ESTD : 1946

2022

OBE & CBCS

CURRICULUM

UNDERGRADUATE PROGRAMME

Fourth Year

Department of Electrical & Electronics Engineering (2022 -2026)

THE NATIONAL INSTITUTE OF ENGINEERING

(An Autonomous Institute under Visvesvaraya Technology University, Belagavi)

Recognised by AICTE, New Delhi

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Department Vision

The department will be an internationally recognized centre of excellence imparting quality education in electrical engineering for the benefit of academia, industry, and society at large.

Department Mission

M1: Impart quality education in Electrical and Electronics Engineering through theory and its applications by dedicated and competent faculty.

M2: Nurture creative thinking and competence leading to innovation and technological growth in the overall ambit of Electrical Engineering

M3: Strengthen industry-institute interaction to inculcate best engineering practices for sustainable development of the society

Program Educational Objectives

PEO1: Graduates will be competitive and excel in Electrical industry and other organizations.

PEO2: Graduates will pursue higher education and will be competent in their chosen domain.

PEO3: Graduates will demonstrate leadership qualities with professional standards for sustainable development of society

Programme Outcomes

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
9. **Individual and teamwork:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes

Our Electrical and Electronics Engineering graduates will have the ability to:

PSO1: Apply the knowledge of Basic Sciences, Electrical and Electronics Engineering and Computer Engineering to analyse, design and solve real world problems in the domain of Electrical Engineering.

PSO2: Use and apply state-of-the-art tools to solve problems in the field of Electrical Engineering.

PSO3: Be a team member and leader with awareness to professional engineering practice and capable of lifelong learning to serve society

TABLE OF SCHEME AND EXAMINATION FOR VII SEMESTER (2024-28 Batch)

Sl. No	Type of Course	Course Code	Course Title	Teaching Department (TD)	Question Paper setting Board (PSB)	Teaching Hrs/Week				Examination				Credits
						L	T	P	S	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	IPCC	BEE701	High Voltage Engineering	EEE	EEE	3	0	2		3	50	50	100	**4**
2	PCC	BEE702	AI for Electrical Engineering	EEE	EEE	3	0	2		3	50	50	100	**4**
3	PEC	BEE713X	Professional Elective Course - Group III	EEE	EEE	3	0	0		3	50	50	100	**3**
4	OEC	BEE754X	Open Elective Course - Group II	EEE	EEE	3	0	0		3	50	50	100	**3**
5	PROJ	BEE785	Major Project	EEE	EEE	0	0	12		3	100	100	200	**6**
Total											**300**	**300**	**600**	**20**

Professional Elective Course – Group III			
BEE713A	Energy Management Systems and SCADA	BEE713E	MEMS and its Applications
BEE713B	HVDC Transmission	BEE713F	Flexible AC Transmission Systems
BEE713C	Electric Drives	BEE713G	Smart Grid
BEE713D	Photovoltaic System Engineering		
Open Elective Course - Group II (Offered by EEE to other Departments)			
BEE754A	Open Elective – I: Introduction to Smart grid	BEE754D	Open Elective –IV: Agriculture Engineering
BEE754B	Open Elective –II: Soft Computing Techniques	BEE754E	Industry suggested course -I: Power Electronic devices and applications
BEE754C	Open Elective –III: Renewable Energy	BEE754F	Industry suggested course -II: Introduction to Battery Management Systems

Note:*Total Marks = CIE out of 100 marks scaled down to 50 marks + SEE out of 100 marks scaled down to 50 marks.*
Total Marks = CIE out of 100 marks, for courses with no SEE.

TABLE OF SCHEME AND EXAMINATION FOR VIII SEMESTER (2022-26 Batch)

Sl. No	Type of Course	Course Code	Course Title	Teaching Department (TD)	Question Paper setting Board (PSB)	Teaching Hrs/Week				Examination				Credits
						L	T	P	S	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	PEC	BEE801X	Professional Elective - Group IV (Online Course)	EE	EE	-	-	-		-	-	50	100	**3**
2	OEC	BEE802X	Open Elective - Group III (Online Course)	EE	EE	-	-	-		-	-	50	100	**3**
3	INT	BEE803	Internship (Industry/ Research) (14-16 weeks)	EE	EE	0	0	20		3	100	100	200	**10**
Total											**100**	**200**	**400**	**16**

Professional Elective Course - Group IV (Online Courses - NPTEL)
Department will suggest courses based on the availability of courses offered by NPTEL

BEE801A	Elective –I	BEE801D	Elective –IV
BEE801B	Elective –II	BEE801E	Elective –V
BEE801C	Elective –III		

Open Elective Course - Group III (Online Courses -- NPTEL)
Department will suggest courses based on the availability of courses offered by NPTEL

BEE802A	Open Elective – I	BEE802C	Open Elective –III
BEE802B	Open Elective –II	BEE802D	Open Elective –IV

B.E Electrical and Electronics Engineering
(2022-2026)

Syllabus – VII Semester

Department of Electrical and Electronics Engineering
The National Institute of Engineering
Mysuru-570 008

Course Code: BEE701 | **Course Name: High Voltage Engineering**
Credits: 4 | **L: T:P:S - 3:0:2:0**
SEE: 50% Marks | **CIE: 50% Marks**
SEE Hours: 3 | **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To explain the principles of high voltage generation, breakdown mechanisms, and insulation testing. 2. To demonstrate laboratory techniques for high voltage measurement and safety protocols. 3. To analyze the design and operation of impulse generators and cascaded transformers.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss the fundamental concept of High Voltage engineering and breakdown mechanisms of various dielectrics.	Understand
CO2	Describe the principles of generating different forms of High voltage.	Understand
CO3	Analyze the different methods of High Voltage measurements and Testing techniques of HV insulation.	Analyse
CO4	Demonstrate generation of High voltages and breakdown studies.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	3	-	-	3	-	-	-	3	3	-	3		3	3	3
CO4	3	3	-	-	3	-	-	-	3	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to HV Technology		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction to HV technology, need for generating high voltages in laboratory, Electrode configuration, Classification of HV insulating media.	4	Nil
1.2	**Breakdown phenomena in Liquid Dielectrics:** Pure and commercial liquids, properties, Suspended particle theory, Cavity breakdown theory, and Stressed oil volume theory.	4	Nil
Module – 2: Breakdown Phenomena in Gaseous and Solid Dielectrics			
2.1	Gaseous dielectrics: primary and secondary ionization processes. Criteria for Breakdown and Limitations of Townsend's theory.	3	Nil
2.2	Streamer's theory, breakdown in non-uniform fields. Corona discharges. Electronegative gases.	3	Nil
2.3	Breakdown in solid dielectrics: Intrinsic Breakdown, thermal breakdown, Breakdown due to internal discharges.	2	Nil
Module – 3 Generation of HVAC and HVDC Voltage			
3.1	HV transformer; Need for cascade connection and working of cascaded transformers.	3	Nil
3.2	Series resonant circuit- principle of operation and advantages. Tesla coil. Cock roft- Walton voltage multiplier	3	Nil
3.3	Calculation of voltage regulation, ripple and optimum number of stages for minimum voltage drop.	2	Nil

Module – 4: Generation of Impulse Voltage and Current			
4.1	Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator- expression for Output impulse voltage.	3	Nil
4.2	Multistage impulse generator, working of Marx circuit. Components and rating of multistage impulse generator.	3	Nil
4.3	Triggering of impulse generator by Trigetron gap, Generation of high impulse current.	2	Nil
Module – 5: Measurement and Testing Techniques of High Voltages			
5.1	Electrostatic voltmeter principle, construction and limitation. Chubb and Fortescue method for HVAC measurement.	3	Nil
5.2	Generating voltmeter- Principle, construction. Standard sphere gap measurements of high voltages. Factors affecting the measurements.	3	Nil
5.3	Potential dividers-capacitance dividers, Mixed RC potential dividers. Partial discharges and its measurements, dielectric testing of insulators.	2	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

