NEW HORIZON COLLEGE OF ENGINEERING

New Horizon Knowledge Park, Ring Road, Marathalli

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC

Accredited by NAAC with 'A' Grade, Accredited by NBA

Department of Electrical and Electronics Engineering

Academic Year 2021-2022

Seventh and Eighth Semesters

B.E. Scheme and Syllabus

Department of Electrical & Electronics Engineering

Academic Year 2021-22

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.

.

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

.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

Sl. No	Course Code	Course	Credit Distribution				Overall Credits	Contact Hours per Week	Marks		
			L	T	P	S			CIE	SEE	Total
1	20EEE71A	Special Electrical Machines	3	0	0	o	3	3	50	50	100
2	20EEE72A	Relay and High voltage Engineering	3	0	0	0	3	3	50	50	100
3	20EEE73A	Electrical Drives and vehicles	3	0	0	0	3	3	50	50	100
4	20EEE74XA	Professional Elective IV	3	0	0	0	3	3	50	50	100
5	20EEE75XA	Professional Elective V	3	0	0	0	3	3	50	50	100
6	20NHOP7XX	Open Elective- II	3	0	0	0	3	3	50	50	100
7	20EEL76A	Relay and High voltage Engineering laboratory	0	0	1.5	0	1.5	3	25	25	50
8	20EEL77A	Simulation tools for Electrical Engineering laboratory	0	0	1.5	0	1.5	3	25	25	50
9	20EEE78A	Project Phase I	0	0	2	0	2	4	50	50	100
TOTAL							**23**	**28**	**400**	**400**	**800**

Professional Elective IV	
Course Code	**Course**
20EEE741A	Digital Signal Processing
20EEE742A	FACTS and HVDC transmission
20EEE743A	Testing and Commissioning
20EEE744A	Energy Auditing and Demand side Management
Professional Elective V	
Course Code	**Course**
20EEE751A	Utilization of Electrical Energy
20EEE752A	Power System Operation and Control
20EEE753A	Professional Ethics
20EEE754A	Neural network and Fuzzy logic in Electrical Engineering

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

Sl. No	Course Code	Course	Credit Distribution				Overall Credits	Contact Hours per Week	Marks		
			L	T	P	S			CIE	SEE	Total
1	20EEE81XA	Professional Elective VI	3	0	0	0	3	3	50	50	100
2	20EEE82XA	Professional Elective VII	3	0	0	0	3	3	50	50	100
3	20EEE83A	Internship	0	0	4	0	4	8	50	50	100
4	20EEE84A	Project Phase II	0	0	10	0	10	20	50	50	100
TOTAL							**20**	**34**	**200**	**200**	**400**

Professional Elective VI		
Sl No	**Course Code**	**Course**
1	20EEE811A	Estimation and Costing of electrical systems
2	20EEE812A	Smart Grid Technologies
3	20EEE813A	Power Quality
4	20EEE814A	Integration of distributed generation

Professional Elective VII		
Sl No	**Course Code**	**Course**
1	20EEE821A	Photo Voltaic Systems and Applications
2	20EEE822A	Simulation of Power Electronics
3	20EEE823A	Biomedical Instrumentation
4	20EEE824A	Applications of IOT in Electrical Engineering

SPECIAL ELECTRICAL MACHINES

Course Code	**: 20EEE71A**	**Credits**	**: 3**
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	Acquire knowledge about construction and working principles of special electrical machines.
CO2	Analyze the performance of special electrical machines.
CO3	Acquire knowledge on various types of controllers for special motors
CO4	Understand the linear and nonlinear characteristics of special electrical machines.
CO5	Evaluate and formulate the EMF and torque equations.
CO6	Choose appropriate special machines based on applications.

Mapping of Course Outcomes to Program Outcomes:

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

Module No	Module Contents	Hours	Cos
1	**Reluctance Motors :** Constructional features, Principle of operation, Types, Axial and radial air gap motors, Phasor diagram, Torque Characteristics, Non-linear analysis, Power controllers, Microprocessor based control and Computer based control and Applications.	09	CO1, CO2, CO3, CO4, CO6
2	**Permanent Magnet Brushless Dc Motors & its Controllers :** Commutation in DC motors, Hall sensors, Torque and EMF equation, Torque- speed characteristics, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Microprocessor based controller, Sensor less control and Applications	09	CO1, CO3, CO4, CO5, CO6
3	**Stepping Motors & its Drive Systems :** Constructional features, principle of operation, modes of excitation, single phase stepping motors, torque production in variable Reluctance (VR) stepping motor, Dynamic characteristics, Circuit for open loop & Closed loop control of stepping motor, microprocessor based controller and Applications	09	CO1, CO3, CO4, CO5, CO6
4	**Permanent Magnet Synchronous Motors & its controllers:** Principle of operation, EMF equation, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self-control, Vector control, Current control schemes and Sensor less control, Applications	09	CO1, CO2, CO3, CO6
5	**Industrial Special Machines & Applications:** AC servomotors, D.C servo motors, universal motors, hysteresis motor, Repulsion motor, Vernier motor, Construction, Working Principles, Characteristics and Applications	09	CO1, CO4, CO5, CO6

Text Books:

1. Special Electrical Machines, mrunal despande ,scitech publications,2017
2. Stepping Motors – A Guide to Motor Theory and Practic, P.P. Aearnley, , Peter Perengrinus, London, 1982.
3. Stepping Motors and Their Microprocessor Controls, Kenjo, Takashi, Sugawara, Akira, Clarendon Press London, 2003
4. Stepper Motors – Fundamentals, Applications and Design, V. V. Athani, New Age International Publications, 2006
5. Switched Reluctance Motor and Drives, R. Krishnan, CRC Press, Washington.

Reference Books:

1. Special electrical machines, E.G. Janardanan, PHI learning Private Limited, 2014
2.Special Electrical Machines, K. V. Rathnam Orient Blackswan 2008
3. Permanent Magnet and Brushless DC Motors, T. Kenjo and S. Nagamori, Clarendon Press, London, 1988

Assessment Pattern:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	4	
Understand	5	4	2
Apply	5	3	4
Analyze	5	2	4
Evaluate	5	2	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	-

RELAY AND HIGH VOLTAGE ENGINEERING

Course Code	**: 20EEE72A**	**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 different breakdown mechanisms of dielectrics
CO2	Study the different generation and measurement techniques of high voltage
CO3	Apply different techniques for the testing of high voltage apparatus
CO4	Evaluate the characteristics of different protection relays and different types of electromagnetic relay.
CO5	Acquire the knowledge on digital relays
CO6	Apply the high voltage knowledge on real time applications

Mapping of Course Outcomes to Program Outcomes:

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

	Module Contents	**Hours**	**COs**

1	**Break Down in Gaseous , Liquid and solid Dielectrics** Gases as insulating media, collision process, Ionization process, Townsend's criteria of breakdown in gases, Paschen's law. Suspended Solid Particle Mechanism, Cavity breakdown Intrinsic breakdown, electromechanical breakdown, thermal breakdown.	09	CO1
2	**Generation and Measurement of high voltages and High currents** Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse voltages, Generation of Impulse currents, Tripping and control of impulse generators. Measurement of High Direct Current voltages, Measurement of High Voltages alternating and impulse.	09	CO2
3	**High Voltage Tests ,Non-Destructive Insulation Test Techniques** Measurement of D. C. Resistivity, Measurement of Dielectric Constant and loss factor, Partial discharge measurements, Testing of Insulators and circuit breakers, testing of cables, Testing of Transformers, Testing of Surge Arresters.	09	CO3
4	**Protective and Distance Relays** Basic requirement of protective relaying, Zones of protection , Over Current relay- IDMT relays, PSM, TSM, problems, directional and non-directional relays ,negative sequence relays. Impedance ,Reactance, Mho and off set Mho relays, Characteristic of distance relays and comparison of differential relay-Circulating current and opposite voltage differential scheme, Comparison of static and electromagnetic relay.	09	CO4
5	**Digital Relay & Industrial Applications to High Voltage Engineering** Introduction to digital relay , microprocessor application to protection, desirable features in a protection scheme, integrated hierarchical computer control and protection Electrostatic applications – Electro static precipitator, Electro static separator, Electro static coating, Electro Static copying, pulsed power.	09	CO5, CO6

Text Books:

1. High Voltage Engineering by M.S.Naidu & V. Kamaraju – TMH Publications, 5th Edition , 2013.
2. High Voltage Engineering by C.L.Wadhwa , New Age Internationals (P) Limited , 3rd Edition
3. Switchgear and Protection, J.B.Guptha ,S.K. Kataria & Sons , 2013
4. Switch gear Protection and Power systems, Sunil S.Rao , Khanna Publishers ,4th ec

Reference Books:

1. Advances in High Voltage Engineering by A.Haddad & D.Warne , The institution of engineering and technology , 2007
2. High Voltage and Electrical Insulation Engineering by Ravindra Arora& Wolfgang Mosch , Wiley Publishers , 2011.
3. High Voltage Engineering Fundamentals by E.Kuffel & W.S.Zaengl , Elsevier press , 2nd Edition , 2013.

