Vidyayāmruthamashnuthe

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical & Electronics Engineering

Autonomous 2022 Scheme & Syllabus

B.N.M Institute of Technology

An Autonomous Institution Under VTU
Approved by AICTE, Accredited as Grade A Institution by NAAC.
All UG branches – CSE, ECE, EEE, ISE & Mech.Engg Accredited by NBA for academic years 2018-19 to 2024-25 & valid upto 30.06.2025
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Department of Electrical and Electronics Engineering

Proposed 2022 Scheme for Autonomous Program

Summary of Semester wise Credits

Sl. No.	Semester	Credits
1	1	20
2	2	20
3	3	22
4	4	21
5	5	22
6	6	23
7	7	16
8	8	16
	Total	160

Semester: III EEE

Sl. No.	Course and Course Code		Course Title	Teaching Department	Teaching Hours/week					Credits	Examination		
					Theory Lecture	Tutorial	Practical	Project	Total Hours		CIA	SEA	Total
					L	T	P	J					
1	BSC	22MAC131	Fourier Series, Transforms and Statistical Techniques	Mathematics	2	2	--	--	4	**3**	50	50	100
2	PCC	22EEE132	Generation, Transmission and Distribution	EEE	2	2	--	--	4	**3**	50	50	100
3	PCC	22EEE133	Network Analysis	EEE	2	2	--	--	4	**3**	50	50	100
4	PCI	22EEE134	Transformers and Induction Motors	EEE	3	--	2	--	5	**4**	50	50	100
5	PCI	22EEE135	Analog and Digital Electronics	EEE	3	--	2	--	5	**4**	50	50	100
6	PBL	22EEE136	Python Programming for Electrical Engineers	EEE	--	--	2	2	4	**2**	50	50	100
7	HSS	22CIP137	Constitution of India and Professional Ethics	HSS	--	2	--	--	2	**1**	100	--	100
8	AEC	22SFT138	Soft Skills -1	HSS	--	2	--	--	2	**1**	100	--	100
9	IPL	22EEE139	Innovative Project Lab (Social Concern)	EEE	--	--	--	2	2	**1**	100	--	100
			Total		12	10	6	4	32	**22**	600	300	900

++ **L-Theory lecture, T – Tutorial, P – Practical, J – Project**

CIA: Continuous Internal Assessment, SEA: Semester End Assessment, NCMC: Non Credit Mandatory Course

AICTE Activity points to be earned by students admitted to BE day college programme

Over and above the academic grades, every day college regular student admitted to the 4 year Degree programme and every student entering 4 years degree programme though lateral entry, shall earn 100 and 75 activity points respectively for the award of degree through AICTE activity programme. The activities can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hour's requirement should be fulfilled. Activity points have no effect on SGPA/CGPA and shall not be considered for vertical progression.

Semester: IV EEE

Sl. No.	Course and Course code		Course Title	Teaching Department	Teaching Hours/week					Credits	Examination		
					Theory Lecture	Tutorial	Practical/ Training	Project	Total Hours		CIA	SEA	Total
					L	T	P	J					
1	BSC	22MAC141	Complex Analysis, Probability and Random Process	Mathematics	2	2	--	--	**4**	3	50	50	100
2	PCC	22EEE142	Linear Control Systems	EEE	2	2	--	--	**4**	3	50	50	100
3	PCI	22EEE143	Electrical Motors and Synchronous Machines	EEE	3	--	2	--	**5**	4	50	50	100
4	PCI	22EEE144	Power Electronic Devices and Circuits	EEE	3	--	2	--	**5**	4	50	50	100
5	PBL	22EEE145	Simulation of Electrical and Electronic Circuits	EEE	--	--	2	2	**4**	2	50	50	100
6	PCC	22EEE146	Electronic Instrumentation and measurements	EEE	2	--	--	--	**2**	2	50	50	100
7	AEC	22SFT147	Soft Skills - 2	HSS	--	2	--	--	**2**	1	100	--	100
8	INT	22EEE148	Internship- 1 / Innovative Project Lab	EEE	--	--	2	2	**4**	2	100	--	100
			Total		12	6	8	4	30	**21**	500	300	800

Internship: All the students registered to II year of BE shall have to undergo mandatory internship of 4 weeks during II semester or III semester vacation. Continuous Internal Assessment will be conducted in IV semester and the prescribed credit will be included. Internship shall be considered as a head of passing and shall be considered for the award of degree.

AICTE Activity points to be earned by students admitted to BE day college programme

Over and above the academic grades, everyday college regular student admitted to the 4 year Degree programme and every student entering 4 years degree programme though lateral entry, shall earn 100 and 75 activity points respectively for the award of degree through AICTE activity programme. The activities can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hour's requirement should be fulfilled. Activity points have no effect on SGPA/CGPA and shall not be considered for vertical progression.

Semester: V EEE

Sl. No.	Course and Course code		Course Title	Teaching Department	Teaching Hours/week					Credits	Examination		
					Theory Lecture	Tutorial	Practical/ Training	Project	Total Hours		CIA	SEA	Total
					L	T	P	J					
1	PCC	22EEE151	Power System Analysis and Stability	EEE	2	2			4	**3**	50	50	100
2	PCC	22EEE152	Electromagnetic Fields and Wave Theory	EEE	2	2	--	--	4	**3**	50	50	100
3	PCI	22EEE153	Introduction to AI & ML	EEE	3	--	2	--	5	**4**	50	50	100
4	PCI	22EEE154	Digital Signal Processing	EEE	3	--	2	--	5	**4**	50	50	100
5	PBL	22EEE155	ARM processors and Applications	EEE	--	--	2	2	4	**2**	50	50	100
6	POE	22EEE156X	Open Elective course	EEE	3	--	--	--	3	**3**	50	50	100
7	AEC	22EEE157	Employability Skills -1 (Technical)	T & P	--	2	--	--	2	**1**	100	--	100
8	INT	22EEE158	Internship- 2	EEE	--	--	4	--	4	**2**	100	--	100
			Total		13	6	10	2	31	**22**	500	300	800

Open Elective Course			
22EEE1561	Energy Audit and Energy ManagementSystem	22EEE1563	Fundamentals of Hybrid and Electric Vehicles
22EEE1562	Non-Conventional Energy Resources	22EEE1564	Sensors and Transducers

Internship: All the students registered to III year of BE shall have to undergo mandatory internship of 4 weeks during IV semester vacation. Continuous Internal Assessment will be conducted in V semester and the prescribed credit will be included. The internship shall be slated for CIA only and will not have SEA. Internship shall be considered as a head of passing and shall be considered for the award of degree. Internship of 04 weeks during the intervening period of IV and V semesters; The letter grade earned through CIA shall be included in the V semester grade card. Those, who do not take up / complete the internship shall be considered under F(fail) grade and shall have to complete subsequently after satisfying the internship requirements.

AICTE Activity points to be earned by students admitted to BE day college programme

Over and above the academic grades, every day college regular student admitted to the 4 year Degree programme and every student entering 4 years degree programme though lateral entry, shall earn 100 and 75 activity points respectively for the award of degree through AICTE activity programme. The activities can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hour's requirement should be fulfilled. Activity points have no effect on SGPA/CGPA and shall not be considered for vertical progression.