List of Experiments:

Sl. No.	**Experiment**	**Hands on/ Virtual**
1	Breakdown strength of transformer oil using oil-testing unit.	Hands on
2	Field mapping using electrolytic tank for coaxial cable /capacitor/transmission Line Conductors models.	Hands on
3	Generation and measurement of Lightning Impulse Voltage.	Hands on
4	Study of Impulse Current Generator	Hands on
5	Parametric Analysis of Impulse Current Waveform	Hands on
6	Study of Rectangular Pulse Current Generator	Hands on
7	Power frequency AC Test Source	Hands on
8	Generation of Critical Flashover of a Sphere Gap using Impulse Voltage Generator.	Hands on
9	Voltage doubler circuit	Hands on
10	Cockroft Walton voltage multiplier circuit	Hands on

Textbooks:

1. M.S.Naidu and Kamaraju, **“High Voltage Engineering”,** 3rd edition, THM, 2007.
2. C.L.Wadhwa**, “High Voltage Engineering”**, New Age International Private limited, 1995.

Reference Books:

1. Kuffel and W.S. Zaengl, “High Voltage Engineering Fundamentals”, 2nd edition, Elsevier publication, 2000.

Course Code: BEE702 **Course Name: AI for Electrical Engineering**
Credits: 4 **L: T:P:S - 3:0:2:0**
SEE: 50% Marks **CIE: 50% Marks**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Basic knowledge of mathematics, set theory, and introductory programming
Learning objectives	1. To introduce foundational concepts of ANN, fuzzy logic, and machine learning in electrical systems. 2. To guide students in applying AI techniques for fault diagnosis and load forecasting. 3. To facilitate hands-on projects using Python for AI model development in power systems.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs		Bloom's level
CO1	Explain ANN, fuzzy logic, and machine learning concepts and algorithms.	Understand
CO2	Apply machine learning algorithms to solve basic electrical engineering problems.	Apply
CO3	Implement classification and regression models for engineering tasks.	Apply
CO4	Analyze and select appropriate AI solutions for real-world engineering problems.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	-	3		3	2	2
CO2	3	3	2	2	3	-	-	-	-	-	-	2		3	3	2
CO3	3	3	3	2	3	-	-	-	-	-	-	2		3	3	2
CO4	3	3	3	3	3	-	-	-	-	-	-	3		3	3	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

	Module – 1: Foundations of Artificial Neural Networks	**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction to ANN: Definition, Inspiration, Biological vs Artificial, Structure & Function: Neurons, Connections, Weights, Activation, Learning and Adaptation, Activation Functions	3	Nil
1.2	Network Architectures: Single Layer, Multilayer, Recurrent, Comparison with Conventional AI, Advantages of ANN, Applications of ANN (Pattern recognition, etc.)	5	Nil
	Module – 2: ANN Paradigm		
2.1	Types of Network Architectures, Learning Algorithms: Supervised, Unsupervised, Reinforcement, Activation Functions (Theory & Exercises)	4	Nil
2.2	Associative Memory (Auto-, Hetero-, BAM), Hebb's Rule, Hopfield Networks & Storage Capacity, Clustering & Competitive Learning: Hamming, SCL, Maxnet	4	Nil
	Module – 3: Fuzzy Logic		
3.1	Introduction to classical sets - properties, Operations and relations, Introduction to Fuzzy sets - Fuzzy versus crisp, Membership function	2	Nil
3.2	Introduction to Fuzzy sets - Fuzzy versus crisp, Membership function, Basic Fuzzy set operations, Properties of Fuzzy sets, Fuzzy cartesian Product, Defuzzification methods.	4	Nil
3.3	Numerical problems on fuzzy sets	2	Nil

Module – 4 Introduction to Machine Learning			
4.1	Overview of machine learning: supervised, unsupervised, and reinforcement learning	2	Nil
4.2	Classification Techniques: Logistic Regression, K-Nearest Neighbors, Support Vector Machines, Decision Tree	2	Nil
4.3	Regression Techniques: Linear Regression, Support Vector Regression	2	Nil
Module – 5: Application of AI			
5.1	Pattern Recognition Problems: Fault detection, Power Quality, False data injection attack detection	6	Nil
5.2	Regression Problems: Fault location, Load forecasting	4	Nil
	Total No. of Lecture Hours	**40**	
	Total No. of Tutorial Hours		Nil

<u>List of Experiments:</u>

Sl. No.	Experiment	Hands on/ Virtual
1	Basics of Python Programming for AI in Electrical Engineering.	Hands on
2	Data Preprocessing and Feature Engineering for Electrical Engineering Applications.	Hands on
3	Building and Training Artificial Neural Network (ANN) Models	Hands on
4	Building and Training Fuzzy Logic Models	Hands on
5	Developing Classification Models for Fault Detection using ANN.	Hands on
6	Developing Classification Models for Fault Detection using Fuzzy Logic.	Hands on
7	Developing Classification Models for False Data Injection Attack Detection (ANN/Fuzzy).	Hands on
8	Implementing Regression Models for Short-Term Load Forecasting using ANN.	Hands on
9	Implementing Regression Models for Medium-Term Load Forecasting using Support Vector Machine (SVM).	Hands on
10	Implementing Regression Models for Short-Term Load Forecasting using Decision Tree (DT).	Hands on

Textbooks:

1. S. N. Sivanandam, S. N. Deepa – Principles of Soft Computing, Wiley India.
2. Christopher Bishop – Pattern Recognition and Machine Learning, Springer.

Reference Books:

1. Thimothy J Ross, Fuzzy Logic with Engineering Applications, Wiley Student Edition.
2. Tom M. Mitchell – Machine Learning, McGraw Hill.
3. Simon Haykin – Neural Networks and Learning Machines, Pearson
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman – The Elements of Statistical Learning, Springer.

Course Code: BEE785
Credits: 6
SEE: 50% Marks
SEE Hours: 3

Course Name: Major Project
L: T:P:S - 0:0:12:0
CIE: 50% Marks
Max. Marks: 200

Prerequisites if any	Nil
Learning objectives	1. To mentor students in identifying research gaps and ethical project design and implementation. 2. To guide systematic documentation and presentation of project outcomes. 3. To foster innovation through interdisciplinary problem-solving.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Identify the topic of relevance and carry out literature review inculcating ethical practice	Apply
CO2	Formulate the problem, identify the objectives and implement solution methodology	Create
CO3	Present and document the project work	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	1	1	3	-	2	2	3	3	3	-	3		3	-	3
CO2	3	3	3	-	3	-	-	-	3	3	1	3		3	3	3
CO3	3	-	-	-	3	-	-	-	3	3	-	3		3	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Evaluation:

Project work need to be carried out in groups and the evaluation will be done individually using appropriate rubrics.