Assessment Pattern:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	5	2
Understand	5	5	2
Apply	5	5	2
Analyze	5		2
Evaluate	5	-	2
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	-

ELECTRICAL DRIVES AND VEHICLES

Course Code : 20EEE73A **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 dynamics of electrical drives
C02	Analyze the operation of the Converter and Chopper fed dc drives
C03	Analyze the operation of the induction and Synchronous Motor AC drive
CO4	Understand various types of motors used in electric vehicles and energy sources
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.	**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	CO1

2	**DC MOTOR DRIVES:** Starting, Braking, Transient Analysis, Speed control, Chopper-Controlled DC drives, Steady state analysis of the single and three phase converter fed separately excited DC motor drive Chopper control of separately excited DC motors, Chopper control of series motors, converter ratings and closed loop control, Applications Applications	09	CO2
3	**AC MOTOR DRIVES and SPECIAL MACHINES AC DRIVES:** 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. Synchronous Motor variable speed drives, Brushless DC motor drives, Switched Reluctance Motor Drive Construction-Working Principle.	09	CO3
4	**ELECTRIC VEHICLES:** History of Electric vehicle, Definition vehicle, Need of electric vehicle, Architecture of Electric Vehicle, Configuration of Electric vehicle, 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	CO4,
5.	**ELECTRIC VEHICLE ENERGY SOURCES:** Electrochemical batteries, Electrochemical reaction, Thermodynamic voltage, Specific energy, specific power, energy efficiency, Battery technology, ultracapacitors, Flywheels.	09	CO5,

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

.

Assessment Pattern:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom'sTaxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	4	-	-
Understand	4	5	2
Apply	9	5	3
Analyze	4	5	2
Evaluate	4	-	3
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

PROFESSIONAL ELECTIVE-IV

DIGITAL SIGNAL PROCESSING

Course Code : 20EEE741A	**Credits : 03**
L: T: P: S : 3:0:0:0	**CIE Marks : 50**
SEE Marks : 50	**Exam Hours : 03**

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

CO1	Classify signals and systems & study their mathematical representation.
CO2	Determine the response of LTI systems to any input signal by using convolution.
CO3	Analyse the discrete time signals by Z transforms, DTFS, & DTFT.
CO4	Analyze the discrete time signals by DTFS, & DTFT.
CO5	Determine the spectrum of a signal by using various transformation techniques DFT & FFT.
CO6	Design and digital implementation of IIR, FIR filters using MATLAB.

Mapping of Course Outcomes to Program Outcomes:

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

Module No	Module Contents	Hours	COs
1	**Introduction** Elements of a Digital Processing System - Advantages of Digital over Analog Signal Processing. Discrete-Time Signals and Systems: Elementary Discrete-Time Signals- Classification of Discrete-Time Systems - LTIV systems- -Causality, Stability. **LTI Systems** Convolution Sum - Impulse response, Properties - Solution of difference equation - block diagram representation.	09	CO1
2	**Z-Transforms** Z-transform and its properties, Region of convergence (RoC) and its Properties, inverse z-transforms; difference equation – Solution by z-transform, Stability analysis, and frequency response – Convolution **Fourier Representation** Discrete Time Fourier Series (DTFS) and its properties - Discrete Time Fourier transform (DTFT) and its properties.	09	CO1,CO2
3	**Discrete Fourier Transform** Discrete Fourier Transform- properties, magnitude and phase representation, IDFT, linear convolution, circular convolution, periodic convolution, overlap add and save methods. **Fast Fourier Transform** Computation of DFT using FFT algorithm – DIT & DIF using radix 2 FFT – Butterfly structure.	09	CO3
4	**Realization Of Digital Filters** FIR & IIR filter realization – Parallel form, Cascade form, Lattice Ladder form. **Design Of Digital Filters** FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. IIR design: Analog filter design – Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation.	09	CO3,CO4
5	**MATLAB Programs** Linear and Circular Convolutions in time domain and frequency domain, Fast Fourier Transform – DIT and DIF algorithm, Design of Butterworth & Chebyshev Filter using Impulse Invariant and Bilinear transformation **Applications** Audio and video compression, Audio signal processing, Image processing, Radar -Sonar signal analysis and processing	09	CO5,CO6

