Department of Electrical & Electronics Engineering

Academic Year 2020-21

Seventh and Eighth Semesters B.E

Scheme and Syllabus

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.

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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)	Contac t 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	NHOPX	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	50
TOTAL							**22**	**19**	**06**	**350**	**350**	**700**

Professional Elective III		
Sl 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		
Sl 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)	Contac t 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
TOTAL							**22**	**8**	**0**	**200**	**200**	**400**

Professional Elective V		
Sl No	**Course Code**	**Course**
1	EEE811A	Estimation and Costing of electrical systems
2	EEE812A	Smart Grid
3	EEE813A	Power Quality
4	EEE814A	Integration of distributed generation
Professional Elective VI		
Sl 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**	**Credits**	**: 03+02**
L:T:P:S	**: 3:0:2:0**	**CIE Marks**	**: 50+25**
Exam Hours	**: 03**	**SEE Marks**	**: 50+25**

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

CO1	Get introduced to various network topology and compare the same with practical power system network
CO2	Evaluate network matrices for power system using prevailing methods
CO3	Conduct the load flow analysis of typical power system network using conventional algorithms
CO4	Understand importance of economic operation of the power system
CO5	Develop mathematical models for power system using dedicated software tools and thus analyze power system stability.
CO6	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**
CO1	3	3	2	2	2	2	1	1	1	1	2	2
CO2	3	3	2	2	2	2	1	1	1	1	2	2
CO3	3	3	2	2	2	2	1	1	1	1	2	2
CO4	3	3	2	2	2	2	1	1	1	1	2	2
CO5	3	3	2	2	2	2	1	1	1	1	2	2
CO6	3	2	2	2	2	2	1	1	1	1	2	2

SYLLABUS			
Module.	**Contents of Module**	**Hrs**	**Cos**
1	**NETWORK TOPOLOGY**: 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 **NETWORK MATRICES:** Introduction, Formation of YBUS by method of inspection (including transformer off-nominal tap setting) and method of singular transformation (YBUS = $A^T yA$), Formation of Bus Impedance matrix by step by step building algorithm (without mutual coupling elements).	9	C01 C02 C05

	List of Experiments **1.** Y Bus formation for power systems with and without mutual coupling, by singular transformation and inspection method. **2.** Determination of bus currents, bus power and line flow for a specified system voltage (Bus) Profile. **3.** Formation of Z-bus(without mutual coupling) using Z-bus building Algorithm .	9	
2	**LOAD FLOW STUDIES:** Introduction, Power flow equations, Classification of buses, Operating constraints, Data for load flow-modeling of power system components (Load, Shunt elements, Transformer, Generator). **LOAD FLOW TECHNIQUES:** 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.	9	C03 C05
	List of Experiments **1.** Write a program to perform load flow analysis using Gauss-Seidel method (both PQ and PV bus). **2.** Formation of Jacobian for a system not exceeding 4 buses (no PV buses) in polar coordinates. **3.** Load flow analysis using Gauss Siedel method, NR method, Fast decoupled method for both pq and pv buses using MiPower.	9	
3	**ECONOMIC OPERATION OF POWER SYSTEM:** 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. **HYDROTHERMALCOORDINATION:** Indroduction, Optimal scheduling for Hydrothermal plants – problem formulation, solution procedure and algorithm (excluding problems).	9	C03 C04
	List of Experiments **1.** Optimal Generation Scheduling for Thermal power plants.	6	

4	**TRANSIENT STABILITY STUDIES.A:** 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. **TRANSIENT STABILITY STUDIES.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
	List of Experiments **1.** 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. **2.** 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	**CASE STUDY:** 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
	List of Experiments **1.** ABCD parameters: Formation for symmetric π/T configuration. Verification of AD-BC=1 Determination of efficiency and regulation **2.** 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 EI-Abiad, McGraw Hill International, 2nd edision ,2014.
3. Computer Techniques in Power System, M.A.Pai, Tata McGraw Hill,2nd edision,2014.