Semester: VI EEE

Sl. No.	Course and Course code		Course Title	Teaching Department	Teaching Hours/week					Credits	Examination		
					Theory Lecture	Tutorial	Practical/ Training	Project	Total hours		CIA	SEA	Total
					L	T	P	J					
1	PCC	22EEE161	Switchgear & Protection	EEE	2	2	--	--	4	**3**	50	50	100
2	PCI	22EEE162	Computer Techniques in Power System	EEE	2	2	2	--	6	**4**	50	50	100
3	PCI	22EEE163	High Voltage Engineering	EEE	3	--	2	-	5	**4**	50	50	100
4	PBL	22EEE164	Simulation of Electric vehicle and Alternate energy systems	EEE	--	--	2	2	4	**2**	50	50	100
5	PEC	22EEE165X	Professional Elective Course	EEE	3	--	--	--	3	**3**	50	50	100
6	PEC (Online Courses)	22EEE166X	Professional Elective (online Courses)	EEE	3	--	--	--	3	**3**	50	50	100
7	POE	22EEE167X	Open Elective course	EEE	3	--	--	--	3	**3**	50	50	100
8	AEC	22EEE168	Employability Skills – 2 (Technical)	T & P	--	2	--	--	2	**1**	100	--	100
			Total		16	6	6	2	30	**23**	450	350	800

Professional Elective Courses			
22EEE1651	Renewable Energy Sources	22EEE1655	Introduction to UNIX Programming
22EEE1652	Sensors and Transducers	22EEE1656	Principles of Fuzzy Logic
22EEE1653	Fundamentals of Electric and Hybrid Electric Vehicles	22EEE1657	Strategic Management
22EEE1654	Embedded Systems		

Professional Elective Courses (Online Courses)			
22EEE1661	Operation and Planning of Power Distribution Systems	22EEE1665	Programming in JAVA
22EEE1662	Industrial Automation and Drives	22EEE1666	Data Mining
22EEE1663	Battery Technology and Battery Management System	22EEE1667	Digital Marketing
22EEE1664	Digital Design with Verilog		

Open Elective Courses			
22EEE1671	PLC and SCADA	22EEE1673	Industrial Motor control and Automation
22EEE1672	Fuel Cell Technology	22EEE1674	Solar Photo Voltaic Systems

Semester: VII EE

Sl. No.	Course and Course code		Course Title	Teaching Department	Teaching Hours/week					Credits	Examination		
					Theory Lecture	Tutorial	Practical/ Training	Project	Total Hours		CIA	SEA	Total
					L	T	P	J					
	PCC	22EEE171	Engineering project Management and Finance	EEE	3	--	--	--	3	**3**	50	50	100
2	PEC	22EE172X	Professional Elective Course	EEE	3	--	--	--	3	**3**	50	50	100
3	PEC (Online Courses)	22EEE173X	Professional Elective (online Courses)	EEE	3	--	--	--	3	**3**	50	50	100
4	AEC	22EEE174	Research Methodology and IPR	EEE	1	2	--	--	3	**2**	50	50	100
5	PPW	22EEE175	Main Project- Phase 1	EEE	--	--	--	10	10	**5**	50	50	100
			Total		10	2	--	10	22	**16**	300	200	500

Professional Elective Courses			
22EEE1721	Electrical Estimation and Costing	22EEE1725	Data Base Management System
22EEE1722	Utilization of Electrical Power	22EEE1726	Artificial Neural Network
22EEE1723	Advanced Techniques in Electric Vehicles	22EEE1727	Accounts & Financing for Engineers
22EEE1724	Industrial Internet of Things		

Professional Elective Courses (Online Courses)			
22EEE1731	Advances in UHV Transmission and Distribution	22EEE1735	Big Data Computing
22EEE1732	Digital Control systems for Industrial applications	22EEE1736	Deep Learning
22EEE1733	Charging Infrastructure	22EEE1737	Operations and Supply Chain Management
22EEE1734	Drone Systems and Control		

Project work: Based on the abilities of the students and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

Semester: VIII EEE

Sl. No.	Course and Course code		Course Title	Teaching Department	Teaching Hours/week					Credits	Examination		
					Theory Lecture	Tutorial	Practical/ Training	Project	Total Hours		CIA	SEA	Total
					L	T	P	J					
1	PEC (Online Courses)	22EEE181X	Professional Elective (online Courses)	EEE	3	--	--	--	3	**3**	50	50	100
2	INT	22EEE182	Internship-3	EEE	--	--	8	--	8	**4**	50	50	100
3	PPW	22EEE183	Main Project Work- Phase 2	EEE	--	--	--	20	20	**9**	50	50	100
			Total		3	--	8	20	31	**16**	150	150	300

Professional Elective Courses (Online Courses)			
22EEE1811	Smart Grid	22EEE1815	Blockchain and its Applications
22EEE1812	Computer-Aided Design of Electrical Machines	22EEE1816	Natural Language Processing
22EEE1813	Simulation of Electric and Hybrid Electric Vehicle	22EEE1817	Business Analytics for Management Decision
22EEE1814	VLSI Design		

Project work: Based on the abilities of the students and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

Internship: All the students admitted to IV year of BE shall have to undergo mandatory internship of 16 weeks during the vacation of VI semester and during VII semester. End Assessment will be conducted in VIII semester and the prescribed credit shall be included. Internship shall be considered as a head of passing and shall be considered for the award of degree.

AICTE Activity points to be earned by students admitted to BE day college programme

Over and above the academic grades, every day college regular student admitted to the 4 year Degree programme and every student entering 4 years degree programme though lateral entry, shall earn 100 and 75 activity points respectively for the award of degree through AICTE activity programme. The activities can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hour's requirement should be fulfilled. Activity points have no effect on SGPA/CGPA and shall not be considered for vertical progression.

Professional Elective courses: (PEC)

I.	**Power engineering stream: PE**	**V.**	**Information Technology – IT**
22EEE1651	Renewable Energy Sources (Professional Elective Course)	22EEE1655	Introduction to UNIX Programming (Professional Elective Course)
22EEE1661	Operation and Planning of Power Distribution Systems (MOOC)	22EEE1665	Programming in JAVA (MOOC)
22EEE1721	Electrical Estimation and Costing (Professional Elective Course)	22EEE1725	Data Base Management System (Professional Elective Course)
22EEE1731	Advances in UHV Transmission and Distribution (MOOC)	22EEE1735	Big Data Computing(MOOC)
22EEE1811	Smart Grid (MOOC)	22EEE1815	Blockchain and its Applications (MOOC)
II.	**General Electrical stream: GE**	**VI.**	**AI & ML stream: AI**
22EEE1652	Sensors and Transducers (Professional Elective Course)	22EEE1656	Principles of Fuzzy Logic (Professional Elective Course)
22EEE1662	Industrial Automation and Drives (MOOC)	22EEE1666	Data Mining (MOOC)
22EEE1722	Utilization of Electrical Power (Professional Elective Course)	22EEE1726	Artificial Neural Network (Professional Elective Course)
22EEE1732	Digital Control systems for Industrial applications (MOOC)	22EEE1736	Deep Learning (MOOC)
22EEE1812	Computer-Aided Design of Electrical Machines (MOOC)	22EEE1816	Natural Language Processing (MOOC)
III.	**Electric vehicle stream: EV**	**VII.**	**Management Stream:**
22EEE1653	Fundamentals of Electric and Hybrid Electric Vehicles (Professional Elective Course)	22EEE1657	Strategic Management (Professional Elective Course)
22EEE1663	Battery Technology and Battery Management System (MOOC)	22EEE1667	Digital Marketing (MOOC)
22EEE1723	Advanced Electric Drive Vehicles (Professional Elective Course)	22EEE1727	Accounts & Financing for Engineers (Professional Elective Course)
22EEE1733	Charging Infrastructure (MOOC)	22EEE1737	Operations and Supply Chain Management (MOOC)
22EEE1813	Simulation of Electric and Hybrid Electric Vehicle (MOOC)	22EEE1817	Business Analytics for Management Decision (MOOC)
IV.	**Interface stream: ES**		
22EEE1654	Embedded System (Professional Elective Course)		
22EEE1664	Digital Design with Verilog (MOOC)		
22EEE1724	Industrial Internet of Things (Professional Elective Course)		
22EEE1734	Drone Systems and Control (MOOC)		
22EEE1814	VLSI Design (MOOC)		