Professional Elective Course - Group III

Course Code: BEE713A | **Course Name: Energy Management Systems and SCADA**
Credits: 3 | **L: T:P:S - 3:0:0:0**
SEE: 50% Marks | **CIE: 50% Marks**
SEE Hours: 3 | **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To describe the concept of Power system automation. 2. To discuss SCADA fundamentals and communication. 3. To evaluate the performance of Substation Automation-Conventional substations. 4. To provide insight into the role of SCADA within the Energy Management Systems (EMS) for Control Centers.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Describe the concept of Power system automation.	Understand
CO2	Discuss SCADA fundamentals and communication.	Understand
CO3	Evaluate the performance of Substation Automation-Conventional substations.	Apply
CO4	Apply SCADA fundamentals in Energy Management Systems for effective monitoring and control of generation, transmission and distribution operations	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-		3	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-		3	-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Power system automation		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction, Components of SCADA systems, SCADA in power systems, Advantages of SCADA in power systems.	2	Nil
1.2	Power system field- Types of data and signals in power system. Flow of data from field to SCADA control center.	3	Nil
Module – 2: SCADA fundamentals			
2.1	Building blocks of SCADA systems, Remote terminal unit (RTU), Communication subsystem, Logic subsystem	3	Nil
2.2	Termination subsystem, Intelligent electronic devices (IEDs), Testing and human-machine interface (HMI) subsystem.	3	Nil
2.3	Master Station – software and hardware components, Server systems, small, medium, and large master stations	2	Nil
2.4	Human Machine Interface – components, software functionalities, Intelligent alarm filtering, Classification of SCADA Systems	2	Nil
Module – 3: Communications			
3.1	SCADA communication requirements, SCADA communication topologies, SCADA data communication techniques	4	Nil
3.2	SCADA communication protocol architecture, SCADA and smart grid protocols.	4	Nil
3.3	Media for SCADA and smart grid communication	2	Nil
Module – 4: Substation Automation			
4.1	Conventional substations: Islands of automation, New smart devices for substation automation	4	Nil

4.2	Substation automation: Technical issues, Substation automation architectures, Substation automation (SA) application functions - intelligent bus failover, automatic load restoration, adaptive relaying, equipment condition monitoring, intelligent alarm processing, power quality monitoring	4	Nil
Module – 5: Energy Management Systems (EMS) for Control Centers			
5.1	Introduction, Energy control centers, Data acquisition and communication (SCADA systems)	1	Nil
5.2	Generation operation and management: Load forecasting, Unit commitment, Hydrothermal coordination, economic dispatch and real time automatic generation control	3	Nil
5.3	Transmission operations and management: Real time – State estimation, contingency analysis, islanding of power systems, Smart transmission – PMU, EMS with WAMS	3	Nil
5.4	Distribution Automation: customer automation, feeder automation, substation automation, subsystems in a distribution control centre, DMS application functions.	2	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Mini S.Thomas and John D. McDonald,"Power System SCADA and Smart Grids",1stedition, CRC Press, 2015

2. Stuart A. Boyer: "SCADA- Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, The Instrumentation system and Automation Society, 4th Edition, 2010

Course Code: BEE713B **Course Name: HVDC Transmission**
Credits: 3 **L: T:P:S - 3:0:0:0**
SEE: 50% Marks **CIE: 50% Marks**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To discuss the state-of-art technology in HVDC transmission. 2. To describe converter control and analyze HVDC converter performance 3. To describe the HVDC converter faults and protection schemes.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss the state-of-art technology in HVDC transmission.	Understand
CO2	Analyze HVDC converter performance and describing the techniques of converter control.	Analyse
CO3	Apply the concepts of faults and protection schemes for HVDC converters.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	-		3	-	1
CO3	3	3	-	-	-	-	-	-	-	-	-	-		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: DC Power Transmission Technology		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction, Comparison of AC and DC transmission	4	Nil
1.2	Applications of Dc transmission, description of DC transmission system, Types of DC links, planning for HVDC transmission	4	Nil
Module – 2: Analysis of HVDC Converters			
2.1	Pulse Number, Choice of Converter configuration	3	Nil
2.2	Simplified analysis of Gratez circuit without and with overlap	3	Nil
2.3	Characteristics of Twelve Pulse Converter.	2	Nil
Module – 3: Converter and HVDC Systems			
3.1	Principles of DC link control, Converter control characteristics and its modifications	3	Nil
3.2	System control hierarchy, firing angle control, current and extinction angle control	3	Nil
3.3	Starting and stopping of DC link, Power control.	2	Nil
Module – 4: Smoothening Reactor and DC line			
4.1	Introduction, smoothing reactor, DC line corona effects	3	Nil
4.2	DC line insulators, Transient over voltage in a DC line	3	Nil
4.3	Protection of DC line, DC breakers –basic concept of current interruption.	2	Nil
Module – 5: Converter Faults and Protection			
5.1	Introduction, Converter Faults, Protection against over currents	4	Nil
5.2	Over voltages in converter stations, protection against over voltages.	4	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. K R Padiyar , **"HVDC Power Transmission Systems Techno-Logy and System Interactions",** 5th edition, New age international limited, 2005.

Reference Books:

2. Rao, **"EHV-AC, HVDC Transmission & Distribution Engineering"** 3rd edition, Khanna publishers New Delhi, 2008.

Course Code: BEE713C **Course Name: Electric Drives**
Credits: 3 **L: T:P:S - 3:0:0:0**
SEE: 50% Marks **CIE: 50% Marks**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To teach motor selection criteria based on torque-speed characteristics. 2. To demonstrate control techniques for DC and AC motor drives. 3. To analyze dynamic modeling of drive systems for industrial applications.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Describe the dynamics of electric drive system.	Analyse
CO2	Select and Size the motors and drives for different applications with different torque speed characteristics.	Apply
CO3	Analyse DC motor drives and AC motor drives.	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-		3	-	-

Mapping Strength: **Strong– 3** **Medium – 2** **Low – 1**

Course Structure

Module – 1: An introduction to Electrical drives & its dynamics		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Electrical drives advantages, parts and choice of electrical drives.	3	Nil
1.2	Dynamics of electrical drives: Fundamental torque equation, speed torque conventions and multi-quadrant operation	4	Nil
1.3	Equivalent values of drive parameters, components, nature and classification of load torques,	2	Nil
Module – 2: Selection of motor power rating			
2.1	Thermal model of motor for heating and cooling	3	Nil
2.2	Classes of motor duty	2	Nil
2.3	Determination of motor rating	2	
2.4	Frequency of operations of motors subjected to intermittent loads.	1	Nil
Module – 3: DC motor drives			
3.1	Starting, braking, single phase fully controlled rectifier control of separately excited dc motor	3	Nil
3.2	Single-phase half-controlled rectifier control of separately excited dc motor.	2	Nil
3.3	Three phase half and fully controlled rectifier control of separately excited dc motor.	2	Nil
3.4	Chopper control of DC separately excited dc motors.	1	Nil
Module – 4: Induction motor drives			
4.1	Operation with unbalanced source voltages and single phasing, analysis of induction motor fed from non- sinusoidal voltage supply, Starting and braking.	3	Nil
4.2	Stator voltage control: Variable frequency control of an induction motor,	2	Nil
4.3	VSI fed induction motor drives, closed loop speed control for VSI fed induction motor drives, rotor resistance control, slip power recovery.	2	Nil
Module – 5: Synchronous motor drive			
5.1	Operation from fixed frequency supply, synchronous motor variable speed drives, variable frequency control of multiple synchronous motors.	4	Nil

5.2	Self-controlled synchronous motor drive employing load commutated thyristor inverter.	4	Nil
Total No. of Lecture Hours		40	
Total No. of Tutorial Hours			Nil

Textbooks:

1. G.K Dubey, **"Fundamentals of Electrical Drives",** Narosa publishing house, 2nd Edition, 2010.

Reference Books:

1. N.K De and P.K. Sen, **"Electrical Drives",** - PHI, 2009.
2. S.K Pillai**,"A First Course on Electric Drives",** -Wiley Eastern Ltd 1990.
3. V.R. Moorthi, **"Power Electronics, Devices, Circuits and Industrial Applications",**Oxford University Press, 2005.
4. R. Krishnan, **"Electric motor drives, modeling, analysis and control",** PHI, 2008.