Reference Books:
1. Power system Analysis & Design, Glover Sarma, Thomson Learninfg,3rd 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,1st edision, 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	Curricular/Co-Curricular Activities = 10	Examination = 25
Remember	3	-	2	-	5
Understand	6	5	2	-	-
Apply	7	5	2	-	5
Analyze	3	5	2	10	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**	**Credits**	**: 03+02**
L:T:P:S	**: 3:0:2:0**	**CIE Marks**	**: 50+25**
Exam Hours	**: 03**	**SEE Marks**	**: 50+25**

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

CO1	Understand the architecture of an advanced industrial automation system and SCADA
CO2	Analyse and configure connections between elements of an advanced or a building automation system.
CO3	Analyse and configure the fire alarm system the components
CO4	Analyse and configure connections of CCTV and access control system
CO5	Understand the various security system for home automation
CO6	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
CO1	3	2	2	3	3	2	1	-	2	2	2	3
CO2	3	3	3	3	3	2	2	1	1	3	3	3
CO3	3	3	3	3	3	2	2	1	2	3	3	3
CO4	3	3	3	3	3	2	2	1	2	3	3	3
CO5	3	2	2	3	3	2	1	-	1	3	2	3
CO6	3	3	3	3	3	3	2	1	2	2	3	3

Module	Contents of the Module	Hours	COs
1	**Introduction to Advanced PLC and SCADA:** 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. **List of Experiments** 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.	9	CO1
2	**Introduction to Building management system and energy management systems:** 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 **List of Experiments** 1.Design of a EMS and BMS, 2. Configuration of a EMS and BMS, Applications with Schneider Software.	9	CO2 , CO6
3	**Fire alarm systems:** Applications, FAS architecture: Types of Architecture and Examples. Fire Alarm System Devices and Standards **Practical activities:** 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 **List of Experiments** 1.Design of a fire alarm system, 2. Configuration of a fire alarm system, Applications with Schneider control panel and software tools.	9	CO3

4	**CCTV and access control systems:** Access Components, Access control system Design and Standards. CCTV: Camera: Operation & 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. **List of Experiments** 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	9	CO4
5	**Home automation systems:** 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. **List of Experiments** 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 .	9	CO5, CO4

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	Curricular/Co-Curricular Activities = 10	Examination = 25
Remember	5	2	2	-	-
Understand	6	4	2	-	5
Apply	5	6	2	10	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 **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:

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

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**POI0**	**POII**	**PO12**
CO1	3	1	1	1	1	3	3	2	1	1	2	3
CO2	3	1	1	1	1	3	3	2	1	1	2	3
CO3	3	3	3	1	2	3	2	2	1	1	2	3
CO4	3	3	3	1	2	3	3	2	1	1	2	3
CO5	3	3	3	1	2	3	3	2	1	1	2	3
CO6	3	1	1	1	1	3	3	3	3	1	2	3

Module No	Module Contents	Hours	COs
1	**INTRODUCTION TO ELECTRIC VEHICLES:** History of Electric vehicle, Definition vehicle, Need of electric vehicle, Architecture of Electric Vehicle, Configuration of Electric vehicle **VEHICLE FUNDAMENTALS:** 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.	09	CO1, CO2
2	**ELECTRIC VEHICLE ENERGY SOURCES:** Electrochemical batteries, Electrochemical reaction, Thermodynamic voltage, Specific energy, specific power, energy efficiency, Battery technology, ultracapacitors, Flywheels. **ELECTRIC VEHICLE MOTORS (CONSTRUCTIONS AND FEATURES ONLY):** Electric vehicle Motor requirements, Induction motor, DC Motors, Permanent Magnet Brushless DC motor, Switched Reluctance Motors, Stator Permanent Magnet Motor.	09	CO3
3	**DYNAMICS OF ELECTRICAL DRIVES:** 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. **SELECTION OF MOTOR POWER RATINGS:** Thermal Model of motor for heating and cooling, Classes of Motor duty, Determination of Motor rating.	09	CO4
4	**DC MOTOR DRIVES:** 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. **INDUCTION MOTOR DRIVES:** 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.	09	CO5
5	**SYNCHRONOUS MOTOR AND BRUSHLESS DC MOTOR DRIVES:** Synchrounous Motor variable speed drives, Permanent magnet AC motor drives, Sinusoidal PMAC motor drives, Brushless DC motor drives.	09	CO2, CO4, CO5,

	SWITCHED RELUCTANCE MOTOR DRIVE: Operation and control requirements, converter circuits, modes of operation, Case studies of different EVs.		