Open Elective -1 (V semester)			**Open Elective – 2 (VI semester)**		
1.	Energy Audit and Energy Management System	22EEE1561	1.	PLC and SCADA	22EEE1671
2.	Non-Conventional Energy Resources	22EEE1562	2.	Fuel Cell Technology	22EEE1672
3.	Fundamentals of Hybrid and Electric Vehicles	22EEE1563	3.	Industrial Motor control and Automation	22EEE1673
4.	Sensors and Transducers	22EEE1564	4.	Solar Photo Voltaic Systems	22EEE1674

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical and Electronics Engineering

III Semester Syllabus

Department of Mathematics

Semester: III			
Course: Fourier Series, Transforms and Statistical Techniques **Course Code: 22MAC131 (Common to ECE, EEE & ME)**			
L:T:P:J	**2:2:0:0**	**CIA**	**: 50**
Credits:	**03**	**SEA**	**: 50**
Hours:	**40**	**SEA Duration**	**: 03 Hours**

Course Learning Objectives: The students will be able to develop the theoretical and practical knowledge of Statistical methods, Laplace transform, Fourier series, Fourier transforms and Z-transforms in a comprehensive manner in various fields of engineering.

Module-1: Curve fitting & Statistical methods	No. of hours	Blooms cognitive Levels
Examples from Engineering field that require curve fitting and statistical methods. **Curve Fitting:** Curve fitting by the method of least squares-fitting the curves of the form: $y = ax+b$, $y = ax^2 + bx + c$ and $y = ax^b$. **Statistical methods:** Introduction to Moments, Skewness, Kurtosis and problems. Karl Pearson's coefficient of correlation and lines of regression. Experiential Learning component: Problems on curve fitting and statistical methods	**L: 04** **T: 04**	**Apply**
Module-2: Laplace Transform		
Examples from Engineering field that require Laplace transforms. Transformation for time domain to frequency domain. Definition and Laplace transforms of elementary functions (statements only). Laplace transform of $e^{at} f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$, $\int_0^t f(t)dt$ and $f^n(t)$ (without proof). Laplace transforms of Periodic functions, unit-step function and unit impulse function. *Experiential Learning component: Finding the Laplace transforms of a function .*	**L: 04** **T: 04**	**Apply**
Module-3: Inverse Laplace Transform		
Examples from Engineering field that require inverse Laplace transforms. Definition and problems. Inverse Laplace transform using convolution theorem (without proof). Solution of linear differential equations and simultaneous differential equations. Applications to engineering problems. *Experiential Learning component: Problems on convolution theorem.*	**L: 04** **T: 04**	**Apply**
Module-4: Fourier Series		
Examples from Engineering field that require Fourier series. Periodic functions, Introduction to Fourier Series, Dirichlet's condition. Fourier series of periodic functions with period 2π and arbitrary period. Half range Fourier sine and cosine series. Practical harmonic analysis over the interval *(0, 2l).* *Experiential Learning component: Finding the Fourier series.*	**L : 04** **T : 04**	**Apply**
Module-5: Fourier Transforms & Z -Transforms		

Examples from Engineering field that require Fourier Transforms & Z -Transforms. **Fourier Transforms:** Fourier transform and properties-problems, Fourier sine and cosine transforms. Inverse Fourier transforms. **Z-Transforms:** Introduction to Z-transform, Z-transform of standard functions and properties (without proof). Initial value and final value theorems, problems. *Experiential Learning component: Finding the Fourier Transforms & Z –Transforms of a function.*	**L : 04** **T : 04**	**Apply**

Course Outcomes: After completing the course, the students will be able to

CO 1: Make use of correlation and regression analysis to fit a suitable mathematical model for the statistical data.

CO 2: Use Laplace transform to find the transformation for time domain to frequency domain

CO 3: Use inverse Laplace transform in solving differential equations arising in network analysis , control system and other fields of engineering

CO 4: Demonstrate Fourier series to study the behavior of periodic functions and their applications in system communications, digital signal processing and field theory.

CO 5: Make use of Fourier transform and Z-transform to illustrate discrete / continuous function arising in wave and heat propagation, signals and systems

Reference Books:

1. E. Kreyszig: “Advanced Engineering Mathematics”, John Wiley & Sons, 10"Ed.(Reprint), 2016.
2. B. S. Grewal: “Higher Engineering Mathematics”, Khanna Publishers, 44th Ed., 2017.
3. H. K. Dass, “ Advanced Engineering Mathematics” S. Chand publication.
4. C. Ray Wylie, Louis C. Barrett : “Advanced Engineering Mathematics", 6" Edition, 2. McGraw-Hill Book Co., New York, 1995.
5. James Stewart : “Calculus —Early Transcendentals”, Cengage Learning India Private Ltd., 2017.
6. B.V. Ramana: "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill, 2010.
7. Srimanta Pal & Subodh C Bhunia: “Engineering Mathematics”, Oxford University Press, 3 Reprint, 2016.
8. Gupta C. B., Singh S. R. and Mukesh Kumar: “Engineering Mathematics for Semester I & II”, Mc-Graw Hill Education (India) Pvt. Ltd., 2015.

Web links and Video Lectures:

1. https://youtu.be/BsVtMnp3vks
2. https://youtu.be/Nz4WB8-gNBg
3. https://youtu.be/6MXMDrs6ZmA
4. https://youtu.be/r18Gi8lSkfM
5. https://youtu.be/cy_KI_FiS7I
6. https://youtu.be/sMYtHaSIXbU

Department of Electrical and Electronics Engineering

Semester: III	
Course Name: Generation, Transmission and Distribution (PCC) **Course Code: 22EEE132**	
Teaching Hours/Week (L:T:P:J): (2:2:0:0)	**CIA Marks:50**
Credits:3	**SEA Marks:50**
Hours:40	**SEA Duration: 03 hours**

Course Learning Objectives:

- To understand the concepts of various methods of generation of power
- To understand the merits and demerits of hydroelectric power plant, thermal power plant and nuclear power plant
- To understand the conductor and insulator selection
- To calculate the parameters of the transmission line for different configurations and assess the performance of the line
- To understand the basics of the AC distribution system

Pre-Requisites: Basic Electrical Engineering, Transmission and Distribution

Course Outcomes: After the completion of the course the students will be able to:

- Explain the generation of electrical energy, its sources, conventional and non-conventional generation of power
- Explain the structure of power system & selection of conductors and string efficiency
- Calculate the line parameters for a single phase, three phase–symmetrical and unsymmetrical systems.
- Calculate the performance and efficiency of short and medium transmission lines
- Explain primary & secondary distribution system
- Explain the impact of high-power transmission and distribution systems on society

Module-1: Power Generation	RBT	Hrs.
Introduction: Importance of electricity, Generation of electrical energy, Sources of energy, Comparison of energy sources. **Hydro-electric power station:** Introduction, Advantages and disadvantages, Schematic arrangement, Selection of site, Constituents of plant – Hydraulic structures, Water turbine, Electrical equipment **Steam power station:** Introduction, Advantages and disadvantages, Schematic arrangement, Choice of site, Equipment of steam power station **Nuclear power station:** Introduction, Advantages and disadvantages, Schematic arrangement - Nuclear reactor, Heat exchanger, Steam turbine, Alternator, Selection of site **Reference Book 1 : Chapters 1, 2**	**Understand**	**8**
Module-2: Electrical Supply System	**RBT**	**Hrs.**
Electrical Supply System: Layout, Advantages of HV transmission, Elements of a transmission line, Conductors –Aluminium Conductor steel reinforced (ACSR), Gap type thermal resistant aluminium alloy conductor steel reinforced (GTACSR), High Tension Low Sag (HTLS) conductor, Bundle conductor and its advantages. Importance of sag, Sag calculation – supports at same and different levels, **Overhead line Insulators:** A brief introduction to types of insulators, material used- porcelain, toughened glass and polymer (composite). Potential distribution over suspension insulator string, String efficiency, Methods of increasing string efficiency (Description only). **Reference Book 1 : Chapters 8**	**Apply**	**8**

Module-3: Transmission Line Parameters	RBT	Hrs.
Introduction to line parameters- resistance, inductance and capacitance. Calculation of inductance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Inductance of composite – conductors, geometric mean radius (GMR) and geometric mean distance (GMD). Calculation of capacitance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines, geometric mean radius (GMR) and geometric mean distance (GMD). Advantages of single circuit and double circuit lines. **Reference Book 2 : Part 2 Chapter 2**	**Apply**	**8**
Module-4: Performance of Transmission Lines and Underground Cables	**RBT**	**Hrs.**
Performance of Lines: Classification of lines – short, medium and long. Current & voltage relations, line regulation, transmission efficiency, and ABCD constants in short and medium-length lines, Ferranti effect on long-length lines**.** **Underground Cables:** Introduction, construction features, insulating materials for cables, classification of cables – belted cables, screened cables and pressure cables, comparison between AC and DC cables and limitations of cable. **Reference Book 1: Chapters 10, 11**	**Apply**	**8**
Module-5: Distribution Systems	**RBT**	**Hrs.**
Distribution: Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system, Methods of solving AC distribution problems, Secondary AC distribution systems – Three phase 4 wire system, Effect of disconnection of neutral in a 3 phase four wire system. **Reference Book 1: Chapters 12, 14**	**Understand**	**8**

Reference Books:

1. Principles of Power System,V.K. Mehta & Rohit Mehta, S. Chand Technical Publications.
2. A Course in Electrical Power, Soni Gupta & Bhatnagar Dhanpat Rai & Sons. 1st Edition, 2013

Department of Electrical and Electronics Engineering

Semester: III

Course Name: Network Analysis (PCC)
Course Code: 22EEE133

Teaching Hours/Week (L:T:P:J): 2:2:0:0	**CIA: 50**
Credits: 3	**SEA: 50**
Hours: 40 Hrs	**SEA Duration: 03 Hours**

Course Objectives:

- To explain about the various elements used in electrical circuits.
- To explain the use of network reduction and network solution methods for the analysis of electric circuits.
- To apply the concept of network theorems for the solution of electric circuits.
- To explain the concept of the time domain approach to analyze the initial and final behaviour of electric circuit elements.
- To explain the simplified Laplace transformation approach to analyze the behaviour of electric circuits.

Pre-requisites: KVL, KCL, series-parallel reduction of circuits with R, L, and C elements, complex variable operations, linear algebra, solution of differential equations, Laplace transforms and inverse Laplace transforms

Course outcomes: At the end of the course the student will be able to

- Analyse the given circuit (both single phase and three phases) using network reduction & other network solution methods.
- Solve the given electric circuit by applying the concept of network theorems.
- Analyse the behaviour of electrical network under initial, steady state condition and variation of parameters.
- Analyse electric circuits using Laplace transformations.
- Model the given two port networks in terms of network parameters (Z, Y, h and T)

Module-1: Fundamentals of Network Theory	**RBT**	**Hrs**
Basic network elements, classification, representation. Network reduction using Source transformation, and source shifting. Star-delta transformations, network reduction using star-delta transformations. Applications of KVL and KCL for Mesh current and node voltage analysis of AC and DC electric circuits with and without control sources. Super loop and super node methods. Illustrative examples	**Apply**	**8**
Module–2: Network Theorems	**RBT**	**Hrs**
Integro-differential equations on loop and node basis of circuits with R, L and C. Duality in electric networks. Superposition theorem, Thevenin's and Norton's theorems, Millman's theorem, and Maximum power transfer theorem. Illustrative examples (dependent sources excluded).	**Apply**	**8**
Module–3: Initial conditions and Resonance in networks.	**RBT**	**Hrs**
Initial conditions Initial conditions, definition and its importance in networks, evaluation of initial conditions in R-L, R-C, and R-L-C series and parallel circuits excited by DC sources. Interpretation of derivatives and waveform prediction, illustrative examples. **Resonance-** Meaning, importance, definitions of terminologies, series resonance, resonant frequency, Quality factor, half power frequencies, bandwidth of series and parallel resonant circuits, illustrative examples.	**Apply**	**8**
Module–4: Laplace transform	**RBT**	**Hrs**
Definition, importance, and applications. Laplace transforms of various parameters, Standard input signals (impulse, step, ramp, and parabolic). Inverse Laplace transformations, Partial fraction expansions. Applications of Laplace transformations for Analysis of simple R-L, R-C,	**Apply**	**8**

and R-L-C series parallel circuits excited by DC sources. Initial value and final value theorems, illustrative examples.		
Module-5: Two port Network parameters and Three phase circuits.	**RBT**	**Hrs**
Two port Network parameters Two-port network modeling through Z, Y, h and T-parameters. Relationship between the network parameters. Illustrative examples of evaluating the parameters of two-port networks containing independent and controlled sources. **Three-phase circuits:** Three-phase systems - three-phase 3-wire and 4-wire systems, unbalanced star and delta connected loads, evaluation of current, powers in unbalanced star and delta connected loads excited by balanced three-phase supply, illustrative examples.	**Apply**	**8**

Reference Books:

1. Network Analysis. Prof.K.Chennavenkatesh, Dr. Ganesh Rao, Publisher-Sanguine Technical Publishers.
2. Circuit Theory (Analysis and synthesis), A. Chakrabharathi, Dhanpat rai @co.(pvt.) Ltd, 6th ed. 2010.
3. Electric Circuits, Joseph A Edminister & Mahmood Nahavi, 5th ed. Schaum's outlines, McGraw Hill.