Course Code: BEE713D **Course Name: Photovoltaic System Engineering**
Credits: 3 **L:T:P:S - 3:0:0:0**
CIE: 50% Marks **SEE: 50% Marks**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To explain solar energy conversion, PV module sizing, and shading analysis. 2. To design grid-tied PV systems using tools like PV Watts. 3. To evaluate MPPT algorithms and DC-DC converters for solar applications

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		Bloom's level
CO1	Explain variations in available solar energy and use resources to determine the available insolation for a given location.	Understand
CO2	Apply circuitry basics to explain voltage, current, and power in photovoltaic systems and evaluate output of different PV modules in an array.	Apply
CO3	Design a PV system using commercially available components for the safe and efficient operation at local site conditions.	Analyse
CO4	Analyse the performance of DC- DC converters and Inverters for solar PV application	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	1		3	-	1
CO2	3	3	-	-	-	-	-	-	-	-	-	1		3	-	1
CO3	3	3	3	-	-	-	-	-	-	-	-	3		3	-	1
CO4	3	3	3	-	-	-	-	-	-	-	-	3		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

	Module – 1: Energy from Sun to panel	**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	The sun and solar spectrum, sun-earth relationship, sun and atmosphere	3	Nil
1.2	Insolation and irradiance, solar geometry, insolation and energy on a horizontal flat plate	3	Nil
1.3	Energy on tilted flat plate, energy with atmospheric effects, clearness index	2	Nil
	Module – 2: PV module and array circuits		
2.1	PV cell characteristics and equivalent circuit, modelling of PV cell, short circuit, open circuit and peak power parameters.	3	Nil
2.2	Cell efficiency, Effect of temperature, fill factor	2	Nil
2.3	PV cells in series and parallel, protecting cells in series and parallel, bypass diodes and blocking diodes	3	Nil
	Module – 3: PV sizing and output calculation		
3.1	PV sizing and output, Orientation and tilt, temperature dependant output	3	Nil
3.2	PV output reduction due to shading	2	Nil
3.3	PV sizing and output calculation using PV Watts tool	3	Nil
	Module – 4: Grid-tied PV system design under real world conditions		
4.1	Array sizing and module selection with real world data	3	Nil
4.2	Inverter sizing and selection, string sizing of inverter	3	Nil
4.3	Module and inverter selection – Numerical	3	Nil
	Module – 5: Power Converters in PV Applications		
5.1	Maximum power point tracking, DC-DC Converters for PV systems – Bidirectional converters, multi-input converters, PV Inverters, PV inverter types	5	Nil
5.2	Interfacing PV Systems with the Electric Grid	2	Nil
	Total No. of Lecture Hours	**40**	
	Total No. of Tutorial Hours		**Nil**

Reference Books:

1. Roger Messenger, Amir Abtahi, **"*Photovoltaic Systems Engineering*"**, 4^{th} edition, CRC Press, Taylor & Francis Group, 2017
2. L. Ashok Kumar, S. Albert Alexander, Madhuvanthani Rajendran, **"Power Electronic Converters for Solar Photovoltaic Systems"** Academic Press, Elsevier, 2021
3. https://www.coursera.org/learn/solar-energy-system-design

Course Code: BEE713E
Course Name: MEMS and its Applications
Credits: 3
L:T:P:S - 3:0:0:0
CIE: 50% Marks
SEE: 50% Marks
SEE Hours: 3
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To explain the working principles, design and fabrication of Microsystems. 2. To formulate general guidelines for miniaturization and design of MEMS and Microsystems. 3. To discuss the materials for MEMS and Microsystems. 4. To describe the processes of Micro Manufacturing and Fabrication of microsystems

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Explain the working principles, design and fabrication of Microsystems.	Understand
CO2	Formulate general guidelines for miniaturization and design of MEMS and Microsystems.	Apply
CO3	Discuss the materials for MEMS and Microsystems.	Understand
CO4	Describe the processes of Micro Manufacturing and Fabrication of microsystems	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Overview of MEMS & Microsystems		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	MEMS and Microsystems, Typical MEMS and Microsystems products, Evolution of Micro fabrication	4	Nil
1.2	Microsystems and Microelectronics, the Multidisciplinary Nature of Microsystems Design and Manufacture, Microsystems and Miniaturization, markets for Microsystems.	4	Nil
Module – 2: Working Principles of Microsystems			
2.1	Introduction, Micro sensors, Micro actuation, MEMS and Micro actuators	4	Nil
2.2	Micro accelerometers, Study of Micro fluidics.	4	Nil
Module – 3: Scaling laws in miniaturization			
3.1	Introduction to scaling, scaling in geometry, scaling in rigid-body dynamics, scaling in electrostatic forces	4	Nil
3.2	Scaling in electromagnetic forces, scaling in electricity, scaling in fluid mechanics.	4	Nil
Module – 4: Materials for MEMS and Microsystems			
4.1	Introduction, Substrate and wafers, Active substrate Materials, Silicon as substrate materials	3	Nil
4.2	Silicon compounds, silicon Piezo resistors, Gallium arsenide, Quarts, Piezoelectric crystals, packaging materials.	3	Nil
4.3	Polymers materials for MEMS and Microsystems	2	Nil
Module – 5: Introduction to Microrobotics			
5.1	Applications for MEMS-Based Microrobots, Microassembly, Design of Locomotive Microrobot Devices Based on Arrayed Actuators	3	Nil

5.2	Microrobot Powering, Microrobot Communication, Microdroplets, flow control.	3	Nil
5.3	Arrayed Actuator Principles for Microrobotic Applications	2	Nil
	Total No. of Lecture Hours	40	
		Total No. of Tutorial Hours	Nil

Textbooks:

1. Tai Ran Hsu**, ‘MEMS and Microsystems’**, Tata McGrow Hills 2002

Course Code: BEE713F | **Course Name: Flexible AC Transmission Systems**
Credits: 3 | **L:T:P:S - 3:0:0:0**
CIE: 50% Marks | **SEE: 50% Marks**
SEE Hours: 3 | **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To explain series/shunt compensation techniques. 2. To analyse power flow control, voltage profile enhancement and stability enhancement pf power systems using FACTS controllers.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		Bloom's level
CO1	Analyse the behaviour of uncompensated AC transmission system	Analyse
CO2	Analyse series and shunt compensated systems with fixed compensators and FACTS controllers	Analyse
CO3	Explain the structure and analyse the operation of combined compensators	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	3	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-		3	-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Basic types of reactive power compensation		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Fundamental requirements in AC power transmission, Control of power flow in AC transmission line	2	Nil
1.2	Concept and objectives of series and shunt capacitive compensation, Virtual surge impedance loading compensation	2	Nil
1.3	Line length compensation and compensation by sectioning, Uniformly distributed compensation and discrete compensation	2	Nil
1.4	Compensation by a fixed series capacitor connected at the midpoint of the line, fixed shunt compensation connected at the midpoint of the line.	2	Nil
Module – 2: Introduction to FACTS controllers			
2.1	Relative importance of different types of controllers, Brief description and definitions of FACTS controllers	3	Nil
2.2	Benefits from FACTS technology, A General Equivalent circuit for FACTS controllers	2	Nil
2.3	Basic concept of Voltage-Sourced Converters, Operation of Single-Phase and three-phase full-wave bridge converters.	3	Nil
Module – 3: Static Shunt Compensators			
3.1	Introduction, Analysis of SVC, Configuration of SVC, SVC Controller	3	Nil
3.3	**Static Synchronous Compensator (STATCOM):** Introduction, Principle of operation of STATCOM	3	Nil
3.4	Analysis of a three phase six pulse STATCOM, Applications of STATCOM.	2	Nil
Module – 4: Static Series Compensators			
4.1	Basic concepts of controlled series compensation	2	Nil
4.2	**Thyristor Controlled Series Capacitor (TCSC):** Operation of TCSC, Analysis of TCSC, Control of TCSC, Applications of TCSC.	2	Nil
4.3	**Static Synchronous Series Compensator (SSSC):** Introduction, Operation of SSSC and the Control of power flow, Comparison between variable series compensation and SSSC	2	Nil
4.4	Power flow control Characteristics, Applications of SSSC	2	Nil

Module – 5: Combined Compensators			
5.1	**Unified Power Flow Controller (UPFC):** Introduction to UPFC, Operation of UPFC connected at sending end, midpoint and receiving end	2	Nil
5.2	Control of UPFC, Interline power flow controller, Applications of UPFC	2	Nil
5.3	**Interline Power Flow Controller (IPFC):** Basic operating principles and characteristics, Control Structure, Applications.	4	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Narain. G. Hingorani & Laszlo Gyugyi, "***Understanding FACTS*** ", IEEE Press, 2000.
2. K. R. Padiyar, "***FACTS Controllers in Power Transmission & Distribution***", New Age International Publishers, 1st edition, 2007.

