributed energy resources, Power Quality and its issues of Grid connected Renewable Energy Sources, Power Quality Audit.
<b>CO5</b>	Understand the concept of SG stake holders and market drivers
<b>CO6</b>	Understand the concept of Electric vehicles in smart grid

**Mapping of Course Outcomes to Program Outcomes:**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	3	2	1	1	-	2	-	-	-	-	-	1
<b>CO2</b>	3	2	2	1	-	3	-	-	-	-	-	2
<b>CO3</b>	2	2	1	2	-	2	-	-	-	-	-	2
<b>CO4</b>	2	3	2	2	-	2	-	-	-	1	-	3
<b>CO5</b>	3	3	3	3	1	2	-	-	2	1	-	3
<b>CO6</b>	3	3	2	1	1	1	-	-	2	2	1	2

Module No	Module Contents	Hours	COs
1	<p><b>SMART GRID EVOLUTION:</b></p> <p>Evolution of Indian Power Grid, Smart Grid-Definitions, Functions of Smart Grid, Opportunities &amp; Barriers of Smart Grid, Drivers for SG in India, Challenges for SG, Difference between conventional &amp; smart grid, Smart Grid Vision &amp; Roadmap for India, Concept of Resilient and Self-Healing Grid, Present development &amp; International policies of Smart Grid.</p> <p><b>ARCHITECTURE AND APPLICATIONS OF SMART GRID:</b></p> <p>Functionalities and key components of smart grid. Smart grid Components for Transmission system, Smart grid components at distribution level, Architecture of smart grid, Pilot projects of Smart Grid in India.</p>	09	CO1
2	<p><b>SMART GRID TECHNOLOGIES:</b></p> <p>Introduction to Smart Meters, Advanced Metering Infrastructure, Distribution Automation, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid Technology (V2G), Smart Sensors, Smart Homes, Building Energy Management System</p> <p><b>AUTOMATION AND ENERGY STORAGE:</b></p> <p>Substation Automation, Feeder Automation. Geographic Information System (GIS), Peak load Management, Energy Storage systems, Pumped hydro storage, CAES, FES, storage batteries, Thermal energy storage, Super capacitors.</p>	09	CO2 CO3
3	<p><b>MICROGRIDS:</b></p> <p>Architecture and Layout of Microgrid, Types of Micro grid- DC Micro grid, AC Microgrid, Hybrid AC/DC Microgrid, Benefits of Distributed generation, Energy storage in Microgrids, Micro grid-Protection, Case studies of Micro grid in India</p> <p><b>DISTRIBUTED ENERGY RESOURCES:</b></p> <p>Small scale distributed generation, Distributed Generation Resources-Fuel Cells, Solar Photovoltaic cells, Wind power, Fixed speed Wind Turbine generators, Variable speed wind turbine generators, Synchronous generator with In-line frequency control, Advantages of DG.</p>	09	CO4
4	<b>POWER QUALITY MANAGEMENT IN SMART GRID:</b>	09	CO4

	<p>Power Quality-Basic definitions, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Power Quality Audit and its significance.</p> <p><b>INFORMATION AND COMMUNICATION TECHNOLOGY FOR SMART GRID:</b></p> <p>Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi- Max based communication, Wireless Mesh Network, Broadband over Power line (BPL).</p>		
5	<p><b>SMART GRID MARKET DRIVERS:</b></p> <p>Introduction – Comparison of Micro grid, power grid and Smart grid – Case study of STUXNET –Cyber security, Smart Grid Stake holders-Roles and Responsibilities, Technical challenges in SG Market operation.</p> <p><b>Electric Vehicles:</b></p> <p>Electric Vehicle Technology, EV charging Infrastructure, EVSE Power standards, EVSE communication standards, Vehicle grid Integration (VGI), Challenges associated with VGI.</p>	09	CO5