Department of Electrical and Electronics Engineering

Semester: III

Transformers and Induction Motors (PCI)

Course Code: 22EEE134

Teaching Hours/Week (L:T:P:J): (3:0:2:0)	**CIE Marks:** 50
Credits: 4	**SEE Marks:** 50
Hours: 40 Hours Theory+ 10 Lab Sessions	**SEE Duration:** 03 Hours

Course Learning Objectives:

- To understand the working of transformer, auto-transformer, and IM
- To understand the performance of single-phase & three phase transformer
- To understand the characteristics, starting methods, speed control of three phase IMs
- To understand the performance of three phase IMs and single-phase IM

-Requisites: Electromagnetic Induction, Single phase and three phase AC circuits, KCL & KVL

Course Outcomes: After the completion of the course the students will be able to:

- Explain the construction and working of single-phase & 3-phase transformer, auto-transformer.
- Determine the performance parameters of single-phase transformers and three-phase transformers through load and no-load tests
- Explain the construction, working, and types of 3-phase & single-phase Induction motor
- Explain the performance characteristics, starting methods and speed control of three phase IMs
- Determine the performance parameters and characteristics of Induction Motor through load and no-load test.

Module-1: Single-Phase Transformers	RBT	Hrs
Single-Phase Transformers: Necessity of transformer, principle of operation, Types and construction, EMF equation, Operation of practical transformer under no-load and on-load with phasor diagrams, equivalent circuit, Transformer losses, efficiency, and condition for maximum efficiency, voltage regulation, all day efficiency. Illustrative examples	**Apply**	**8**
Module-2: Testing and Parallel operation of Single-phase transformers	**RBT**	**Hrs**
Testing: Open circuit and short circuit tests, polarity test, Sumpner's test, and separation of hysteresis and eddy current losses, Illustrative examples **Parallel operation -** need, conditions to be satisfied for parallel operation– Single phase and three phase, Load sharing in case of similar and dissimilar transformers, Illustrative examples	**Apply**	**8 hours**
Module-3: Three phase transformers and Auto Transformers	**RBT**	**Hrs**
Three-phase Transformers: Introduction, Constructional features of three-phase transformers. Choice between single unit three-phase transformer and a bank of three single-phase transformers, Transformer connections for three phase operation - delta/star, delta/delta, star/delta, and vee/vee, choice of connections. Tertiary winding, Scott connection for three-phase to two-phase conversion, Illustrative examples **Autotransformers:** Single phase and three phase auto transformer, saving of conductor material, comparison of auto transformer and two winding transformer, Illustrative examples	**Apply**	**8 hours**
Module-4: Three phase Induction Motor	**RBT**	**Hrs**
Three phase Induction Motor: Concept and generation of rotating magnetic field, Principle of operation, construction, classification, and types; squirrel-cage, slip-ring. Slip and its significance, Torque equation, torque-slip characteristics Starting torque and Maximum torque, Equivalent circuit, Losses and efficiency, power flow diagram, Phasor	**Apply**	**8 hours**

diagram of induction motor on no load and loaded conditions. (numerical as applicable), Applications		
Module-5: Testing, Starters and Speed Control of 3-phase IM & Single-Phase IM	**RBT**	**Hrs**
Tests on three phase Induction Motor: Brake test, No-load and blocked rotor tests, circle diagram, Performance of the motor from the equivalent circuit. Illustrative examples **Starters and Speed control for 3-phase IMs:** Need for starter. Direct on line (DOL), Star-Delta and autotransformer starting, Rotor resistance starting. Speed control by V/f control (qualitative) and rotor resistance control **Single-Phase Induction Motor:** Double field revolving theory and principle of operation. Construction and operation of split-phase, capacitor start and capacitor run and shaded pole motors, and applications. (Excluding Numerical)	**Apply**	**8 hours**

Laboratory Experiments:

1. Open Circuit and Short circuit tests on single phase transformer and predetermination of (i) Efficiency and regulation (ii) Calculation of parameters of equivalent circuit.
2. Sumpner's test on transformers and determination of individual transformer efficiency
3. Polarity test and Parallel operation of two dissimilar single-phase transformers and determination of load sharing and analytical verification using the short circuit test data.
4. Scott connection with balanced and unbalanced loads
5. Separation of hysteresis and eddy current losses in single phase transformer.
6. Connection of 3 single-phase transformers in (a) star – delta, (b) delta – delta and (c) V – V (open delta) and determination of efficiency and regulation under balanced resistive load.
7. Load test on three phase induction motor.
8. No load and Blocked rotor tests on three phase induction motor to draw the circle diagram and hence to determine (i) the performance parameters at different load conditions and (ii) obtain the equivalent circuit.
9. Load test on single-phase induction motor
10. Performance characteristics of Induction Generator

Reference Books

1. Electrical Machinery, J.B. Gupta, S K Kataria & Sons
2. Electric Machines, D P Kothari, I J Nagrath, TMH
3. Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Co. Publications
4. Electrical Technology, B L Theraja and A K Theraja

Web links and Video Lectures:

NPTEL Courses

https://nptel.ac.in/courses/108106071
https://archive.nptel.ac.in/courses/108/105/108105155/
https://nptel.ac.in/courses/108106072
https://archive.nptel.ac.in/courses/108/105/108105131/
https://archive.nptel.ac.in/courses/108/102/108102146/

Department of Electrical and Electronics Engineering

Semester: III	
Analog and Digital Electronics (PCI) **Course Code: 22EEE135**	
Teaching Hours/Week (L:T:P:J): (3:0:2:0)	**CIE Marks:** 50
Credits: 4	**SEE Marks:** 50
Hours: 40 hours Theory+ 10 lab sessions	**SEE Duration: 0**3 Hours

Course Learning Objectives: The students will be able to

- ❖ Understand non-linear application of op-amp and realize function generator using op-amp.
- ❖ Design and analyse Butterworth filter circuit
- ❖ Use D/A and A/D convertors, Linear ICs 555, Voltage regulators for Analog circuit applications
- ❖ Implement Boolean switching functions after using K-map to simplify equations
- ❖ Use combinational circuits like Code converters, multiplexers, decoders
- ❖ Use flip flops to realize registers, and counters

Pre-Requisites: Course on Basic Electronics

Course outcomes: At the end of the course the student will be able to
CO1: Implement filters, waveform generators and non-linear applications of Op-Amp for a given requirement
CO2: Use Timer IC, Regulators, D/A and A/D converters for a given application
CO3: Simplify given Boolean expression using k-map
CO4: Build combinational circuits for code conversion, multiplexer, decoder, and encoder.
CO5: Build sequential circuits using flip flops for registers and counter operations