Course Code: BEE713G **Course Name: Smart grid**
Credits: 3 **L:T:P:S – 3:0:0:0**
CIE: 50% Marks **SEE: 50% Marks**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To equip students with the ability to explain core smart grid concepts, components, and benefits compared to traditional power systems. 2. To demonstrate how smart meters, demand response, and renewable integration improve grid efficiency through real-world examples. 3. To train students in identifying cybersecurity risks and basic protection strategies for smart grid infrastructure. 4. To develop skills in understanding EV-grid interactions.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Explain the concept of smart grid and dynamic energy management systems.	Understand
CO2	Explain interoperability, standards and cyber security of smart grid	Understand
CO3	Apply the concept of smart grid in transmission and distribution grids and explain the characteristics	Apply
CO4	Apply the concept of smart grid on electric vehicles and explain the interaction of EV with smart grid.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	1		3	-	1
CO2	3	-	-	-	-	-	-	-	-	-	-	1		3	-	1
CO3	3	2	-	-	-	-	-	-	-	-	-	1		3	-	1
CO4	3	2	-	-	-	-	-	-	-	-	-	1		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

<u>Course Structure</u>

Module – 1: Introduction to Smart Grid		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Background and history of smart Grid evolution, Definition and characteristics of smart grid, Benefits of smart grid.	4	Nil
1.2	Smart Grid vision and its realisation, Motives behind developing the Smart Grid concept, Examples of Smart Grid projects/initiatives, The Smart Grid basic infrastructure.	4	Nil
Module – 2: Dynamic Energy Systems Concept			
2.1	Smart energy efficient end use devices, Smart distributed energy resources, Advanced whole building control systems	2	Nil
2.2	Integrated communications architecture, Energy management, Role of technology in demand response	2	Nil
2.3	Current limitations to dynamic energy management, Distributed energy resources, Overview of a dynamic energy management	2	Nil
2.4	Key characteristics of smart devices, Key characteristics of advanced whole building control systems	2	Nil
Module – 3: Interoperability Standards and Cyber Security			
3.1	Introduction to Interoperability, Analogy between the interoperability of a digitally based device and human interoperability	2	Nil
3.2	Type and characteristics of interoperability standards for Smart Grid	1	Nil
3.3	Grid Electrical power industry standards development organizations (SDOs) and key interoperability standards: IEEE, ANSI, NIST, NERC, W3C	2	Nil
3.4	Smart Grid communication system infrastructure, Cyber security of power	3	Nil

	systems: Smart Grid cyber-security challenges, Communication-based attacks, Emerging Smart Grid cyber-security technologies, Smart Grid cyber-security standards.		
Module – 4: Smart Transmission and Distribution Grids			
4.1	Smart distribution networks versus conventional distribution networks, Basic building blocks of a smart distribution network	3	Nil
4.2	Introduction to smart transmission grid, Challenges and requirements of future STG, Characteristics of smart transmission network	3	Nil
4.3	Characteristics of a smart substation. IEEE C 37.118 and series standards communications in smart grid.	2	Nil
Module – 5: Smart Grid Interaction with Electric Vehicles			
5.1	Types of electric drive vehicle, Characteristics of energy storage devices/systems	2	Nil
5.2	Types, characteristics and benefits of EES systems, Types of EV charging systems	3	Nil
5.3	Smart charging in smart grid, Load management of EVs using Smart-Grid technologies.	3	Nil
	Total No. of Lecture Hours	**40**	
		Total No. of Tutorial Hours	**Nil**

Textbooks:

1. Salman K. Salman, ***"Introduction to the Smart Grid Concepts, Technologies and Evolution",*** The Institution of Engineering and Technology, London, United Kingdom, 2017.
2. Clark W Gellings, "**The Smart Grid, Enabling Energy Efficiency and Demand Side Response**", CRC Press, 2009.
3. Kostas Siozios, Dimitrios Anagnostos, Dimitrios Soudris, Elias Kosmatopoulos, ***"IoT for Smart Grids: Design Challenges and Paradigms",*** Springer, 2019

Reference Books:

1. Hongjian Sun, Nikos Hatziargyriou, ***"Smarter Energy: From Smart Metering to the Smart Grid",*** IET Power and Energy Series, 2016.

Open Elective Course - Group II
(Offered by EEE to other Departments)

Course Code: BEE754A | **Course Name: Introduction to Smart grid**
Credits: 3 | **L:T:P:S – 3:0:0:0**
CIE: 50% Marks | **SEE: 50% Marks**
SEE Hours: 3 | **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To explain smart grid infrastructure and decentralized control models. 2. To demonstrate IoT applications for energy monitoring and security

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss the fundamentals of smart grid, its modelling and features	Understand
CO2	Explain the communication protocols and security features associated with smart grid	Understand
CO3	Apply IoT for solar energy forecasting in smart grid	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	1	-	-	-	-	1	To be mapped by Respective Department		
CO2	3	-	-	-	-	2	1	-	-	-	-	1			
CO3	3	3	2	-	-	2	1	-	-	-	-	2			

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to Smart Grid		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Background and history of smart Grid evolution, Definition and characteristics of smart grid.	3	Nil
1.2	Benefits of smart grid, Smart Grid vision and its realisation, Motives behind developing the Smart Grid concept.	2	Nil
1.3	Examples of Smart Grid projects/initiatives, The Smart Grid basic infrastructure.	1	Nil
1.4	Comparison between Smart Grid and conventional electrical networks.	1	Nil
Module – 2: Smart Grid modelling, control, and optimization			
2.1	Decentralized models for real-time renewable integration in future grid - Introduction to future smart grid.	2	Nil
2.2	Hybrid model of centralized resource management and decentralized grid control, Graph Modelling, General decentralized approaches - Distributed Nodal Approach.	2	Nil
2.3	Distributed Clustering Approach - Tie Set Graph theory and its Application to Distribution Systems.	2	Nil
2.4	Case Study of decentralized Grid Control.	1	Nil
Module – 3: Smart Grid to Evolve a Perfect Power System			
3.1	Introduction, overview of the perfect power system configurations, device level power system	3	Nil
3.2	Building integrated power systems, distributed power systems, overview of a dynamic energy management, key characteristics of smart devices.	4	Nil
Module – 4: Communication Protocols for the Smart Grid			
4.1	Introduction, IoT Application types, IoT based Smart-Grid review, Current IoT Based Smart Grid Technology Enablers.	3	Nil
4.2	**Smart Grid Hardware Security:** Introduction, Smart Grid Architecture Patterns, Hardware Device Authentication,	3	Nil
4.3	Confidentiality of Power Usage, Integrity of Data, Software and Hardware.	2	Nil
4.4	Future and Enabling Technologies for IoT based Smart Grid.	1	Nil

Module – 5: Solar Energy Forecasting in the Era of IoT Enabled Smart Grids			
5.1	Introduction, The Future Role of Forecasting, Summary of Solar Forecasting Methods, Example of a Detailed, Short-Term Forecasting Method.	3	Nil
5.2	**Intelligence in IoT-enabled Smart Cities:** Energy Consumption monitoring in IoT based smart cities, Smart homes in the crowd of IoT based cities,	3	Nil
5.3	Smart meters for the smart city's grid, Intelligent parking solutions in IoT based smart cities.	3	Nil
	Total No. of Lecture Hours	40	
		Total No. of Tutorial Hours	Nil