**Text Books:**

1. Smart grid Advance Technology and solution, Stuart Borlase, CRC Press, Second edition, Nov 2017
2. Smart Grids: Clouds, Communications and Automation, Krzysztof Iniewski, David Bakken, Open Source, CRC Press, Taylor and Francis group, May 2014
3. Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities, Peter S. Fox Penner, Island Press; 1 edition, Jun 2010
4. Microgrids and Active Distribution Networks, S. Chowdhury, S. P. Chowdhury, P. Crossley, Institution of Engineering and Technology, Jun 2009

**References Books:**

1. Control and Automation of Electric Power Distribution Systems (Power Engineering), James Northcote, Green, Robert G. Wilson CRC Press, 2017.
2. Substation Automation systems Design and Implementation, Evelio Padilla Wiley Publishers, 2015.
3. Smart Grid: Fundamentals of design and analysis, James Momoh, John Wiley & sons Inc, IEEE press, 2015.
4. Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, John Wiley & sons inc, 2012.
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication, 2012.

## Assessment Pattern

Blooms levels	CIE –Theory (50 Marks)				SEE - Theory(50 Marks)
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10	Examination = 50
Remember	2	-	1	-	5
Understand	2	-	1	-	8
Apply	8	-	1	-	10
Analyze	5	5	1	10	10
Evaluate	4	5	1	-	12
Create	4	-	-	-	5

## POWER QUALITY

Course Code : EEE813A

Credits : 04

L: T: P: S : 3:0:0:1

CIE Marks : 50

Exam Hours : 03

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Describe and Classify power quality issues in a power system and know the standards
<b>CO2</b>	Analyze Voltage sag ,Over voltage and Harmonics problems and suggest preventive techniques
<b>CO3</b>	Identify the DG sources, analyze the power quality issues and operating conflicts when DG is interconnected to the grid
<b>CO4</b>	Solve power quality problems using Power Quality Equipments
<b>CO5</b>	Understand and analyze the functions of Custom Power Devices
<b>CO6</b>	Apply in industries and Power System Engineering

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	1	1	1	1	1	1	1	-	1	1	1
<b>CO2</b>	3	2	2	2	1	1	1	-	-	-	-	1
<b>CO3</b>	3	2	2	2	1	2	1	-	-	1	1	1
<b>CO4</b>	3	2	2	2	2	2	1	-	-	-	1	1
<b>CO5</b>	3	2	2	2	1	2	1	1	1	1	-	1
<b>CO6</b>	3	2	2	2	1	2	1	1	1	1	1	1

Module No	Module Contents	Hours	COs
1	<p><b>INTRODUCTION:</b> Power quality definitions, Power quality as voltage quality, power quality evaluation procedure, terms and definitions, sources of pollution, international power quality standards and regulations, Computer Business Equipment Manufacturers Associations (CBEMA) curve.</p> <p><b>POWER QUALITY PROBLEMS:</b> Concepts of transients - short duration variations such as interruption - long duration variation such as sustained interruption - Sags and swells - voltage sag - voltage swell - voltage imbalance - voltage fluctuation - power frequency variations.</p>	09	CO1
2	<p><b>VOLTAGE SAGS:</b> Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, motor starting sags, Solutions at end-user level</p> <p><b>OVERVOLTAGE:</b> Sources of over voltages - Capacitor switching – lightning - ferro resonance. Mitigation of voltage swells - surge arresters - low pass filters - power conditioners</p>	09	CO1 CO2 CO4
3	<p><b>HARMONICS:</b> Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics - Harmonics vs transients. Effect of harmonics - harmonic distortion - voltage and current distortion</p> <p><b>APPLIED HARMONICS:</b> Harmonic indices - inter harmonics – Harmonic distortion evaluation - devices for controlling harmonic distortion - passive and active filters.</p>	09	CO1 CO2 CO4
4	<p><b>POWER QUALITY MONITORING:</b> Monitoring considerations, power quality measurement equipments, Power line disturbance analyzer –harmonic / spectrum analyzer - flicker meters - disturbance analyzer</p> <p><b>CUSTOM POWER DEVICES:</b> Operation and characteristics of DVR, STATCOM, UPFC</p>	09	CO4 CO5 CO6
5	<p><b>DISTRIBUTED GENERATION AND POWER QUALITY:</b> DG technologies, interface to utility system, power quality issues</p> <p><b>FUTURE APPLICATIONS:</b></p>	09	CO3 CO5 CO6