Text Books:

1. Digital Signal Processing Principle, Algorithm & application, Proakis, Pearson, 4th edition, 2014.
2. Digital Signal Processing, Sanjit. K. Mitra, TMH, 4th Edition, 2013.
3. Practical Applications in Digital Signal Processing, Richard Newbold, Prentice Hall, 1st Edition, 2013

Reference Books:

1. Introduction to Digital Signal Processing, Johnny R. Johnson, 1st Edition, PHI, 2011
2. Discrete Time Signal Processing, Alan V. Openheim, pearson, 2nd Edition, 2012
3. Digital Signal Processing, S.Salivahanan, TMH, 3rd Edition, 2014.
4. Digital Signal Processing, Ifeachor Emmauel- Pearson education, 2nd Edition, 2006.
5. Fundamentals of Digital Signal Processing, Lonnie C. Ludeman, John Wiley, 3rd Edition, 2009
6. Signals & Systems, Simon Haykin and Barry Van Veen, John Wiley and Sons, 2nd Edition, 2010

Assessment Pattern:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	4	-	-
Understand	4	5	2
Apply	9	5	2
Analyze	4	5	2
Evaluate	4	-	2
Create	-	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

FACTS AND HVDC TRANSMISSION

Course Code	**: 20EEE742A**	**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,CO2, 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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	-	4
Understand	5	-	2
Apply	5	7.5	2
Analyze	10	7.5	2
Evaluate		-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	15
Understand	15
Apply	10
Analyze	10
Evaluate	-
Create	-

TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENT

Course Code	**: 20EEE743A**	**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 procurement process and the state-of-the art global practices in maintenance of electrical equipment.
CO2	Mention the requirement of electrical equipment
CO3	Understand the specifications in Installation and testing of transformers
CO4	Design the Installation process of induction motors and synchronous machines
CO5	Analyze the testing process of induction motors and synchronous machines
CO6	Choose the appropriate electrical equipment for the real time applications

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, CO6
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	CO4, CO5, CO6
5	**SYNCHRONOUS MACHINES:** Specifications: As per BIS Standards**.** Acceptance Tests: Type, routine-and special tests applicable as per BIS. Installation:	9	CO4, CO5, CO6

	Location and details of mounting and foundations, control gear, excitation system and cooling arrangements**.** Commissioning 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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	-	2
Understand	5	-	2
Apply	5	7.5	2
Analyze	10	7.5	2
Evaluate	-	-	2
Create	-	-	

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	10
Understand	15
Apply	10
Analyze	15
Evaluate	-
Create	-

ENERGY AUDITING AND DEMAND SIDE MANAGEMENT

Course Code	**: 20EEE744A**	**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.	09	CO2, CO3, CO6,

	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		

Text Books:

1. Handbook on Energy Audit, Sonal Desai, McGraw Hill 2014.
2. Generation of Electrical Energy, B R Gupta, S. Chand, 1st 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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	**Tests**	**Assignments**	**Quizzes**
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	7	-	2
Understand	8	-	2
Apply	5	7.5	2
Analyze	3	7.5	2
Evaluate	2	-	2
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	**Marks Theory (50)**
Remember	15
Understand	15
Apply	10
Analyze	5
Evaluate	5
Create	-

PROFESSIONAL ELECTIVE-V

UTILIZATION OF ELECTRICAL ENERGY

Course Code	**: 20EEE751A**	**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	Obtain the fundamental concept of electric traction
CO2	Design the different lighting system for various requirement
CO3	Understand the concepts of electric welding and heating
CO4	Acquire knowledge in refrigeration and air conditioning system
CO5	Identify the economic aspects of power factor necessity and its improvement methods
CO6	Utilize the electrical energy as per the requirement

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, CO6
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, CO6
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, CO6
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, CO6
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, CO6

Text Books:

1. N.V.Suryanarayana, Utilisation of Electric Power : Including Electric Drives and Electric Traction, New Age International Publishers, Second Edition 2014

2. Utilization of Electric Power and Electric Traction, J.B. Gupta, 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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	4	-	-
Understand	4	-	2
Apply	9	7.5	2
Analyze	4	7.5	2
Evaluate	4	-	2
Create	-	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