Textbooks:

1. Salman K. Salman, ***"Introduction to the Smart Grid Concepts, Technologies and Evolution",*** The Institution of Engineering and Technology, London, United Kingdom, 2017.
2. Clark W Gellings, "**The Smart Grid, Enabling Energy Efficiency and Demand Side Response**", CRC Press, 2009

Course Code: BEE754B **Course Name: Soft Computing Techniques**
Credits: 3 **L:T:P:S - 3:0:0:0**
CIE: 50% Marks **SEE: 50% Marks**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To teach fuzzy logic and ANN architectures for system optimization. 2. To guide mini-projects on pattern recognition or predictive modeling.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs		Bloom's level
CO1	Explain fuzzy sets, methods of fuzzy logic and fuzzy mathematics.	Understand
CO2	Explain the Artificial Neuron Models, functions and apply the various learning rules of Neural Networks.	Apply
CO3	Explain the various Neuro -fuzzy controller technique	Understand
CO4	Apply the concepts of soft computing techniques to implement mini project	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		To be mapped by Respective Department		
CO2	3	-	-	-	-	-	-	-	-	-	-	-				
CO3	3	-	-	-	-	-	-	-	-	-	-	-				
CO4	3	3	3	2	3	-	-	-	3	3	-	3				

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Fuzzy Control		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Fuzzy Logic, Fuzzy Sets, Membership Functions - Piecewise Linear MF,	2	Nil
1.2	Nonlinear Smooth MF, Sigmoidal MF, Polynomial or Spline-Based Functions, Irregular Shaped MF, Linguistic Variables,	2	Nil
1.3	Fuzzy If–then Rules, Fuzzy Proposition,	2	Nil
1.4	Methods for Construction of Rule-Base	2	Nil
Module – 2: Fuzzification and Defuzzification:			
2.1	Fuzzification - Inference Mechanism Mamdani Fuzzy Inference,	3	Nil
2.2	Sugeno Fuzzy Inference, Tsukamoto Fuzzy Inference, Defuzzification,	3	Nil
2.3	Defuzzification Methods, Properties of Defuzzification	2	Nil
Module – 3: Artificial Neural Networks			
3.1	Introduction Neural Networks, Biological Neuron, Biological and Artificial Neuron Models, types of Neuron Activation function.	2	Nil
3.2	ANN Architectures, supervised, and unsupervised learning, Perceptron Models, training Algorithms,	2	Nil
3.3	Limitations of the Perceptron Model and Applications,	2	Nil
3.4	Computer based simulation.	2	Nil
Module – 4: ANN Paradigms			
4.1	Multilayer Feed forward Neural Networks - Back propagation Algorithm, Limitations of Back propagation Algorithm, Radial Basis	3	Nil
4.2	Function network structure - covers theorem and the separability of patterns - RBF learning strategies.	3	Nil
4.3	Applications in forecasting and pattern recognition and other engineering problems,	2	Nil

	Computer based simulation		
Module – 5: Neuro-Fuzzy Control			
5.1	Combinations of Neural Networks and Fuzzy Controllers - NN for Correcting FLC, NN for Learning Rules, NN for Determining MFs, NN for Learning/Tuning Scaling Parameters.	3	Nil
5.2	Scaling Parameters of PD-PI Fuzzy Controller, Reducing the Number of Scaling Parameters,	2	Nil
5.3	Neural Network for Tuning Scaling Factors, Backpropagation Learning with Linear Activation Function, Learning with Non-Linear Activation Function.	3	Nil
	Total No. of Tutorial Hours	40	
		Total No. of Tutorial Hours	Nil

Textbooks:

1. Nazmul Siddique, **"Intelligent Control A Hybrid Approach Based on Fuzzy Logic, Neural Networks and Genetic Algorithms",** Springer International Publishing Switzerland, 2014
2. S.Rajasekaran and G.A.V.Pai,"**Neural Networks, Fuzzy Logic & Genetic Algorithms"**, PHI, New Delhi, 2003.

Reference Book*:*

1. Robert J. Schalkoff, "**Artificial Neural Networks"**, Tata McGraw Hill Edition, 2011.

Course Code: BEE754C **Course Name: Renewable Energy**
Credits: 3 **L:T:P:S - 3:0:0:0**
CIE: 50% Marks **SEE: 50% Marks**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To familiarise energy Sources, energy storage and Energy Conversion systems. 2. To provide proficiency in Photo Voltaic Cell systems, Biomass, Biogas and Urban waste conversion 3. To describe Ocean Energy Technologies.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Explain the classification of energy resources, environmental impacts of energy use, and the role of renewables in mitigating climate change.	Understand
CO2	Calculate solar angles, insolation, and day length using celestial coordinates, and analyze the I-V characteristics of solar cells under varying conditions.	Apply
CO3	Compare different solar thermal systems and wind turbine designs based on efficiency, application, and Betz's law limitations.	Analyse
CO4	Design basic biomass conversion processes, hydrogen energy systems and evaluate tidal energy schemes for site selection.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	2	1	-	-	-	3	3	-	-	-	-	1		To be mapped by Respective Department		
CO2	3	3	2	-	1	1	3	-	-	-	-	1				
CO3	2	3	2	-	1	1	3	-	-	-	-	1				
CO4	2	3	3	-	1	1	3	-	-	-	-	1				

Mapping Strength: **Strong– 3** **Medium – 2** **Low – 1**

Course Structure

Module – 1: Renewable Energy Sources		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction, Classification of Energy Resources, Environmental Aspects of Energy, Global Warming & Climate Change, Green footprint, carbon footprint, ecological footprint concepts, Initiatives, schemes, and policies by MNRE, Government of India	2	Nil
1.2	**Hydrogen Energy Systems:** Hydrogen Production Methods – Electrolysis, Thermochemical Processes, Photoelectrochemical (PEC) water splitting	2	Nil
1.3	Hydrogen Storage & Safety: Storage technologies- compressed gas, liquid hydrogen, metal hydrides.	2	Nil
1.4	Hydrogen Conversion Technologies - Fuel Cells: PEMFC, SOFC – working principles, applications, Hybrid Systems: Ammonia-hydrogen blends for power generation.	3	Nil
Module – 2: Photo Voltaic (PV) Cell Systems			
2.1	Sun and solar spectrum, The sun-earth relationship, Solar irradiance, Finding solar insolation, using insolation data, Insolation PV energy	3	Nil
2.2	Single Crystal Silicon Solar Cell, I-V Characteristics, Effect of Insolation and Temperature on the Performance of Silicon Cells.	2	Nil
2.3	Different Types of Solar Cells, Modern Technological Methods of Producing These Cells, Indian and World Photovoltaic Energy Scenario, Solar Cell, Module, and Array Construction, Maximizing the Solar PV Output and Load Matching, Design of solar arrays, Numerical problems	3	Nil