	Industrial Power Quality Monitoring Applications, Power System Performance Assessment and Benchmarking, Power Quality Monitoring and Internet, Future direction – Smart Grid		
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**Text Books:**

1. Electrical Power Systems Quality, Roger. C. Dugan, Mark. F. McGranaghan, Surya Santoso, H.Wayne Beaty, McGraw Hill, 3<sup>rd</sup> edition, 2012
2. Power Quality, C.Sankaran, CRC publication, 2017

**Reference Books:**

1. Electric Power Quality, G.T. Heydt, 2nd Edition, West Lafayette, IN, Stars in a Circle Publications, 1994.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, M.H.J Bollen, New York: IEEE Press, 2000.
3. Power System Quality Assessment, J. Arrillaga, N.R. Watson, S. Chen, New York: Wiley, 1999.
4. Power Quality, Simmi P.Burman, Bipin Singh, S.K.Kataria publication, re-print-2014

**Assessment Pattern**

Blooms levels	CIE –Theory (50 Marks)				SEE – Theory(50 Marks)
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10	Examination = 50
Remember	5	-	1	-	5
Understand	10	5	2	-	15
Apply	5	5	1	10	15
Analyze	5	-	1	-	10
Evaluate	-	-	-	-	5
Create	-	-	-	-	-

## INTEGRATION OF DISTRIBUTED GENERATION

Course Code : EEE814A

Credits : 04

L: T: P: S : 3:0:0:1

CIE Marks : 50

Exam Hours : 03

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Understand and evaluate economic issues and key engineering features and concepts of distributed generation that are used in grid integration
<b>CO2</b>	Able to investigate the operation of renewable energy generators at a systems level and analysis of distributed generation systems.
<b>CO3</b>	Analyze the grid integration issues of renewable generation and its performance of the network
<b>CO4</b>	Understand the converter principles and electronic devices developed for the integration of distributed generations into the grid.
<b>CO5</b>	Determine the different topologies used for grid integration of distributed power generations.
<b>CO6</b>	Understand the different law and economic regulations in distributed generation for the liberalized markets, and to identify the boundaries and opportunities in those fields.

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2	2	2	2	1	2	-	1	2	1	1
<b>CO2</b>	3	2	1	1	2	1	1	-	1	1	1	1
<b>CO3</b>	3	2	2	2	2	1	1	-	1	2	-	1
<b>CO4</b>	3	2	2	1	2	1	1	-	1	1	1	1
<b>CO5</b>	3	2	1	2	2	1	1	-	1	1	-	1
<b>CO6</b>	3	2	1	1	1	-	1	-	1	1	-	1

<b>Module No</b>	<b>Module Contents</b>	<b>Hours</b>	<b>COs</b>
1	<p><b>DISTRIBUTED GENERATION</b></p> <p>Electric grid scenario - Supply guarantee and power quality - Stability - Effects of distributed energy into the grid - Boundaries of the actual grid configuration - Consumption models and patterns- Integration in power systems - Distributed generation advantages and needs.</p>	09	CO1, CO2
2	<p><b>DISTRIBUTED GENERATION AND STORAGE TECHNOLOGIES</b></p> <p>Wind power generation profiles -Photovoltaic and Thermo-solar power generation profiles-Biomass Power-Hydroelectric centrals with asynchronous machine - Hydroelectric centrals with synchronous machine - Secondary regulation-Hydrogen Technologies- Diary/Monthly generation simulations and its comparison to a building consumption- Power Storing- Battery types - Ultra capacitors based energy storage systems – Flywheel- Electric Vehicles</p>	09	CO1, CO2
3	<p><b>DISTRIBUTED GENERATION INTEGRATION SYSTEMS AND ITS CONTROL TECHNIQUES</b></p> <p>AC/DC Drives Control- Introduction to basic analysis and operation techniques on power electronic systems. - Functional analysis of power converters main topologies - Power conversion schemes between electric machines and the grid- Predictive direct power control of systems connected into the grid- Technological aspects of power electronic systems connection to the grid- Active Network Devices, Control and FACTS Technology- Micro-Grids</p>	09	CO3, CO4
4	<p><b>POWER GRID ANALYSIS AND ITS STUDIES</b></p> <p>Electric Systems Modelling- Simulation grid studies and used tools. Unit systems.</p> <p>Electric systems modelling for permanent regime studies - Steady state simulation studies. Load flow- Optimization and Grid Planning- SMART GRIDS</p>	09	CO3, CO4
5	<p><b>STANDARDS AND ELECTRIC MARKETS</b></p> <p>Electric Market- The electric sector: structures and models - Economics in distributed generation-Regulation comparison with other international electric markets experiences - Regulation of the electric sector impact on distributed generation- Standard State of the art - Power supply quality generic standards - Renewable energies specific standards</p>	09	CO5, CO6