POWER SYSTEM OPERATION AND CONTROL

Course Code	**: 20EEE752A**	**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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	-	4
Understand	5	-	2
Apply	5	7.5	2
Analyze	5	7.5	2
Evaluate	-	-	
Create	5	-	

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	5
Apply	15
Analyze	15
Evaluate	-
Create	10

PROFESSIONAL ETHICS

Course Code : 20EEE753A | **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 ethical behavior of an engineer, professional ethics and human values
CO2	Analyze the basic perception of profession, professional ethics, various moral issues and uses of ethical theories
CO3	Understand various social issues, industrial standards, code of ethics and role of professional ethics in engineering field
CO4	Know the responsibilities of an engineer for safety and risk benefit analysis
CO5	Acquire knowledge about various roles of engineers in variety of global issues
CO6	Apply ethical principles to resolve situations in their professional lives

Mapping of Course Outcomes to Program Outcomes:

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

Module No	Module Contents	Hours	Cos
1	**HUMAN VALUES:** Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.	09	CO1, CO2
2	**ENGINEERING ETHICS:** Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.	09	CO3
3	**ENGINEERING AS SOCIAL EXPERIMENTATION:** Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	09	CO4
4	**SAFETY, RESPONSIBILITIES AND RIGHTS:** Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.	09	CO5
5	**GLOBAL ISSUES:** Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct.	09	CO2, CO4, CO5,

Text Books:

1. Ethics in Engineering, Mike W. Martin and Roland Schinzinger, Tata McGraw Hill, New Delhi, 2003.

2. Engineering Ethics, Govindarajan M, Natarajan S, Senthil Kumar V. S, Prentice Hall of India, New Delhi, 2004.

Reference Books:

1. Engineering Ethics, Charles B. Fleddermann, Pearson Prentice Hall, New Jersey, 2004.
2. Engineering Ethics – Concepts and Cases, Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, Cengage Learning, 2009
3. Ethics and the Conduct of Business, John R Boatright, Pearson Education, New Delhi, 2003
4. Fundametals of Ethics for Scientists and Engineers, Edmund G Seebauer and Robert L Barry, Oxford University Press, Oxford, 2001
5. Business Ethics: Decision Making for Personal Integrity and Social Responsibility , Laura P. Hartman and Joe Desjardins, Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.
6. Value Education, World Community Service Centre, Vethathiri publications, Erode, 2011

Assessment Pattern:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	3	-
Understand	5	3	2
Apply	5	3	4
Analyze	10	6	4
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	10
Understand	10
Apply	10
Analyze	20
Evaluate	-
Create	-

NEURAL NETWORKS AND FUZZY LOGIC IN ELECTRICAL ENGINEERING

Course Code	**: 20EEE754A**	**Credits:03**	
L:P:T :S	**: 3:0:0:0**	**CIE Marks**	**:50**
Exam Hours	**: 3**	**SIE Marks**	**:50**

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

CO1	Understand the concepts of Neuron model and its terminologies
CO2	Develop the Neural Network Models for Single layer and Multi-layer Network
CO3	Apply ANN Techniques to Electrical Load Forecasting problem and Control system problem
CO4	Analyse the operation of Fuzzy based systems
CO5	Apply Fuzzy Logic for motor control and AVR operation and 18 bus bar system
CO6	Apply Modern tools for understanding and implementation of Neuro-fuzzy model

Mapping of Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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	3	2	3	1	3	3	3	3	2
CO5	3	3	3	3	2	3	1	3	3	3	3	2
CO6	3	3	3	3	2	3	1	3	3	3	3	2

Module No	Module Contents	Hours	COs
1	**ARTIFICIAL NEURAL NETWORKS** Basics of ANN - Comparison between Artificial and Biological Neural Networks – Basic Building Blocks of ANN – Artificial Neural Network Terminologies – McCulloch Pitts Neuron Model	9	CO1
2	**SINGLE LAYER AND MULTI LAYER NETWORKS** Learning Rules – ADALINE and MADALINE Models – Perceptron Networks – Back Propagation Neural Networks – Associative Memories.	9	CO2
3	**ANN APPLICATIONS TO ELECTRICAL ENGINEERING** ANN approach to: Electrical Load Forecasting Problem – System Identification –Control Systems – Pattern Recognition.	9	CO3 CO6
4	**FUZZY LOGIC** Classical Sets – Fuzzy Sets – Fuzzy Properties and Operations –	9	CO4