Module – 3: Solar Thermal Energy Conversion Systems			
3.1	Principle of Solar Water Heating Systems, Solar Cookers, Solar Desalination Systems, Solar Ponds, Solar Chimney Power Plant, Central Power Tower Power Plants Etc.	2	Nil
3.2	Classification of Solar Concentrators, Basic Definitions Such as Concentration Ratio, Angle of Acceptance Etc.	2	Nil
3.3	Tracking of the Sun; Description of Different Tracking Modes of Solar Collectors and the Determination of Angle of Incidence of Insolation in Different Tracking Modes, Concept of Green Building and Associated Design Parameters.	4	Nil
Module 4: Wind Energy			
4.1	Origin of Winds, Nature of Winds, Wind Data Measurement, Variation of Wind Speed with Height.	3	Nil
4.2	Estimation of Wind Energy at a Site: Betz's Law, Wind Turbine Aerodynamics, Wind Turbine Types and Their Construction, Characteristics of wind turbine, Power developed by wind turbine, Numerical problems	4	Nil
4.3	Wind Energy Storage, Wind Energy Programme in India and the World.	1	Nil
Module – 5: Biomass Energy Resources & Ocean Energy Technologies			
5.1	Biomass types and characterization, Biochemical conversion processes	2	Nil
5.2	Bioconversion of substrates into alcohol and thermo-chemical conversion of biomass, Numerical problems	3	Nil
5.3	Thermal energy conversion by Claude cycle, Anderson cycle and Hybrid cycle.	1	Nil
5.4	**Tidal Energy Conversion** –Site selection criteria, Single basin and double basin schemes, Tidal power potential in India.	2	Nil
	Total No. of Lecture Hours	40	
		Total No. of Tutorial Hours	Nil

Textbooks:

1. S. Rao and Dr. B.B. Parulekar, **"Energy Technology",** 3rd edition, Khanna Publishers.
2. Rai G.D**, "Non-conventional Sources of Energy",** 4th edition, Khanna Publishers, New Delhi, 2007.
3. Gupta R.B., **"Hydrogen Fuel: Production, Transport, and Storage"**, CRC Press, 2008.

Reference Books:

1. Mukherjee D, and Chakrabarti S, **"Fundamentals of Renewable Energy Systems",** New Age International Publishers, 2005.
2. B.H. Khan, **"Non-conventional energy resources",** 2nd Edition, McGraw Hill, Education (India) Pvt. Ltd, 2009.

Course Code: BEE754D **Course Name: Agriculture Engineering**
Credits: 3 **L:T:P:S - 3:0:0:0**
CIE: 50% Marks **SEE: 50% Marks**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To discuss the fundamental concepts of Agriculture practices. 2. To demonstrate the techniques of precision farming. 3. To develop skills to apply modern techniques in agriculture practices.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss the basic concepts of Agriculture practices.	Understand
CO2	Apply modern technologies to precision farming.	Apply
CO3	Apply nanotechnology and IoT in agriculture practices.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	3	-	-	-	-	1	To be mapped by Respective Department		
CO2	3	2	2	-	2	2	3	-	-	-	-	1			
CO3	3	2	2	-	2	2	3	-	-	-	-	1			

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to Agriculture		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction, scope and its role in crop production, Major field crops of India	4	Nil
1.2	Farming and cropping systems,soil–plant-water-relationships, water requirement of crops, scheduling irrigation based on various approaches, Tillage, Soil productivity and fertility, Nutrient sources	2	Nil
1.3	Control vs prevention of weeds, planting systems and planting densities, Horticultural zones of state and country, Impact of Agriculture in GDP of the nation	2	Nil
Module – 2: Sensors and signal conditioning in Agricultural Engineering			
2.1	Introduction to sensors, selection criteria for sensors, pH sensor, moisture sensor, humidity sensor	3	Nil
2.2	Measurement of soil nutrients (NPK), need for signal conditioning.	2	Nil
2.3	Fundamentals circuits of signal conditioning – Filtering, Amplifying, DAC and ADC	3	Nil
Module – 3: Geoinformatics and Precision Farming			
3.1	Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture	3	Nil
3.2	Geoinformatics- definition, concepts, tool and techniques; their use in Precision Agriculture. soil mapping; fertilizer recommendation using geospatial technologies; Global positioning system (GPS).	3	Nil
3.3	Spatial data creation and editing in GIS	2	Nil
Module – 4: Nanotechnology in Agriculture Engineering			
4.1	Brief introduction concepts and techniques, nano-pesticides, nano fertilizers, nano-sensors	4	Nil
4.2	Carbon nano tubes for trapping nutrients in soil, use of nanotechnology in seed, water, fertilizer, plant protection for scaling up farm productivity	4	Nil
Module – 5: Computer Vision and IoT in Agricultural Engineering			
5.1	Toxins in Agriculture products, (Aflatoxin), Methods of detection of toxins, Detection of Aflatoxin in Agricultural products by Deep Learning	4	Nil
5.2	**IoT in Agriculture Engineering:** Introduction to IoT, Case Studies – Design of	4	Nil

	IoT based smart irrigation system, Design of smart agriculture monitoring system using IoT.		
	Total No. of Lecture Hours	**40**	
	Total No. of Tutorial Hours		**Nil**

Textbooks:

1. Francisco J. Villalobos, Elias Fereres, **"Principles of Agronomy for Sustainable Agriculture",** Springer International Publishing, 2017.
2. Balasubramaniyan P and Palaniappan S.P., **"Principles and Practices of Agronomy",** AgroBios (India) Ltd., Jodhpur,2001.
3. Ramon Pallas-Areny, John G. Webster**, "Sensors and Signal Conditioning",** Wiley,2012.
4. Campbell J.B., **"Introduction to Remote Sensing"**-Third edition. Taylor and Francis, London 2002.
5. Prasant Kumar Pattnaik, Raghvendra Kumar, Souvik Pal, S. N. Panda, **"IoT and Analytics for Agriculture",** 2019

Reference Books:

1. Brady, N.C. and Well, R.R., **"The Nature and Properties of Soils",** (13th ed.), Pearson Education, Delhi, 2002.
2. Brouwer C., Prins K, Kay, M., and Heibloem M, **"Irrigation Water Management: Irrigation Methods".** Training Manual No. 5. FAO, Rome,1989
3. Mohesin, N.N. **"Thermal Properties of Foods and Agricultural Materials".** Gordon & Breach Science Publishers, New York, 1980.
4. Joseph T. and Morrison M., **"Nano Technology in Agriculture and Food".** Nanoforoum.org., 2006

Course Code: BEE754E
Credits: 3
CIE: 50% Marks
SEE Hours: 3

Course Name: Power Electronic Devices and Applications
L:T:P:S - 3:0:0:0
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To analyze switched-mode converters and resonant circuits. 2. To demonstrate the simulation of PWM techniques for inverter designs. 3. To impart proficiency in applying soft switching schemes for resonant converter design.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Analyze and design DC-DC switched mode power converters	Analyse
CO2	Apply pulse width modulated techniques for switched mode DC-AC converter design	Apply
CO3	Explain soft switching and apply for resonant converter design	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	3	-	-	-	-	-	-	-	-	1		To be mapped by Respective Department		
CO2	3	3	-	-	-	-	-	-	-	-	-	1				
CO3	3	-	-	-	-	-	-	-	-	-	-	1				

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Fundamentals of DC-DC Converters		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Analysis of Buck, Boost and Buck-Boost converters – continuous conduction mode only	4	Nil
1.2	Analysis of Cuk converter- continuous conduction mode only	4	Nil
Module – 2: Switched Mode DC-to-DC Converter -I			
2.1	Linear Power Supply, disadvantages of linear power supply, Switched mode power supply, dc-dc converters with electrical isolation, Unidirectional core excitation & bidirectional core excitation.	4	Nil
2.2	Fly back converter – continuous & discontinuous conduction mode, Double ended fly back converter	4	Nil
Module – 3: Switched Mode DC-to-DC Converter -I			
3.1	Forward converters, basic forward converter, practical forward converter – continuous conduction mode only	3	Nil
3.2	Double ended forward converter, Push pull converter	3	Nil
3.3	Half bridge converter, Full bridge converter – continuous conduction mode, current source dc-dc converter	2	Nil
Module – 4: Switched Mode DC to AC converter			
4.1	Single-phase square wave full-bridge inverter, square wave switching scheme, sine PWM switching scheme – PWM with bipolar & unipolar voltage switching	2	Nil
4.2	Harmonic analysis of output voltage, output control by voltage cancellation	2	Nil
4.3	3-phase voltage source inverter, 3-phase sine PWM inverter, RMS line to line voltage & RMS fundamental line-to-line voltage	2	
4.4	Square wave operation Switching utilisation ratio of 1-phase & 3-phase full-bridge inverters.	2	
Module – 5: Resonant Converters			
5.1	Resonant Converters, Basic resonant circuit concepts - series resonant Circuit, parallel resonant circuit	4	Nil