**Text Books:**

1. Renewable and Efficient Electric Power Systems, Gilbert M, A John Wiley & Sons, Inc., Publication
2. Integration of Distributed Generation in the Power System-2011, Math H. J. Bollen and Fainan Hassan, IEEE Press
3. Control of Power Inverters in Renewable Energy and Smart Grid Integration (Wiley-IEEE Press, 2013).

**Reference Books:**

1. Integration of Alternative Sources of Energy, Felix A. Farret and M. Godoy Simoes. 2006, John Wiley and Sons.
2. Distributed Generation The Power Paradigm for the New Millennium Anne-Marie Borbely, Jan F. Kreider CRC Press, 2001.
3. Large Energy storage Systems Handbook , Frank S. Barnes & Jonah G. Levine, CRC Press, 2011.
4. Integration and Control of Renewable Energy in Electric Power System, Ali Keyhani Mohammad Marwali and Min Dai John Wiley publishing company 2009.
5. Renewable Energy Sources and Emerging Technologies, Ranjan Rakesh, Kothari D.P, Singal K.C, 2<sup>nd</sup> Ed.

**Assessment Pattern**

Blooms levels	CIE –Theory (50 Marks)				SEE - Theory
	Test = 25	Assignment = 10	Quiz = 5	Curricular/Co-Curricular Activities = 10	Examination = 50
Remember	5	-	-	-	5
Understand	4	-	1	-	10
Apply	8	5	1	10	10
Analyze	4	5	1	-	10
Evaluate	4	-	1	-	10
Create	-	-	1	-	5

## PROFESSIONAL ELECTIVE-VI

### SOLAR PHOTO VOLTAIC FUNDAMENTALS, TECHNOLOGIES AND APPLICATIONS

Course Code : EEE821  
L: T: P: S : 3:0:0:1  
Exam Hours : 03

Credits : 04  
CIE Marks : 50  
SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Understand the basics of photovoltaic cells
<b>CO2</b>	Choose appropriate battery charging for different applications
<b>CO3</b>	Develop maximum power point tracking techniques
<b>CO4</b>	Analyze solar irradiation and design an appropriate solar PV system for power generation
<b>CO5</b>	Evaluate and design standalone and grid connected PV systems based on the consumer demand
<b>CO6</b>	Design appropriate PV arrays based on the applications

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3	3	2	2	-	1	-	1	-	1	1
<b>CO2</b>	3	3	3	2	2	-	1	-	1	-	1	1
<b>CO3</b>	3	3	3	2	2	-	1	-	1	-	1	1
<b>CO4</b>	3	3	3	2	2	-	1	-	1	-	1	1
<b>CO5</b>	3	3	3	2	2	-	1	-	1	-	1	1
<b>CO6</b>	3	3	3	2	2	-	1	-	1	-	1	1