Module-1: Introduction to Digital Circuits and Combinational circuits	RBT	Hrs
Review of Digital basics and logic gates, Switching equations, Canonical form of SOP and POS, Simplification and realization of Digital switching equations using K-map [3 and 4 variables], Design Code convertors [BCD to Excess-3, BCD to 7-segment code]	**Apply**	**8**
Module-2: Combinational circuits and Introduction to sequential circuits	**RBT**	**Hrs**
Multiplexers (Mux): Implementation of 4:1, 8:1 Mux, Realization of Boolean expression using Mux. **Decoders:** Implementation of 2:4, 3:8 decoders, Realizing higher order decoder using lower order decoders, realization of Boolean expression using Decoders. **Encoders:** Implementation of 4:2, 8:3 encoders **Flip Flops:** Basic bistable element, Gated SR Latch, Need for Edge triggered flip flops, Edge triggered D-flip flop, JK-flip flops and T-flip flops [Block diagram and Functional truth table only], Characteristic equation of flip flops, Excitation table of flip flops, Interconversion of flip flops.	**Apply**	**8**
Module-3: Sequential circuits	**RBT**	**Hrs**
Registers: Types of registers, Shift registers, 4-bit PIPO, PISO, SISO, SIPO registers, Universal shift registers, **Counters:** Binary ripple counters, Synchronous Binary counters, Counters based on Registers, Design of Synchronous counters	**Apply**	**8**
Module-4: Operational Amplifier Applications		
Review of op-amp parameters **Op-Amp Non-Linear Applications:** ZCD, Schmitt Trigger [Analysis and Design] **Waveform generation:** Generation of Square wave using Astable circuit [Analysis and Design], Phase shift oscillator, Triangular wave generation **Filters:** Advantage of active filter, First order Butterworth Low pass, High pass, [Analysis and Design]	**Apply**	**8**
Module-5: Linear IC applications	**RBT**	**Hrs**

D/A and A/D convertors: Introduction to D/A and A/D convertors, R-2R D/A convertor, Successive approximation A/D convertors **555 Timer IC:** Internal Block diagram of 555, working of 555 as astable and monostable circuit. Applications of monostable and astable circuits[Analysis and Design] **Voltage regulators:** Fixed voltage regulators using 78XX and 79XX IC, Adjustable voltage regulators using LM317	**Apply**	**8**

Reference Books

1. Op-Amps and Linear Integrated Circuits, by Ramakant A.Gayakwad, 4th edition, PHI, 2012.
2. Digital Design, by M.Morris Mano, Michael D.Ciletti, 5th edition, Pearson Education Inc.
3. Digital Principles and Design, Donald D. Givone, TMH Edition 2002
4. Charles H Roth JR, Larry L Kimney, "Fundamentals of Logic Design", Cengage Learning, 5th edn.
5. S. Shalivahanan et.al., "Linear Integrated Circuits", McH, 2nd edn, 2014

Lab Experiments (10 Lab sessions)	
Sl. No.	**Experiments**
1	Design and realization of 1st order Butterworth High pass and low pass filter
2	Design and realization of Schmitt trigger circuit of a given UTP and LTP
3	Design and realization of square wave generation using 555 Timer IC
4	Realization of R-2R ladder D/A convertor
5	Realization of op-amp based function generator for Square and Triangular wave generation.
6	Design and realization of Op-Amp based Sine wave generator.
7	Simplification and realization of a given Boolean expression using logic gates
8	Realization of 4-bit adder/subtractor using Adder IC
9	Realization of 3-bit mod-N counter using counter IC
10	Realization of Johnson and Ring counter

Department of Electrical and Electronics Engineering

Semester: III	
Course Name: Python Programming for Electrical Engineers (PBL) **Course Code: 22EEE136**	
Teaching Hours/Week (L:T:P:J): (0:0:2:2)	**CIE Marks:** 50
Credits: 2	**SEE Marks:** 50
Hours: 30	**SEE Duration: 0**3 Hours

Course objectives: The students will be able to

- To know the basics of algorithmic problem solving using python.
- To develop Python programs with conditionals, loops, and functions.
- To use Python data structures –- lists, tuples, dictionaries.
- To write Python programs for problem solving and analysis in the field of Electrical Engineering.
- To develop programs using Python for embedded applications

Pre-requisites:

Fundamental knowledge of computer systems, Basic knowledge of C Programming, Basic Electrical Engineering, Electrical Circuit Analysis, Analog and Digital Circuits

Lab Course outcomes: At the end of the course the student will be able to:

- Develop applications using Python Programming
- Develop programs with different data types utilizing loops, decision-making statements, and functions.
- Evaluate the characteristics of the machines and transformer parameters using Python.
- Develop a python program for linear circuits and digital circuits.
- Develop a Python program to interface sensors, actuators with a Python supported microcontroller board.
- Communicate effectively about the chosen problem
- Write technical report for the chosen problem

Sl. No.	Experiments
1	**Installation Guide, Operators, Datatypes, and Basic I/P and O/P operations.** 1. Write a python program to convert temperature to and from Celsius to Fahrenheit. 2. Write a Python program to compute the distance between two points taking input from the user.
2	**Decision Making and Loop Statements, strings** 1. Write a program to create, concatenate and print a string and access substring from a given string. 2. Write a python program to print prime numbers less than 50. 3. Develop a python code to design and realize Combinational/Sequential logic circuits.
3	**Lists, Tuples, Dictionaries.** 1. Write a python program to create a list and perform the following methods 1) insert() 2) remove() 3) append() 4) len() 5) pop() 6) clear() 2. Write a program to Create a tuple and perform the following methods 1) Add items 2) len() 3)check for item in tuple 4)Access items 3. Write a program to create a dictionary and apply the following methods 1) Print the dictionary items 2) access items 3) use get() 4)change values 5) use len()
4	**Functions, Modules** 1. Write a function to compute GCD, LCM of two numbers. Each function shouldn't exceed one line. **2.** Write a Python program to define a module to find Fibonacci Numbers and import the module to another program.
5	**Error Handling, Numpy and Matplotlib modules** 1. Write a program in Python to handle user-defined exception for given problem. 2. Write a python program to perform AC Analysis.

6	**Introduction to PySpice (Python, Installation Guide)** Write a program to perform DC Nodal Analysis using Pyspice(Python)
7	Write a program to plot the Characteristics of the Induction Motor
8	Write a python code plot the efficiency of Transformer at different loads.
9	**Introduction to RaspberryPi, Installation Guide** Write a program in Python to send digital data on Raspberry pi GPIO pins to blink LED, Fade an LED and develop a simple traffic light system.
10	Connect the Digital/Analog I/O module and write a program in python to interface the various Analog Sensors such as temperature sensors, Motion sensors.
11	Write a python script to control the speed of Servomotor.
12	Speed control of DC motor using Raspberry-pi and python

Sl. No.	List of indicative Projects
1	Electricity Bill Management System using python
2	Smart Surveillance Monitoring System Using Raspberry PI and PIR Sensor:
3	Temperature based DC Fan Control
4	Autonomous Lane Detection Car Using Raspberry Pi and python
5	Raspberry Pi-based Automated Street Lighting System
6	Raspberry Pi based Battery monitoring system
7	Smart Energy meter using Raspberry pi and IoT
8	Text to Speech Converter using Python
9	Create an analog clock using python.
10	Power theft identification and alerting system using Raspberry Pi

Reference Book

1.	Think Python: How to ThinkLike a Computer Scientist	Allen B. Downey	Green Tea Press	2nd Edition, 2015
2.	"Automate the Boring Stuff with Python"	Al Sweigart	Starch Press	1st Edition, 2015
3	"Python programming using problem solving approach"	Reema Thareja	Oxford university press	1st Edition, 2018
5	Introduction to programming using Python,	Y. Daniel Liang	Pearson Publications	1st Edition,2017.
6	Python for Science and Engineering	Hans-etter Halvorsen	https://www.halvorsen.blog/documents/programming/python/	August,2020
7	Programming the Raspberry Pi, Getting Started with Python	Simon Monk	McGraw Hill	Third Edition

Web links and Video Lectures:

https://www.learnbyexample.org/python/
https://www.learnpython.org/
https://pythontutor.com/visualize.html#mode=edit
https://pyspice.fabrice-salvaire.fr/releases/v1.3/examples/index.html
https://nptel.ac.in/courses/106106145
https://www.w3schools.com/python/

Semester: III		
COURSE: CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS		
Course Code: 22CIP137	**L:T:P:J: 0:2:0:0**	**CIE Marks:** 100
Credits:	**1**	**SEE Marks:- -**
Hours:	**15 hrs**	**SEE Duration:--**

Course Learning Objectives: The students will be able to

1	know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens
2	know the Indian top civil service positions and the exams conducted by UPSC and SPSC for the same
3	Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.