5.2	Load resonant converter, ZCS resonant converter- L type & M type, ZVS resonant converter, comparison of ZCS & ZVS Resonant Converters	4	Nil
	Total No. of Lecture Hours	**40**	
	Total No. of Tutorial Hours		**Nil**

Textbooks:

1. Mohan, Undeland, Robbins, "**Power Electronics – Converters Application and Design"**, Wiley-India
2. Muhammad H. Rashid, "**Power Electronics – Circuits, Devices and Applications"**, Pearson Education

Reference Books:

1. Abraham Pressman, "**Switching Power supply Design**", McGraw Hil

Course Code: BEE754F | **Course Name: Introduction to Battery Management Systems**
Credits: 3 | **L:T:P – 3:0:0:0**
CIE: 50% Marks | **SEE: 50% Marks**
SEE Hours: 3 | **Total Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To familiarise the terminologies of batteries 2. To develop skills on deriving the circuit models of Li-ion batteries 3. To describe SoC, SoH, cell balancing and power estimation algorithms

Course Outcomes:

On the successful completion of the course, the student will be able to

COs		Bloom's level
CO1	Understand the terminologies and working of batteries.	Understand
CO2	Develop Equivalent-Circuit Models of Lithium-ion Battery.	Apply
CO3	Describe requirements and functionalities of a BMS.	Understand
CO4	Explain the methods of Battery SOC, SOH Estimation, Cell balancing and Computation of power limits.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	2	-	-	-	-	1		To be mapped by Respective Department		
CO2	3	3	-	-	-	2	2	-	-	-	-	1				
CO3	3	-	-	-	-	2	2	-	-	-	-	1				
CO4	3	3	-	-	-	2	2	-	-	-	-	1				

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to Battery Technology		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction to battery terminologies: Cell voltage, cell nominal charge capacity, cell nominal energy capacity, Specific energy and energy density	3	Nil
1.2	Working of a cell, Working of Li-ion Cells: Negative electrode, Positive electrode, Electrolyte, Separator, Current Collectors, Charging and Discharging	3	Nil
1.3	Manufacturing of Li-ion cells, Ageing, Uncontrolled operating conditions and abuses of Battery.	2	Nil
Module – 2: Equivalent Circuit Modelling of Battery Packs			
2.1	Equivalent-Circuit Models: Open-circuit voltage (OCV), State-of-charge dependence, Equivalent series resistance, Diffusion voltages.	4	Nil
2.2	Effect of ageing on Total capacity and Equivalent Series Resistance, Negative-electrode aging, Positive electrode aging.	4	Nil
Module – 3: Battery Management System Design Requirements			
3.1	Purposes of a battery- management system, Battery-pack sensing of Voltage, Temperature and Current	3	Nil
3.2	High-voltage contactor control, Isolation sensing, Thermal control, Protection, Charger control	3	Nil
3.3	Communication via CAN bus, Log book function, State of charge estimation, Energy estimation, Power estimation, SOH estimation.	2	Nil
Module – 4: Battery State of Charge and Health Estimation			
4.1	**Battery State of Charge Estimation:** Definition of State of Charge, Classification of SOC estimation methods, Estimation method based on characteristic parameters	2	Nil
4.2	Ampere-hour integral estimation method, Model-based estimation method, Data-	2	Nil

	driven estimation (qualitative approach only).		
4.3	**Battery State of Health Estimation:** Sensitivity of voltage to Equivalent Series Resistance, Sensitivity of voltage to total capacity, Estimating SOH parameters	2	Nil
4.4	Classification of SOH estimation method, Direct measurement methods, Indirect analysis methods, Adaptive algorithms, Data-driven based methods (qualitative approach only).	2	Nil
Module – 5: Cell Balancing and Power Limit estimation			
5.1	**Cell Balancing:** Causes of imbalance, Balancer design choices, Circuits for balancing: Fixed shunt resistor, Switched shunt resistor, Multiple switched capacitors.	4	Nil
5.2	**Power Limit estimation:** Terminal-voltage-based power limits, Voltage-based power limits, using a simple cell model, Rate limits based on SOC, maximum current and power.	4	Nil
	Total No. of Lecture Hours	**40**	
		Total No. of Tutorial Hours	**Nil**

Textbooks:

1. Gregory L. Plett, "**Battery Management Systems, Vol. 1, Battery Modeling**", Artech House, 2015.
2. Gregory L. Plett, "**Battery Management Systems, Volume II, Equivalent-Circuit Methods**", Artech House, 2016

Reference Books:

1. Rui Xiong, "**Battery Management Algorithm for Electric Vehicles"** Springer publications 2020.

B.E Electrical and Electronics Engineering
(2022-2026)

Syllabus – VIII Semester

Department of Electrical and Electronics Engineering
The National Institute of Engineering
Mysuru-570 008

Course Code: BEE801X
Credits: 3
SEE: 100% Marks
SEE Hours: -

Course Name: Professional Elective IV (Online Course)
L:T:P:S:0:0:0:3
CIE: -
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To be provided by the course instructor – NPTEL

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Apply the knowledge of electrical engineering fundamentals to solve real world problems and design solutions.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	3	3	-	-	-	-	3		3	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

A MOOC course of 12 weeks duration, relevant to Electrical & Electronics Engineering will be decided based on the availability of courses in NPTEL during the corresponding academic year.

Course Code: BEE802X
Credits: 3
SEE: 100% Marks
SEE Hours: -

Course Name: Professional Elective IV (Online Course)
L:T:P:S:0:0:0:3
CIE: -
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To be provided by the course instructor – NPTEL

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Apply the knowledge of engineering fundamentals to solve real world problems and design solutions.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	3	3	-	-	-	-	3		3	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

A MOOC course of 12 weeks duration, of interdisciplinary nature will be decided based on the availability of courses in NPTEL during the corresponding academic year.

Course Code: BEE803
Credits: 10
SEE: 50% Marks
SEE Hours: 3

Course Name: Internship
L:T:P:S : 0:0:20:0
CIE: 50% Marks
Max. Marks: 200

Prerequisites if any	Nil
Learning objectives	1. To facilitate industry/research platforms for hands-on experience. 2. To monitor progress through logbooks and mentor feedback. 3. To evaluate reports and presentations for professional readiness.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		Bloom's level
CO1	Gain field experience in the relevant discipline	Apply
CO2	Present and document the training experience	Apply
CO3	Apply modern tools for Engineering Applications	Apply
CO4	Understand the ethical practices adapted for sustainable development	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	1	-	3	1	-	-	-	-	-	3		3	-	3
CO2	3	3	1	-	-	-	-	-	3	3	-	3		3	-	3
CO3	3	3	1	-	3	-	-	-	-	-	-	3		3	3	3
CO4	-	-	-	-	-	3	3	3	-	-	-	3		-	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Instructions:

- Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, center of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes. The mandatory Research internship /Industry internship / Rural Internship is for 14 to 16 weeks.
- The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent examination after satisfying the internship requirements.
  - ii. **Research internship:** A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.
  - iii. **Industry internship:** Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.
  - iv. **Rural Internship:** Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment. The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship.

Evaluation:

The continuous internal evaluation will be done in two phases using appropriate rubrics, the final evaluation will be done at the end of the semester with industry experts and the internship supervisor.