	Fuzzy Logic System– Fuzzification – Defuzzification – Membership Functions – Fuzzy Rule base – Fuzzy Logic Controller Design.		
5	**FUZZY LOGIC APPLICATIONS TO ELECTRICAL ENGINEERING** Fuzzy Logic Implementation for Induction Motor Control – Switched Reluctance Motor Control –Fuzzy Excitation Control Systems in Automatic Voltage Regulator – Fuzzy Logic Controller in an 18 Bus Bar System	**9**	**CO5** **CO6**

Text Books:

1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Neural Networks using MATLAB", McGraw Hill Edition, 2016.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Third Edition, WILEY India Edition, 2018.

References:

1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Fuzzy Logic using MATLAB", Springer International Edition, 2016.
2. Yung C. Shin and Chengying Xu, "Intelligent System – Modeling, Optimization & Control", CRC Press, 2017.
3. Jacek M. Zurada, "Introduction To Artificial Neural Network", Jaico Publishing House, New Delhi, Third Edition, 2019
4. Vinoth Kumar K, "Fundamentals of Soft Computing", S.K.Kataria and Sons Publishers, New Delhi, Second Edition, 2020

Assessment Pattern:

CIE – Continuous Internal Evaluation (50 Marks)

Blooms Taxonomy	**Tests**	**Assignments**	**Quizzes**
Marks(out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	-	2
Understand	5	-	3
Apply	10	10	3
Analyze	3	5	2
Evaluate	2	-	-
Create		-	-

SEE – Semester End Examination (50 Marks)

Blooms Category	Marks Theory (50)
Remember	10
Understand	10
Apply	20
Analyze	5
Evaluate	5
Create	-

INDUSTRIAL OPEN ELECTIVES

Open Elective - II		
Course Code	**Course**	**BOS**
20NHOP701	Big Data Analytics using HP Vertica-1	CSE
20NHOP702	VM Ware Virtualization Essentials-1	ISE
20NHOP704	Big Data Analytics using HP Vertica-2	CSE
20NHOP705	VM Ware Virtualization Essentials-2	ISE
20NHOP707	SAP	MEE
20NHOP708	Schneider-Industry Automation	EEE
20NHOP709	Cisco-Routing and Switching-1	ECE
20NHOP710	Data Analytics	CSE
20NHOP711	Machine learning	MEE
20NHOP712	CISCO-Routing and switching - 2	ECE
20NHOP713	IIOT Embedded System	MEE
20NHOP714	Block Chain	CSE
20NHOP715	Product Life cycle management	MEE
20NHOP717A	Network Security and Cryptography	ECE
20NHOP718A	Physical Design	ECE
20NHOP719A	AI Data Analysis with Python	AI & ML

RELAY AND HIGH VOLTAGE ENGINEERING LABORATORY

Course Code : 20EEL76A **Credits :1.5**
L:T: P: S : 0:0:1.5:0 **CIE Marks : 25**
Exam Hours : 03 **SEE Marks : 25**

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

CO1	Experimentally verify the characteristics of over current, over voltage, under voltage and negative sequence relays both electromagnetic and static type
CO2	Analyze the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages
CO3	Measure the breakdown strength of transformer oil , electric field and find the capacitance of different electrode configuration models
CO4	Analyzing the Performance of generator and transformer with different techniques

Mapping of Course Outcomes to Program Outcomes:

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

Exp. No.	Experiments	COs
1	Breakdown characteristics of sphere -sphere gap with HVAC	**CO2**
2	Breakdown characteristics of sphere -sphere gap with HVDC	**CO2**
3	Breakdown test of transformer oil	**CO2**
4	Field mapping using electrolytic tank	**CO3**
5	Performance of IDMT characteristic for microprocessor based over current relay	**CO1**
6	Performance of DMT characteristic of solid state under voltage relay	**CO1**
8	Breakdown characteristics of sphere -point gap with HVAC	**CO2**
8	Breakdown characteristics of sphere -point gap with HVDC	**CO2**

9	Protection of generator by differential scheme	**C04**
10	Performance of IDMT characteristic for microprocessor Based under voltage relay	**C02**
11	Negative sequence relay	**C01**
12	Protection of transformer by Merz-Price protection scheme	**C04**

Assessment Pattern:

CIE- Continuous Internal Evaluation (25 Marks)