MODULE 1: Introduction to Indian Constitution	RBT	Hrs
The Necessity of the Constitution, Introduction to Indian Constitution, The Making of the Constitution, Role of Constituent Assembly, Preamble and Salient features of the Constitution of India, Fundamental Rights and its Restriction and limitations in different complex situations, Directive Principles of State Policy, Fundamental Duties.	**1,2,3**	**3**
MODULE 2: System of Government, Central Government, State Government	**RBT**	**Hrs**
System of Government-Parliamentary System, Federal System. Central Government-Basic details, Powers and Functions of Union Executive. Parliament- LS and RS (Composition, Duration, Membership and Presiding officers of Parliament and their functions). Leaders in Parliament (Leader of the House and Leader of the Opposition). Sessions of Parliament (Summoning, Adjournment, Adjournment Sine Die, Prorogation, Dissolution). Quorum of House, Language in Parliament, Joint sitting of two Houses. State Government- Basic details, Powers and Functions of State Executive. State Legislature (Composition, Duration, Membership and Presiding officers of Parliament and their functions).	**1,2,3**	**3**
MODULE 3: Judiciary, Amendments and Emergency Provisions	**RBT**	**Hrs**
Supreme Court, High Court, Judicial Review, Judicial Activism. Methods in Constitutional Amendments (How and Why). Types of Emergencies and its Consequences, Recent Amendments to the Constitution.	**1,2,3**	**3**
MODULE 4: Elections, Constitutional and Non Constitutional Bodies	**RBT**	**Hrs**
Elections- Election Commission of India, Electoral Process. Constitutional Bodies- Election Commission, Union Public Service Commission, State Public Service Commission, Goods and Service Tax Council. Non Constitutional Bodies- Central Information Commission, State Information Commission.	**1,2,3**	**3**
MODULE 5: Professional Ethics	**RBT**	**Hrs**
Scope & Aims of Engineering & Professional Ethics, Positive and Negative Faces of Engineering Ethics, Responsibilities in Engineering, the impediments to Responsibility. Trust and Reliability in Engineering, Risks, Safety and liability in Engineering, Clash of Ethics, IPRs (Intellectual Property Rights)	**1,2,3**	**3**

Course outcome: On completion of this course, students will be able to,
CO1: Have constitutional knowledge and legal literacy.
CO2: Have knowledge on All India Services and State Civil Services.
CO3: Understand Engineering and Professional Ethics and responsibilities of Engineers.

Reference Books

Suggested Learning Resources:

1.**Title of the Book - Indian Polity**
Name of the Author - M Lakshmikanth
Name of the Publisher-Mc Graw Hill Education
Edition and Year- 2019

2.**Title of the Book - Engineering Ethics**
Name of the Authors - M. Govindarajan, S.Natarajan, V.S. Senthilkumar
Name of the Publisher- Prentice-Hall
Edition and Year-2004

3. Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.)Prentice –Hall EEE, 19th / 20th Edn., (Latest Edition) or 2008.

4. Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" byCengage Learning India Private Limited, Latest Edition – 2018.

5. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice –Hall of IndiaPvt. Ltd. New Delhi, 2004

6. M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.

7. Latest Publications of **NHRC - Indian Institute of Human Rights**, New Delhi.

Web Links and Video Lectures www.unacademy.com/lesson/future-perfect-tense/YQ9NSNQZ https://successesacademy

Semester: III		
COURSE: Soft Skills-1		
Course Code: 22SFT138	**L:T:P:J: 0:2:0:0**	**CIA Marks:** 100
Credits:	**1**	**SEA Marks:- -**
Hours:	**15 hrs**	**SEE Duration: --**

Course Learning Objectives: The students will be able

1	To help students understand their strengths and weakness.
2	To develop analytical and creative ability to solve problems individually or as a team.
3	To make students industry ready through practice of corporate etiquettes.
4	To enhance public speaking and presentation skills.

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

CO1	Understand their strength and weaknesses.
CO2	Develop analytical and creative ability to solve problems.
CO3	Identify themselves as industry ready through the practice of corporate etiquettes.
CO4	Enhance public speaking and presentation skills.
CO5	Build team collaboration by working towards shared goals.

Module No.	Contents of the Module	Hours	Cos
1	**Module-1 Understanding and Managing Self** Self-Awareness, Self-Management, Anger Management, Time management, Change management. Vision and goal setting - Diff between vision and goal, smart, stretched goal concept, case studies Knowledge, Skill, Attitude Personality analysis using Big 5 personality test Critical Thinking, Problem solving, Creativity and innovation Integrity, ethics, values	8	**1 &2**
2	**Module -2 Corporate etiquettes and Mannerism** Introduction to Etiquette and Mannerism, Personal Etiquette, Grooming etiquettes- professional styling, Body & personality styling, Video Interview Etiquettes, Personal Interview Etiquettes Effective meeting skills. Workplace behaviour, Personal interview	6	**3**
3	**Module -3 Public Speaking and presentation skills** Introduction to public speaking, making ideas, illustrating and delivering ideas, overcoming fear of public speaking and developing great delivery. Advanced Business presentation skills, PowerPoint presentation, Group discussion	**6**	**4**
4	**Module -4 Team Work** Interpersonal skills, group work vs team work	**4**	**5**

Mapping of Course Outcomes with Programme Outcomes:

CO1	PO8	PO9	PO10	PO11
CO1	3	3		
CO2		3		3
CO3	3	3		3
CO4		3	3	
CO5			3	3

MOOC Course:

Communicate with impact - https://www.coursera.org/learn/communicate-with-impact
Leading Diverse Teams - https://www.coursera.org/learn/leading-diverse-teams

Practical component:

1. Mock GD and interview may be conducted at the end of the course to check their confidence. Students can prepare their SWOT analysis and present the same.
2. The students are to be involved in various activities and games such as Just a Minute or Pick and speak to demonstrate each topic.

Semester: III	
Course Name: Innovative Project Lab (Social Concern) **Course Code: 22EEE139**	
Teaching Hours/Week (L: T:P: J): (0:0:0:2)	**CIA: 100**
Credits: 1	**SEA: -**
Hours: 15 hrs.	**SEA Duration: -**

Course Objectives:

- To encourage independent learning and innovative attitude of the students
- To inspire team working
- To expand Intellectual capacity, Credibility and Judgement.
- To develop Interactive attitude, Communication skills, Time management & Presentation skills.