Module No	Module Contents	Hours	Cos
1	<b>THE PV CELL:</b> Evolution of PV cell, Characteristics and equivalent circuit, Model of PV cell, Short Circuit, Open Circuit and Peak power parameters, Data sheet study Cell efficiency, Effect of temperature, Temperature effect calculation, Fill factor, PV cell simulation, PV cell interconnection	09	CO3
2	<b>PV DESIGN:</b> Solar modules, Storage systems, Power conditioning and regulation, Protection, Sizing and design of PV system	09	CO1
3	<b>MAXIMUM POWER POINT TRACKING:</b> Concept of MPPT, algorithms, Perturb-Observe method, Incremental Conductance method,	09	CO2, CO6
4	<b>STAND ALONE AND GRID CONNECTED PV SYSTEM:</b> Stand –alone PV system, Configurations, Grid connected PV systems, Configuration and working of single stage grid connected PV system	09	CO5, CO6
5	<b>APPLICATIONS OF SOLAR PV SYSTEM:</b> Battery chargers, Domestic and Street lighting, Water pumping, Solar PV power plant, Industry applications and Telecommunications.	09	CO4

**Text Books:**

1. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki, Prentice-Hall of India Pvt. Limited, Third Edition edition, 2018 Reprint.
2. Applied Photovoltaics, Stuart R. Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, 2017, Earthscan, UK
3. Large Energy storage Systems Handbook, Frank S. Barnes & Jonah G. Levine, CRC Press, 2015.

**Reference Books:**

1. Renewable and Efficient Electric Power Systems, Gilbert M. Masters: John Wiley & Sons, 2014.
2. Photovoltaic Systems Engineering, Roger A. Messenger & Jerry Ventre: CRC Press, 2014, 2<sup>nd</sup> edition.

**Assessment Pattern:**

<b>Blooms levels</b>	<b>CIE( 50Marks)</b>				<b>SEE( 50Marks)</b>
	<b>Test = 25</b>	<b>Assignment = 15</b>	<b>Quiz = 05</b>	<b>Self-Study Assessment= 10</b>	<b>Examination = 50</b>
<b>Remember</b>	-	-	-	-	5
<b>Understand</b>	2	2	1	-	10
<b>Apply</b>	5	2	1	5	10
<b>Analyze</b>	8	2	1	-	10
<b>Evaluate</b>	5	2	1	-	10
<b>Create</b>	5	2	1	5	5

## SIMULATION OF POWER ELECTRONICS

**Course Code: EEE822**

**L: T: P: S: 3:0:0:1**

**Exam Hours: 03**

**Credits: 03**

**CIE Marks: 50**

**SEE Marks: 50**

**Course Outcomes:** At the end of the Course, the student will be able to:

<b>CO1</b>	Apply mathematical skills to represent mathematically a physical system
<b>CO2</b>	Apply various modelling methods to develop mathematical modelling
<b>CO3</b>	Design and develop digital controllers to control current and voltage of a Power Electronics system
<b>CO4</b>	Apply modern engineering software tools such as MATLAB software to develop model for various Power Electronics circuits.
<b>CO5</b>	Extract information through appropriate design techniques and tools for simulation of Power Electronics based circuits published in conference/ journal papers.
<b>CO6</b>	Demonstrate capacity for self-management and teamwork, communicate regarding activities carried out as a part of self-study confidently and effectively, to comprehend and write effective reports and design documentation

Mapping of Course Outcomes to Program Outcomes:

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	3	3	2	2	2	-	-	-	-	-	1	1
<b>CO2</b>	3	3	2	2	2	-	-	-	-	-	1	1
<b>CO3</b>	3	3	2	2	2	-	-	-	-	-	1	1
<b>CO4</b>	3	3	2	2	2	-	-	-	-	-	1	1
<b>CO5</b>	3	3	2	2	2	-	-	-	-	-	1	1
<b>CO6</b>	3	3	2	2	2	-	-	-	-	-	1	1

<b>Module</b>	<b>Module Contents</b>	<b>No Hours</b>	<b>COs</b>
<b>1</b>	<b>COMPUTER SIMULATION OF POWER ELECTRONIC CONVERTERS AND SYSTEMS</b> Challenges in computer simulation, simulation process, Types of analysis, mechanics of simulation, circuit-oriented simulators, equation solvers, comparison of circuit oriented simulators and equation solvers.	9	CO1 CO2
<b>2</b>	<b>MODELLING OF SYSTEMS</b> Input-Output relations, differential equations and linearization, state space representation, transfer function representation, modelling of an armature controlled DC Motor, poles and zeroes circuit averaging method of modelling approach for switched power electronic circuits,	9	CO3