Bloom's Category	**Performance (day to day)**	**Internal Test**
Marks (Out of 25)	**15**	**10**
Remember	02	01
Understand	03	03
Apply	05	03
Analyze	05	03
Evaluate	-	-
Create	-	-

SEE- Semester End Examination (25 Marks)

Bloom's Category	**Lab (25)**
Remember	3
Understand	5
Apply	9
Analyze	8
Evaluate	-
Create	-

SIMULATION TOOLS FOR ELECTRICAL ENGINEERING LABORATORY

Course Code : 20EEL77A **Credits : 1.5**
L:T: P:S : 0:0:1.5:0 **CIE Marks : 25**
Exam Hours : 03 **SEE Marks : 25**

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

CO1	Apply the knowledge to simulate DC and AC circuits
CO2	Analyze and simulate the control signals for the requirement
CO3	Design the operational amplifier for the integrated circuits
CO4	Acquire knowledge on the power electronic converters

Mapping of Course Outcomes to Program Outcomes:

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

Exp. No.	Experiments	COs
1	Simulation of DC circuits	**CO1**
2	Simulation of transient response of RLC Circuit to step,pulse and sinusoidal signals	**CO1**
3	Design and simulation of Lag,Lead and Lag-Lead Compensators	**CO2**
4	Analysis of 3 phase circuit representing the generator transmission line and load.	**CO2**
5	Simulation of integrator and differentiator circuits using Op-AMP	**CO3**
6	Simulation of Comparator circuit using OP-AMP	**CO3**
7	Simulation of Schmitt trigger circuit using OP-AMP	**CO3**
8	Simulation of single-phase full converter using RLE loads and single phase AC voltage controller using RL load	**CO4**
9	Simulation of single phase inveter using PWM control	**CO4**
10	Simulation of power electronic converters	**CO4**
11	Simulation of DC separately excited motor using transfer function.	**CO4**
12	Simulation of Chopper fed DC motor drives	**CO4**

Assessment Pattern:

CIE- Continuous Internal Evaluation (25 Marks)

Bloom's Category	Performance (day to day)	Internal Test
Marks (Out of 25)	**15**	**10**

Remember	02	02
Understand	03	02
Apply	05	03
Analyze	05	03
Evaluate	-	-
Create	-	-

SEE- Semester End Examination (25 Marks)

Bloom's Category	**Lab (25)**
Remember	3
Understand	5
Apply	9
Analyze	8
Evaluate	-
Create	-

SYLLABUS

VIII SEMESTER

PROFESSIONAL ELECTIVE-VI

ESTIMATION AND COSTING OF ELECTRICAL SYSTEMS

Course Code	**: 20EEE811A**	**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	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:**	09	CO5

	Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports, Factors governing height of pole, Conductor materials, Determination of size of conductor for overhead transmission line, Cross arms, Pole brackets and clamps, Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Overhead line insulators, Insulator materials, Types of insulators, Lightning Arrestors, Phase plates, Danger plates, Anti climbing devices, Bird guards, Beads of jumpers, Muffs. **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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	4	-	-
Understand	4	-	2
Apply	4	7.5	2
Analyze	4	7.5	2
Evaluate	4	-	2
Create	5	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	10
Apply	10
Analyze	5
Evaluate	10
Create	10

SMART GRID TECHNOLOGIES

Course Code	**: EEE812A**	**Credits**	**: 04**
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 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 SG stake holders and market drivers
CO6	Understand the concept of Electric vehicles 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 Indian Power Grid, Smart Grid-Definitions, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Drivers for 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 of Smart Grid. **ARCHITECTURE AND APPLICATIONS OF SMART GRID:** Functionalities and key components of smart grid. Smart grid Components for Transmission system, Smart grid components at distribution level, Architecture of smart grid, Pilot projects of Smart Grid in India.	09	CO1
2	**SMART GRID TECHNOLOGIES:** Introduction to Smart Meters, Advanced Metering Infrastructure, Distribution Automation, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid Technology (V2G), Smart Sensors, Smart Homes, Building Energy Management System **AUTOMATION AND ENERGY STORAGE:** Substation Automation, Feeder Automation. Geographic Information System (GIS), Peak load Management, Energy Storage systems, Pumped hydro storage, CAES, FES, storage batteries, Thermal energy storage, Super capacitors.	09	CO2 CO3
3	**MICROGRIDS:** Architecture and Layout of Microgrid, Types of Micro grid- DC Micro grid, AC Microgrid, Hybrid AC/DC Microgrid, Benefits of Distributed generation, Energy storage in Microgrids, Micro grid-Protection, Case studies of Micro grid in India **DISTRIBUTED ENERGY RESOURCES:** Small scale distributed generation, Distributed Generation Resources-Fuel Cells, Solar Photovoltaic cells, Wind power, Fixed speed Wind Turbine generators, Variable speed wind turbine generators, Synchronous generator with In-line frequency control, Advantages of DG.	09	CO4
4	**POWER QUALITY MANAGEMENT IN SMART GRID:** Power Quality-Basic definitions, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Power Quality Audit and its	09	CO4