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, 3rd 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

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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:

CO1	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
CO2	Learn the method of shunt compensation by using static VAR compensators and their applications
CO3	Understand the working of STATCOM and UPFC.
CO4	Analyze different converter topologies viz. 3, 6 and 12 Pulse converters and understand it's control aspects.
CO5	Analyze different types of DC links and applications of DC transmission.
CO6	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**	**POI0**	**POII**	**PO12**
CO1	3	2	3	2	2	2	2	-	-	1	1	2
CO2	3	2	3	2	2	2	2	-	-	1	1	2
CO3	3	2	3	2	2	2	2	-	-	1	1	2
CO4	3	2	3	2	2	2	2	-	-	1	1	2
CO5	3	2	3	2	2	2	2	-	-	1	1	2
CO6	3	2	3	2	2	2	2	-	-	1	1	2

Module No	**Module Contents**	**Hours**	**COs**
1	**INTRODUCTION:** 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.	09	CO1, CO2, CO6

2	**STATIC VAR COMPENSATOR (SVC):** 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.	09	CO1,C O2, CO6
3	**VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS:** 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.	09	CO3, CO6
4	**GENERAL ASPECTS OF DC TRANSMISSION AND COMPARISON OF IT WITH AC TRANSMISSION :** 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.	09	CO5, CO6
5	**STATIC POWER CONVERTERS:** 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.	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 Rehtanz
   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:

CO1	Describe the method of procurement process and state-of-the art global practices in maintenance of electrical equipment.
CO2	Analyze and explaining of the requirement common to all equipment.
CO3	Understand the specifications Installation and testing of transformers
CO4	Analyze and explain the Installation and testing of induction motors.
CO5	Understand and explain about the Installation of synchronous machines.
CO6	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**	**POI0**	**POII**	**PO12**
CO1	3	2	2	1	2	3	2	-	-	1	2	2
CO2	3	2	2	1	2	3	2	-	-	1	2	2
CO3	3	2	2	1	2	3	2	-	-	1	2	2
CO4	3	2	2	1	2	3	2	-	-	1	2	2
CO5	3	2	2	1	2	3	2	-	-	1	2	2
CO6	3	2	2	1	2	3	2	-	-	1	2	2

Module No	Module Contents	Hours	COs
1	**PROCUREMENT PROCESS:** Tender specifications based on requirement and national, international codes and standards, compiling tender documents & vendor assessment, inviting tenders, scrutiny and evaluation of bids (technical and financial) acceptance and award of contract with necessary safety and security classes.	6	CO1
2	**REQUIREMENTS COMMON TO ALL EQUIPMENT:** 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.	8	CO2
3	**TRANSFORMERS:** Specification: Power& 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.	12	CO2, CO3
4	**INDUCTION MOTORS:** 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.	10	CO2, CO4
5	**SYNCHRONOUS MACHINES:** 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, excitation system and cooling arrangements. Commissioning	9	CO2, CO5, CO6

	Tests: Pre-Commissioning tests, physical examination, alignment and air gap, armature and filed winding insulation resistance, balancing and vibration, no load run and frame earthing, pedestal insulation, load test and temperature rise, hot and cold IR values.		

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.KrishanPillai, 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:

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

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	POI0	POII	PO12
CO1	3	1	3	1	1	1	-	-	-	-	3	-
CO2	3	1	3	3	3	1	3	-	-	-	3	-
CO3	3	1	1	3	3	1	-	-	-	-	-	-
CO4	3	1	1	3	2	3	3	3	-	-	3	2
CO5	3	2	1	3	2	2	-	-	-	-	1	-
CO6	3	2	1	3	2	2	-	-	-	-	-	-

Module No	Module Contents	Hours	COs
1	**INTRODUCTION:** Energy situation – world and India, energy consumption, conservation. Codes, standards and Legislation. **ENERGY ECONOMIC ANALYSIS:** The time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit – numerical problems.	09	CO1, CO2
2	**ENERGY AUDITING:** Introduction, Elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results **ELECTRICAL SYSTEM OPTIMIZATION:** The power triangle, Motor horsepower, Power flow concept. Electrical Equipment and power factor –correction & location of capacitors.	09	CO3 CO4
3	**LIGHTING AND ENERGY INSTRUMENTS** 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 **ENERGY EFFICIENT MOTORS** 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.	09	CO3 CO5
4	**ENERGY CONSERVATION:** 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 **ENERGY AUDIT APPLIED TO BUILDINGS:** Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings	09	CO4 CO6
5	**DEMAND SIDE MANAGEMENT – I:** 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. **Demand Side Management -II** Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. Management and Organization of Energy	09	CO2, CO3, CO6,

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**	**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:

CO1	Identify the selection of motor depends on its applications
CO2	Design the illumination level for different lighting system
CO3	Understand the basic concept of electric welding & heating and its applications
CO4	Understand the basic principles of refrigeration & air conditioning system
CO5	Identify the power factor necessity and its improvement methods with economic aspects
CO6	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**	**POI0**	**POII**	**PO12**
CO1	3	2	3	2	1	3	1	-	-	-	1	3
CO2	3	3	3	3	1	2	1	-	-	-	1	3
CO3	3	1	1	1	1	-	2	1	-	-	1	2
CO4	3	1	1	-	1	2	3	1	-	-	-	2
CO5	3	3	3	2	1	2	1	-	-	-	3	3
CO6	3	3	3	3	1	2	1	-	-	-	1	3

Module No	SYLLABUS	Hours	COs
1	**ELECTRIC DRIVES AND TRACTION** 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.	09	CO1
2	**ILLUMINATION** 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.	09	CO2
3	**HEATING AND WELDING** 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	09	CO3
4	**REFRIGERATION AND AIR CONDITIONING** 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	09	CO4
5	**ECONOMIC ASPECTS OF UTILISING ELECTRICAL ENERGY** 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	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:

CO1	Understand the Operating States of Power System and Megawatt-frequency and Megavar-Voltage control loops.
CO2	Model the Generator, Turbine, Governor, Tie-Line and analyze the response of single area and two area systems.
CO3	Analyze the reactive power requirement at a point in system and suggest the compensation.
CO4	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
CO5	Analyze the contingency of a system using Linear Sensitivity Factors and understand the concept of Synchrophasors, Phasor Measurement Unit and Wide Area Monitoring Systems
CO6	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**	**POI0**	**PO11**	**PO12**
CO1	3	–	–	–	–	–	–	–	–	–	–	–
CO2	3	3	–	–	–	–	–	–	–	–	–	–
CO3	3	3	1	2	–	–	–	2	–	–	2	3
CO4	3	3	–	2	–	2	2	2	–	–	2	3
CO5	3	3	–	2	–	2	2	–	–	–	–	3
CO6	3	3	–	2	–	2	2	–	–	–	–	3

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

2	**LOAD FREQUENCY CONTROL:** 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	**REACTIVE POWER AND VOLTAGE CONTROL:** 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	**ECONOMIC DISPATCH OF THERMAL UNITS AND UNIT COMMITMENT:** 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	**POWER SYSTEM SECURITY& MODERN TRENDS IN POWER SYSTEM CONTROL:** 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, ,Synchro-phasors**,** Phasor Measurement Unit (PMU)**,** Wide Area Monitoring System (WAMS), Overview of WAMS in Indian Grid.	09	CO5

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**	**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:

CO1	Define the solar related systems efficiently
CO2	List and generally explain the main sources of energy and their primary applications
CO3	Explain the principles that underlie the ability of various natural phenomena to deliver solar energy
CO4	Evaluate the power electronics devices needed for the solar electric systems
CO5	outline the technologies that are used to harness the power of solar energy
CO6	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**
CO1	3	2	1	2	2	3	3	1	1	2	2	3
CO2	3	2	1	2	2	3	3	1	1	2	2	3
CO3	3	2	1	2	2	3	3	1	1	2	2	3
CO4	3	2	1	2	2	3	3	1	1	2	2	3
CO5	3	2	1	2	2	3	3	1	1	2	2	3
CO6	3	2	1	2	2	3	3	1	1	2	2	3

Module No	Module Contents	Hours	Cos
1	**ENERGY SOURCES:** 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. **SOLAR ENERGY BASICS:** 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 Pyrheliometer.	09	CO1, CO2
2	**SOLAR RESOURCE AND RADIATION:** Solar resources, Quantifying solar radiation, The effect of the Earth's atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays. **PV INDUSTRY AND TECHNOLOGY:** 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.	09	CO3
3	**PV CELLS, MODULES AND ARRAYS:** 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 array, Photovoltaic array performance, Irradiance, Temperature, Shading. **SOLAR THERMAL SYSTEMS:** 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.	09	CO4

4	**INVERTERS AND OTHER SYSTEM COMPONENTS:** 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.	09	CO5
5	**MOUNTING SYSTEMS:** 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. **SITE ASSESSMENT:** 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.	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, 1st 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, 3rd 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:

CO1	Understand the concepts of neural networks and fuzzy logic
CO2	Design and develop artificial and neural network based algorithms
CO3	Evaluate the better algorithms for the successful implementation
CO4	Analyze the operation of neural network and fuzzy based systems
CO5	Use modern tools for understanding and implementation
CO6	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**	**POI0**	**POII**	**PO12**
CO1	3	3	3	2	1	3	1	2	2	1	1	2
CO2	3	3	3	2	2	3	1	2	3	3	3	2
CO3	3	3	3	3	2	3	1	3	3	3	3	2
CO4	3	3	3	2	2	3	1	2	3	3	3	2
CO5	3	3	3	2	3	3	1	2	3	2	2	2
CO6	3	3	3	2	2	3	1	3	3	2	1	2

Module No	**Module Contents**	**Hours**	**COs**

1	**EVOLUTION OF NEURAL NETWORKS:** Artificial Neural Network: Basic model, Classification, Feed forward and Recurrent topologies, Activation functions; Learning algorithms: Supervised, Un-supervised and Reinforcement; Fundamentals of connectionist modeling: McCulloach – Pits model, Perceptron, Adaline, Madaline.	09	CO1 CO2
2	**TOPOLOGY OF MULTI-LAYER PERCEPTRON:** 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.	09	CO2 CO3
3	**RECURRENT NEURAL NETWORKS:** 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.	09	CO4
4	**CLASSICAL AND FUZZY SETS:** 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 arithmetic; composition and inference; Considerations of fuzzy decision-making	09	CO4 CO5

5	**BASIC STRUCTURE AND OPERATION OF FUZZY LOGIC CONTROL SYSTEMS:** 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,2nd edition, 2017.
2. Fuzzy Sets and Fuzzy Logic: Theory and A: Theory and Applications , Pearson Education, India, 1st edition , 2015.
3. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Wiley, 3rd edition, 2011.

Reference Books:

1. Make Your Own Neural Network, Tariq Rashid, CreateSpace Independent Publishing Platform, 1st 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	5	-	-	-
Create	-	-	-	-

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**	**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:

CO1	Analyze estimation & costing, Necessity and procedures for estimation and costing, major applicable I.E rules and acts, Types and materials used for wiring
CO2	Understand general rules, guidelines for internal wiring, preparation of detailed estimates and costing of internal wiring, Inspection and testing of wiring installations
CO3	Apply the procedure for service connection, design, estimation and costing of underground and overhead service connections.
CO4	Analyze the Important considerations regarding motor installation wiring, Design and Estimation of components required for Motor installation and costing the same
CO5	Design overhead transmission & distribution lines. Typical AC electrical power system, Estimation & costing of transmission & distribution lines
CO6	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	POI0	POII	PO12
CO1	3	3	2	1	2	2	1	1	3	3	3	3
CO2	3	3	2	2	2	2	1	1	3	3	3	3
CO3	3	3	2	2	2	2	1	1	3	3	3	3
CO4	3	3	3	2	2	2	1	1	3	3	3	3
CO5	3	3	3	2	2	2	1	1	3	3	3	3
CO6	3	3	3	2	2	2	1	1	3	3	3	3

Module No	Module Contents	Hours	Cos
1	**PRINCIPLES OF ESTIMATION & COSTING:** Introduction to estimation & 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. **WIRING:** 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.	09	CO1
2	**INTERNAL WIRING ESTIMATION:** 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. **INSPECTION AND TESTING OF INSTALLATIONS:** 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.	09	CO2
3	**INSTALLATION OF SERVICE CONNECTIONS:** 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, **ELECTRICAL INSTALLATION FOR POWER CIRCUITS** : 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.	09	CO3, CO4
4	**ESTIMATION OF OVERHEAD TRANSMISSION & DISTRIBUTION LINES:** Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports, Factors governing height of pole, Conductor materials, Determination of size of	09	CO5

	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. **ESTIMATION OF OVERHEAD TRANSMISSION & DISTRIBUTION LINES (CONTINUED):** 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.		
5	**DESIGN AND ESTIMATION OF SUBSTATIONS:** 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. **REMOTE CONTROL WIRING:** Remote control Switching, Remote control selection considerations, types of control devices, motor control circuits.	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 1st 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

Course Code : EEE812A **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:

CO1	Understand the concept of Smart Grid, compare with conventional grid, and identify its opportunities and barriers.
CO2	Understand the concept of Smart Meter, Smart Appliances, Plug in Hybrid Electric Vehicles, Vehicle to Grid, Smart Sensors.
CO3	Understand the concept of Substation Automation, Feeder Automation, Intelligent Electronic Devices, Smart storage like Battery.
CO4	Understand the concept of micro grid, distributed energy resources, Power Quality and its issues of Grid connected Renewable Energy Sources, Power Quality Audit.
CO5	Understand the concept of smart grid architectural design.
CO6	Understand the concept of components, smart vehicle in smart grid

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**POI0**	**POII**	**PO12**
CO1	3	2	1	1	-	2	-	-	-	-	-	1
CO2	3	2	2	1	-	3	-	-	-	-	-	2
CO3	2	2	1	2	-	2	-	-	-	-	-	2
CO4	2	3	2	2	-	2	-	-	-	1	-	3
CO5	3	3	3	3	1	2	-	-	2	1	-	3
CO6	3	3	2	1	1	1	-	-	2	2	1	2

Module No	Module Contents	Hours	COs
1	**SMART GRID EVOLUTION:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Drivers of SG in India, Challenges for SG, Difference between conventional & smart grid, Smart Grid Vision & Roadmap for India, Concept of Resilient and Self-Healing Grid, Present development & International policies in Smart Grid, Smart Cities, Pilot projects in India. **OPPORTUNITIES AND APPLICATION OF SMART GRID:** CDM opportunities in Smart Grid. What is a Smart Grid? The Smart Grid Enables the ElectriNetSM, Local Energy Networks, Electric Transportation, Low-Carbon Central Generation, What Should Be the Attributes of the Smart Grid? Why Do We Need a Smart Grid? Is the Smart Grid a "Green Grid"? Case study of Smart Grid.	09	CO1
2	**SMART GRID TECHNOLOGIES:** Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers. **SMART GRID TECHNOLOGIES AND ENERGY STORAGE:** Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS),Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage	09	CO2 CO3
3	**MICROGRIDS:** Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuel cells, Integration of renewable energy sources. **DISTRIBUTED ENERGY RESOURCES:** Small scale distributed generation, Distributed Generation Technology, Internal Combustion Engines, Gas Turbines, Fuel Cells, Solar Photovoltaic, Solar thermal, Wind power, Geothermal, - all sources as a DG. Advantages and disadvantages of DG.	09	CO4
4	**POWER QUALITY MANAGEMENT IN SMART GRID:** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality	09	CO4

	Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. **INFORMATION AND COMMUNICATION TECHNOLOGY FOR SMART GRID:** 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).		
5	**SMART GRID ARCHITECTURAL DESIGN 1:** Introduction – Comparison of Micro grid, power grid and Smart grid – power system enhancement – communication and standards - General View of the Smart Grid Market Drivers **SMART GRID ARCHITECTURAL DESIGN 2:** Stakeholder Roles and Function - Measures - Representative Architecture - Functions of Smart Grid Components-Wholesale energy market in smart grid-smart vehicles in smart grid.	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:

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

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**POI0**	**POII**	**PO12**
CO1	3	1	1	1	1	1	1	1	-	1	1	1
CO2	3	2	2	2	1	1	1	-	-	-	-	1
CO3	3	2	2	2	1	2	1	-	-	1	1	1
CO4	3	2	2	2	2	2	1	-	-	-	1	1
CO5	3	2	2	2	1	2	1	1	1	1	-	1
CO6	3	2	2	2	1	2	1	1	1	1	1	1

Module No	Module Contents	Hours	COs
1	**INTRODUCTION:** 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. **POWER QUALITY PROBLEMS:** 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.	09	CO1
2	**VOLTAGE SAGS:** Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, motor starting sags, Solutions at end-user level **OVERVOLTAGE:** Sources of over voltages - Capacitor switching – lightning - ferro resonance. Mitigation of voltage swells - surge arresters - low pass filters - power conditioners	09	CO1 CO2 CO4
3	**HARMONICS:** 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 **APPLIED HARMONICS:** Harmonic indices - inter harmonics – Harmonic distortion evaluation - devices for controlling harmonic distortion - passive and active filters.	09	CO1 CO2 CO4
4	**POWER QUALITY MONITORING:** Monitoring considerations, power quality measurement equipments, Power line disturbance analyzer –harmonic / spectrum analyzer - flicker meters - disturbance analyzer **CUSTOM POWER DEVICES:** Operation and characteristics of DVR, STATCOM, UPFC	09	CO4 CO5 CO6
5	**DISTRIBUTED GENERATION AND POWER QUALITY:** DG technologies, interface to utility system, power quality issues **FUTURE APPLICATIONS:** Industrial Power Quality Monitoring Applications, Power System Performance Assessment and Benchmarking, Power Quality Monitoring and Internet, Future direction – Smart Grid	09	CO3 CO5 CO6