3	<b>SPACE VECTOR MODELLING</b> Space vectors, representation of space vectors in orthogonal co-ordinates, space vector transformations, modelling of induction motor, and state space representation of the d-q model of the induction motor.	9	CO4
4	<b>DIGITAL CONTROLLER DESIGN</b> Controller design techniques, Bode diagram method, PID controller, design, root locus method, state space method. Tracker, controller design, controlling voltage, controlling current.	9	CO5
5	<b>DISCRETE COMPUTATION ESSENTIALS</b> Numeric formats, fixed -point numeric format, floating -point numeric format, tracking the base point in the fixed point system, addition of numbers, subtraction of numbers, multiplication of numbers, normalization and scaling, multiplication algorithm, arithmetic algorithm reciprocal, square root, reciprocal of square root, sine and cosine exponential, logarithm, implementation examples, pi controller, sine and cosine, pulse width modulation, space vector pwm, over-modulation.	9	CO6

**TEXT BOOKS:**

1. Simulation of Power Electronic circuits, M.B.Patil, M.C.Chandorkar, Ramanarayanan. V, Ranganathan, V. T, Alpha Science International Ltd, 2015
2. Control Design Techniques in Power Electronics Devices, Hebertt Sira-Ramirez, Silva-Ortigoza, Springer, 2016

**REFERENCES:**

1. Power Electronics (With MATLAB), Bansal RC, Joshi RR, Vinod kumar, Himanshu Publications, 2009
2. Power Electronics: Devices, Circuits And Matlab Simulations, Alok Jain, Penram International Publishing Pvt Ltd, 2010

## Assessment Pattern

### Implementation of Bloom's Taxonomy in CIE (50 Marks) and SEE (50 marks)

Blooms levels	CIE( 50Marks)				SEE( 50Marks)
	Test = 25	Assignment = 10	Quiz = 05	Self-Study Assessment= 10	Examination = 50
<b>Remember</b>	2	-	-	-	5
<b>Understand</b>	5	-	1	-	10
<b>Apply</b>	5	3	1	5	10
<b>Analyze</b>	5	2	1	-	10
<b>Evaluate</b>	5	2	1	-	10
<b>Create</b>	3	3	1	5	5

## BIOMEDICAL INSTRUMENTATION

Course Code: EEE823

L: T: P: S: 3:0:0:1

Exam Hours: 03

Credits: 04

CIE Marks: 50

SEE Marks: 50

**Course Outcomes:** At the end of the Course, the student will be able to:

<b>CO1</b>	Inculcate the knowledge about the electrodes and equivalent circuits
<b>CO2</b>	Illustrate origin of bio potentials and its propagations
<b>CO3</b>	Understand the different types of electrodes and its placement for various recordings
<b>CO4</b>	Design bio amplifier for various physiological recordings
<b>CO5</b>	Learn the different measurement techniques for non-physiological parameters.
<b>CO6</b>	Summarize different biochemical measurements.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2	-	-	-	1	-	-	-	1	-	-
<b>CO2</b>	3	2	1	-	-	2	-	-	-	1	-	-
<b>CO3</b>	3	1	1	-	-	2	1	-	-	1	-	2
<b>CO4</b>	3	2	3	2	-	2	1	-	-	-	2	2
<b>CO5</b>	3	1	1	1	-	1	1	1	-	-	-	2
<b>CO6</b>	3	1	1	1	-	2	2	-	-	-	-	-

Module	Module Contents	No Hours	COs
1	<b>BIOPOTENTIAL ELECTRODES:</b> Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode-skin interface, half-cell potential, Contact impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - motion artifacts, measurement with two electrodes.	9	CO1 CO2
2	<b>BIOPOTENTIAL MEASUREMENTS:</b> Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven’s triangle, standard 12 lead system, Principles of vector cardiography. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG and EGG.	9	CO3
3	<b>SIGNAL CONDITIONING CIRCUITS:</b> Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and	9	CO4

	AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering		
4	<b>MEASUREMENT OF NON-ELECTRICAL PARAMETERS:</b> Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods -Auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.	9	CO5
5	<b>BIOCHEMICAL MEASUREMENT AND BIOSENSORS:</b> Biochemical sensors - pH, pO <sub>2</sub> and pCO <sub>2</sub> , Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description) – Bio Sensors – Principles – amperometric and voltometric techniques.	9	CO6

**TEXT BOOK:**

1. Leslie Cromwell, —Biomedical Instrumentation and measurement||, 2nd edition, Prentice hall of India, New Delhi, 2015.
2. John G. Webster, —Medical Instrumentation Application and Design||, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.

**REFERENCES:**

1. Joseph J. Carr and John M. Brown, —Introduction to Biomedical Equipment Technology||, Pearson Education, 2004.
2. Myer Kutz, —Standard Handbook of Biomedical Engineering and Design||, McGraw Hill Publisher, 2003.
3. Khandpur R.S, —Handbook of Biomedical Instrumentation||, 3rd edition, Tata McGraw-Hill

## Assessment Pattern

### Implementation of Bloom's Taxonomy in CIE (50 Marks) and SEE (50 marks)

Blooms levels	CIE( 50Marks)				SEE( 50Marks)
	Test = 25	Assignment = 10	Quiz = 05	Self-Study Assessment= 10	Examination = 50
<b>Remember</b>	2	-	-	-	5
<b>Understand</b>	5	-	1	-	10
<b>Apply</b>	5	3	1	5	10
<b>Analyze</b>	5	2	1	-	10
<b>Evaluate</b>	5	2	1	-	10
<b>Create</b>	3	3	1	5	5

## APPLICATIONS OF IOT IN ELECTRICAL ENGINEERING

Course Code : EEE824

Credits : 04

L: T: P: S : 3:0:0:1

CIE Marks : 50

Exam Hours : 03

SEE Marks : 50

**Course Outcomes: At the end of the Course, the student will be able to:**

<b>CO1</b>	Identify the main components of Internet of Things.
<b>CO2</b>	Program the sensors and controller as part of IOT.
<b>CO3</b>	Assess different Internet of Things technologies and their applications.
<b>CO4</b>	Design a component or a product applying all the relevant standards and with realistic constraints.
<b>CO5</b>	Identify a suitable hardware and software solution for the given electrical and electronics problems.
<b>CO6</b>	Execute their electrical and electronics product ideas into a real-time working model.

**Mapping of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
<b>CO1</b>	-	3	-	-	-	-	-	-	-	-	-	3
<b>CO2</b>	3	1	1	2	3	-	-	-	1	1	-	-
<b>CO3</b>	-	-	3	-	3	3	3	3	-	-	-	-
<b>CO4</b>	3	3	3	3	3	3	3	1	3	-	2	3
<b>CO5</b>	-	3	3	3	3	2	1	2	3	-	3	3
<b>CO6</b>	3	3	3	3	3	3	1	1	3	-	3	3