	significance. **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 MARKET DRIVERS:** Introduction – Comparison of Micro grid, power grid and Smart grid – Case study of STUXNET –Cyber security, Smart Grid Stake holders-Roles and Responsibilities, Technical challenges in SG Market operation. **Electric Vehicles:** Electric Vehicle Technology, EV charging Infrastructure, EVSE Power standards, EVSE communication standards, Vehicle grid Integration (VGI), Challenges associated with VGI.	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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	2	-	-
Understand	2	-	2
Apply	8	7.5	2
Analyze	5	7.5	2
Evaluate	4	-	2
Create	4	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	8
Apply	10
Analyze	10
Evaluate	12
Create	5

POWER QUALITY

Course Code	**: 20EEE813A**	**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 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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	**Tests**	**Assignments**	**Quizzes**
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	-	-
Understand	10	-	2
Apply	5	7.5	2
Analyze	5	7.5	2
Evaluate	-	-	2
Create	-	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	**Marks Theory (50)**
Remember	5
Understand	15
Apply	15
Analyze	10
Evaluate	5
Create	-

INTEGRATION OF DISTRIBUTED GENERATION

Course Code	**: 20EEE814A**	**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 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	09	CO1, CO2

	advantages and needs.		
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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	**Tests**	**Assignments**	**Quizzes**
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	5	-	-
Understand	4	-	2
Apply	8	7.5	2
Analyze	4	7.5	2
Evaluate	4	-	2
Create	-	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	**Marks Theory (50)**
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

PROFESSIONAL ELECTIVE-VI

PHOTO VOLTAIC SYSTEMS AND APPLICATIONS

Course Code	**: 20EEE821A**	**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 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	Test 25 Marks	15 Marks	10 Marks
Remember	-	-	-
Understand	2	-	2
Apply	5	7.5	2
Analyze	8	7.5	2
Evaluate	5	-	2
Create	5	-	2

Semester End Examination:

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

SIMULATION OF POWER ELECTRONICS

Course Code	**: 20EEE822A**	**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	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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	2	-	-
Understand	5	-	2
Apply	5	7.5	2
Analyze	5	7.5	2
Evaluate	5	-	2
Create	3	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

BIOMEDICAL INSTRUMENTATION

Course Code	**: 20EEE823A**	**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	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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	2	-	-
Understand	5	-	2
Apply	5	7.5	2
Analyze	5	7.5	2
Evaluate	5	-	2
Create	3	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	5

APPLICATIONS OF IOT IN ELECTRICAL ENGINEERING

Course Code	**: 20EEE824A**	**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 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:

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks (Out of 50)	**25 Marks**	**15 Marks**	**10 Marks**
Remember	-	-	-
Understand	5	-	2
Apply	5	7.5	2
Analyze	-	7.5	2
Evaluate	5	-	2
Create	10	-	2

SEE- Semester End Examination (50 Marks)

Bloom's Category	Marks Theory (50)
Remember	5
Understand	5
Apply	10
Analyze	10
Evaluate	10
Create	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.

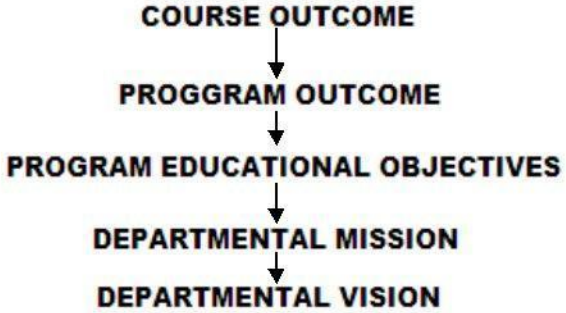
There are three educational Outcomes as defined by the National Board of Accredition:

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



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]**