Text Books:

1. Electrical Power Systems Quality, Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, McGraw Hill, 3rd 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:

CO1	Understand and evaluate economic issues and key engineering features and concepts of distributed generation that are used in grid integration
CO2	Able to investigate the operation of renewable energy generators at a systems level and analysis of distributed generation systems.
CO3	Analyze the grid integration issues of renewable generation and its performance of the network
CO4	Understand the converter principles and electronic devices developed for the integration of distributed generations into the grid.
CO5	Determine the different topologies used for grid integration of distributed power generations.
CO6	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**	**POI0**	**POII**	**PO12**
CO1	3	2	2	2	2	1	2	-	1	2	1	1
CO2	3	2	1	1	2	1	1	-	1	1	1	1
CO3	3	2	2	2	2	1	1	-	1	2	-	1
CO4	3	2	2	1	2	1	1	-	1	1	1	1
CO5	3	2	1	2	2	1	1	-	1	1	-	1
CO6	3	2	1	1	1	-	1	-	1	1	-	1

Module No	Module Contents	Hours	COs
1	**DISTRIBUTED GENERATION** 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.	09	CO1, CO2
2	**DISTRIBUTED GENERATION AND STORAGE TECHNOLOGIES** 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	09	CO1, CO2
3	**DISTRIBUTED GENERATION INTEGRATION SYSTEMS AND ITS CONTROL TECHNIQUES** 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	09	CO3, CO4
4	**POWER GRID ANALYSIS AND ITS STUDIES** Electric Systems Modelling- Simulation grid studies and used tools. Unit systems. Electric systems modelling for permanent regime studies - Steady state simulation studies. Load flow- Optimization and Grid Planning- SMART GRIDS	09	CO3, CO4
5	**STANDARDS AND ELECTRIC MARKETS** 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	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, 2nd 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**		**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:

CO1	Understand the basics of photovoltaic cells
CO2	Choose appropriate battery charging for different applications
CO3	Develop maximum power point tracking techniques
CO4	Analyze solar irradiation and design an appropriate solar PV system for power generation
CO5	Evaluate and design standalone and grid connected PV systems based on the consumer demand
CO6	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**
CO1	3	3	3	2	2	-	1	-	1	-	1	1
CO2	3	3	3	2	2	-	1	-	1	-	1	1
CO3	3	3	3	2	2	-	1	-	1	-	1	1
CO4	3	3	3	2	2	-	1	-	1	-	1	1
CO5	3	3	3	2	2	-	1	-	1	-	1	1
CO6	3	3	3	2	2	-	1	-	1	-	1	1

Module No	Module Contents	Hours	Cos
1	**THE PV CELL:** 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	**PV DESIGN:** Solar modules, Storage systems, Power conditioning and regulation, Protection, Sizing and design of PV system	09	CO1
3	**MAXIMUM POWER POINT TRACKING:** Concept of MPPT, algorithms, Perturb-Observe method, Incremental Conductance method,	09	CO2, CO6
4	**STAND ALONE AND GRID CONNECTED PV SYSTEM:** Stand –alone PV system, Configurations, Grid connected PV systems, Configuration and working of single stage grid connected PV system	09	CO5, CO6
5	**APPLICATIONS OF SOLAR PV SYSTEM:** 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, 2nd edition.

Assessment Pattern:

Continuous Internal Evaluation:

Blooms levels	CIE –Theory (50 Marks)			
	Test = 25	**Assignment = 10**	**Quiz = 5**	**Self-Study Assessment= 10**
Remember	-	-	-	-
Understand	2	2	1	-
Apply	5	2	1	5
Analyze	8	2	1	-
Evaluate	5	2	1	-
Create	5	2	1	5

Semester End Examination:

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

SIMULATION OF POWER ELECTRONICS

Course Code: EEE822 **Credits: 03**
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:

CO1	Apply mathematical skills to represent mathematically a physical system
CO2	Apply various modelling methods to develop mathematical modelling
CO3	Design and develop digital controllers to control current and voltage of a Power Electronics system
CO4	Apply modern engineering software tools such as MATLAB software to develop model for various Power Electronics circuits.
CO5	Extract information through appropriate design techniques and tools for simulation of Power Electronics based circuits published in conference/ journal papers.
CO6	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:

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

Module	**Module Contents**	**No Hours**	**COs**
1	**COMPUTER SIMULATION OF POWER ELECTRONIC CONVERTERS AND SYSTEMS** 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
2	**MODELLING OF SYSTEMS** 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	**SPACE VECTOR MODELLING** 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	**DIGITAL CONTROLLER DESIGN** 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	**DISCRETE COMPUTATION ESSENTIALS** 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				SEE
	Test = 25	Assignment = 15	Quiz = 05	Self-Study Assessment= 10	Examination = 50
Remember	2	-	-	-	5
Understand	5	-	1	-	10
Apply	5	3	1	5	10
Analyze	5	3	1	-	10
Evaluate	5	4	1	-	10
Create	3	5	1	5	5

BIOMEDICAL INSTRUMENTATION

Course Code: EEE823 **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:

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

Mapping of Course Outcomes to Program Outcomes:

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

Module	Module Contents	No Hours	COs
1	**BIOPOTENTIAL ELECTRODES:** 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	**BIOPOTENTIAL MEASUREMENTS:** 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	**SIGNAL CONDITIONING CIRCUITS:** Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier,	9	CO4

	Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering		
4	**MEASUREMENT OF NON-ELECTRICAL PARAMETERS:** 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	**BIOCHEMICAL MEASUREMENT AND BIOSENSORS:** Biochemical sensors - pH, pO2 and pCO2, 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			SEE
	Test = 25	Assignment = 15	Quiz = 05	Examination = 50
Remember	2	-	-	5
Understand	5	-	1	10
Apply	5	3	1	10
Analyze	5	3	1	10
Evaluate	5	4	1	10
Create	3	5	1	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:

CO1	Identify the main components of Internet of Things.
CO2	Program the sensors and controller as part of IOT.
CO3	Assess different Internet of Things technologies and their applications.
CO4	Design a component or a product applying all the relevant standards and with realistic constraints.
CO5	Identify a suitable hardware and software solution for the given electrical and electronics problems.
CO6	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**	**PO10**	**PO11**	**PO12**
CO1	-	3	-	-	-	-	-	-	-	-	-	3
CO2	3	1	1	2	3	-	-	-	1	1	-	-
CO3	-	-	3	-	3	3	3	3	-	-	-	-
CO4	3	3	3	3	3	3	3	1	3	-	2	3
CO5	-	3	3	3	3	2	1	2	3	-	3	3
CO6	3	3	3	3	3	3	1	1	3	-	3	3

Module No	Contents of the Module	Hours	COs
1	**INTRODUCTION TO INTERNET OF THINGS**: Definition & Characteristics of IoT - Challenges and Issues - Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security. **COMPONENTS IN INTERNET OF THINGS:** Control Units – Communication modules –Bluetooth – Zigbee – Wifi – GPS- IOT Protocols (IPv6, 6LoWPAN, RPL, CoAP), MQTT, Wired Communication, Power Sources. Current trends in IoT.	09	**CO1** **CO2**
2	**PROGRAMMING THE MICROCONTROLLER FOR IOT**: 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.	09	**CO2** **CO3**
3	**HARDWARE INTERFACING:** 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.	09	**CO2** **CO3**
4	**RESOURCE MANAGEMENT IN IOT**: 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.	09	**CO2** **CO3** **CO4** **CO5**
5	**IOT APPLICATIONS**: 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.	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 Madisetti, 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

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 aneducational 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 Accredition:

Program Educational Objectives: The Educational objectives of an engineering degree programarethe 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. Graduateattributes are separately listed in Appendix C

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

Mapping of Outcomes

COURSE OUTCOME

↓

PROGGRAM OUTCOME

↓

PROGRAM EDUCATIONAL OBJECTIVES

↓

DEPARTMENTAL MISSION

↓

DEPARTMENTAL VISION

APPENDIX B

The Graduate Attributes of NBA

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

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

Design/development of solutions: Design solutions for complex engineering problemsand 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 bystraightforward 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, andmodern 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 toassess 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 engineeringsolutions 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 responsibilitiesand norms of the engineering practice.

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

Communication: Communicate effectively on complex engineering activities with theengineering 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 theengineering 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 toengage 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 differentlevels 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]**