Module No	Contents of the Module	Hours	COs
1	<p><b>INTRODUCTION TO INTERNET OF THINGS:</b> Definition &amp; Characteristics of IoT - Challenges and Issues - Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security.</p> <p><b>COMPONENTS IN INTERNET OF THINGS:</b> Control Units – Communication modules –Bluetooth – Zigbee – Wifi – GPS- IOT Protocols (IPv6, 6LoWPAN, RPL, CoAP), MQTT, Wired Communication, Power Sources. Current trends in IoT.</p>	09	CO1 CO2
2	<p><b>PROGRAMMING THE MICROCONTROLLER FOR IOT:</b> Introduction of Raspberry Pi 3 B+ - About Raspberry version and processor, specification, pin details, features. Raspberry OS, IP configuration, Wi-Fi configuration, supporting package installation. Basic Linux commands, basic python programming, web server installation, Basic HTML and PHP, connecting My SQL data base. Different type of IoT Gate way.</p>	09	CO2 CO3
3	<p><b>HARDWARE INTERFACING:</b> Working principles of sensors – IOT deployment for Raspberry Pi – Reading from Sensors, Communication: Connecting microcontroller with mobile devices – communication through Bluetooth, Wi-Fi and USB - Contiki OS. Camera interface, Think speck IoT platform, Android interface with IoT.</p>	09	CO2 CO3
4	<p><b>RESOURCE MANAGEMENT IN IOT:</b> Clustering, Clustering for Scalability, Clustering Protocols for IoT - From the internet of things to the web of things - The Future Web of Things – Set up cloud environment – Cloud access from sensors– Data Analytics for IOT- Case studies- Open Source ‘e-Health sensor platform’ – ‘Be Close Elderly monitoring’ – Other recent projects.</p>	09	CO2 CO3 CO4 CO5
5	<p><b>IOT APPLICATIONS:</b> Business models for the internet of things, Home energy management, home automation, smart meter, smart city, smart mobility and transport, smart buildings and infrastructure, smart health, environment monitoring and surveillance.</p>	09	CO6

**Text Books:**

1. Architecting the Internet of Things, Dieter Uckelmann et.al Springer, 2011
2. Internet of Things – A Hand-on Approach, Arshdeep Bahga and Vijay Madiseti, Universities press, 2015

**Reference Books:**

1. Building Internet of Things with the Arduino, Charalampos Doukas, Create space, April 2002.
2. Internet of Things: From research and innovation to market deployment, Dr. Ovidiu Vermesan and Dr. Peter Friess, River Publishers 2014.
3. 8051 Microcontroller: An Application Based Introduction, David Calcutt, Fred Hassan, Newness, 2008.
4. Contiki: The open source for IOT, [www.contiki-os.org](http://www.contiki-os.org)

**Assessment Pattern****Implementation of Bloom's Taxonomy in CIE (50 Marks) and SEE (50 marks)**

Blooms levels	CIE –Theory (50 Marks)				SEE – Theory (50 Marks)
	Test (25 Marks)	Assignment (10 Marks)	Quiz (5 Marks)	Self-Study (10 Marks)	Examination (50 Marks)
Remember	-	-	2	-	5
Understand	5	-	1	-	5
Apply	5	5	-	-	10
Analyze	-	-	1	-	10
Evaluate	5	-	1	-	10
Create	10	5	-	10	10

## APPENDIX A

### Outcome Based Education

**Outcome-based education** (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.

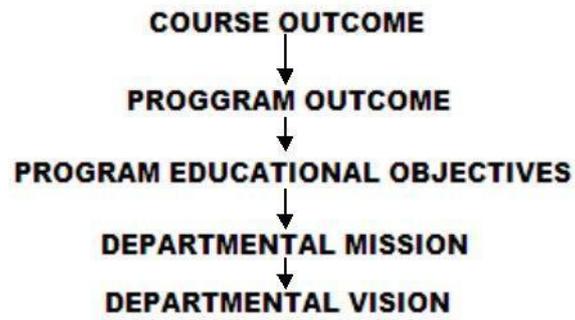
There are three educational Outcomes as defined by the National Board of Accreditation:

**Program Educational Objectives:** The Educational objectives of an engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

**Program Outcomes:** What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix C

**Course Outcome:** The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes

## Mapping of Outcomes



## APPENDIX B

### The Graduate Attributes of NBA

**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Conduct investigations of complex problems:** The problems that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline. \* That may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions. Hat require consideration of appropriate constraints/requirements not explicitly given in the problem statement. (like: cost, power requirement, durability, product life, etc.). which need to be defined (modeled) within appropriate mathematical framework. that often require use of modern computational concepts and tools.#

**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## APPENDIX C

### BLOOM'S TAXONOMY

**Bloom's taxonomy** is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of [assessments](#) (tests and other evaluations of student learning), [curriculum](#) (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies. [eduglosarry.org]