All the students registered to II year of BE shall have to take up Innovative during III semester. Semester End Assessment will be conducted and the prescribed credit will be included.

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilizing a systems approach.
- Communicate with engineers and the community at large in written or oral forms.

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical and Electronics Engineering

IV Semester Syllabus

B.N.M. Institute of Technology

An Autonomous Institution under VTU, Approved by AICTE

Department of Mathematics

Semester: IV		
Course: Complex Analysis, Probability and Random Process **Course Code: 22MAC141 (Common to ECE, EEE & ME)**		
L:T:P:J	**2:2:0:0**	**CIA: 50**
Credits:	**03**	**SEA: 50**
Hours:	**40**	**SEA Duration: 03 Hours**

Course Learning Objectives: The students will be able to

1 Provide an insight into applications of complex variables and conformal mapping arising in potential theory, quantum mechanics, heat conduction and field theory.

2 Develop the knowledge of probability, joint probability distribution and Random process occurring in digital signal processing, design engineering and microwave engineering.

Module-1: Complex Analysis	No. of hours	Blooms cognitive Levels
Examples from Engineering that require complex analysis. Review of function of a complex variable, limits, continuity and differentiability. Analytic functions. Cauchy-Riemann equations in Cartesian and polar forms. Consequences of Cauchy-Riemann equations (only statement), construction of analytic function using Milne-Thomson method. *Experiential Learning component: Problems on construction of analytic functions*	**L: 04** **T: 04**	**Apply**
Module-2: Conformal Mapping & Complex Integration		
Examples from Engineering that require Conformal Mapping & Complex Integration. **Conformal mapping:** Introduction, discussion of transformations: $w = e^z$, $w = z^2$, $w = z + \frac{1}{z} (z \neq 0)$. Bilinear transformations. **Complex integration:** Introduction to complex integration, Cauchy's theorem and Cauchy's integral formula. Poles and residues, Residue theorem (without proof) *Experiential Learning component: Problems on Cauchy's integral formula*	**L: 04** **T: 04**	**Apply**
Module-3: Probability Distributions & Joint probability distribution		
Examples from Engineering that require Probability and Joint probability distribution. **Probability Distributions:** Review of basic probability theory. Discrete and continuous Random variables, probability mass/density functions (definitions only). Binomial, Poisson, exponential and normal distributions (without proof). **Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation, covariance and correlation. *Experiential Learning component: Problems on Binomial, Poisson, Exponential and Normal distributions*	**L: 04** **T: 04**	**Apply**
Module-4: Random Process		
Examples from Engineering that require random process. Introduction, classification of random process, methods of description of a random process, stationary, auto-correlation function, Ergodicity, Spectral representation, Weiner-Kinchine theorem, Poisson process, pure birth process, birth and death process with a constant rate, death process with a linear rate. *Experiential Learning component: Problems on Poisson process, pure birth process, birth and death process*	**L: 04** **T: 04**	**Apply**

Module-5: Markov Chain & Sampling Theory		
Examples from Engineering that require Markov Chain and Sampling Theory. **Markov Chain**: Introduction to Stochastic process, Probability vectors, Stochastic matrices, Regular stochastic matrices, Markov Chains, Higher transition probabilities, Stationary distribution of Regular Markov chains and absorbing states, Markovian processes. **Sampling Theory**: Introduction to sampling theory, Testing of hypothesis, level of significance, confidence limits, test of significance of mean and difference of means for large samples-z-test, test of significance of small samples-Student's t- distribution, Goodness of fit-Chi-square test. *Experiential Learning component: Problems on Markovian processes and, Sampling Theory*	**L: 04** **T: 04**	**Apply**

Course Outcomes: After completing the course, the students will be able to

CO1: Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.

CO2: Utilize conformal mapping and complex integral arising in aerofoil theory, fluid flow visualization and image processing.

CO3: Apply discrete and continuous probability and joint probability distributions in analyzing the probability models arising in engineering field.

CO4: Use Markov chain in prediction of future events and demonstrate the validity of testing the hypothesis.

CO5: Use the concepts of random process in dealing with signals in engineering problems.

Reference Books:

1. E. Kreyszig: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Edition(Reprint), 2016.
2. B. S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017.
3. S. D. Sharma : "Operations Research", KedarNath Ram Nath & Co. Meerut, 2014.
4. T. Veerarajan : "Probability, Statistics and Random processes", McGraw Hill Education (India) Private Limited, Third edition, Nineteenth reprint 2017.
5. C. Ray Wylie, Louis C. Barrett : "Advanced Engineering Mathematics", 6th Edition, 2. McGraw-Hill Book Co., New York, 1995.
6. James Stewart : Calculus —Early Transcendental, Cengage Learning India Private Ltd., 2017.
7. B. V. Ramana: "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill, 2010.
8. Srimanta Pal & Subodh C. Bhunia: "Engineering Mathematics", Oxford University Press, 3rd Reprint, 2016.

Web links and Video Lectures:

1. https://nptel.ac.in/courses/111106141
2. https://www.digimat.in/nptel/courses/video/111107119/L29.html
3. https://archive.nptel.ac.in/courses/122/107/122107036/
4. https://archive.nptel.ac.in/courses/105/105/105105045/
5. https://archive.nptel.ac.in/courses/111/102/111102014/
6. https://archive.nptel.ac.in/courses/111/103/111103159/

Department of Electrical and Electronics Engineering

Semester: IV	
Course Name: Linear Control Systems (PCC) **Course Code: 22EEE142**	
Teaching Hours/Week (L:T:P:J): (2:2:0:0)	**CIA Marks:** 50
Credits: 3	**SEA Marks:** 50
Hours: 40	**SEA Duration:** 03 Hours

Course Learning Objectives:

- To understand modelling of physical systems and obtain the transfer function through block diagrams and signal flow graphs.
- To understand time domain response and estimate transient parameters and errors in steady state conditions.
- To use Routh-Hurwitz and Root locus techniques to determine stability of linear systems.
- To understand the difference between time domain and frequency domain specifications, analysis of systems in frequency domain.
- To use the Bode technique to determine the stability of linear systems.

Pre-Requisites: Knowledge of network duality, Laplace transformations theory and applications. Differential equations. Matrix algebra

Course Outcomes: After the completion of the course the students will be able to:

- Develop electrical analogous circuits for mechanical systems and transfer function for servomotors.
- Develop transfer function using block diagram reduction and signal flow graph techniques.
- Obtain the transient and steady state parameters for a 2nd order system subjected to step input.
- Determine stability of a given system using Routh Hurwitz, Root locus, Bode analysis.

Module-1: Modeling of control systems	RBT	Hrs
Introduction to Control systems, types, and Classification of control systems. **Mathematical modeling:** Modeling of mechanical systems, electrical systems, and Analogous systems. DC Servomotors: modelling of armature-controlled and field-controlled servomotors. Transfer functions. Illustrative examples.	**Apply**	**8**
Module-2: Block Diagrams and Signal flow graphs	**RBT**	**Hrs**
Block diagrams: Block diagram of a closed loop system, construction of block diagram of electrical networks, block diagram reduction algebra to find the overall transfer function. Illustrative examples. **Signal flow graphs:** Definitions, construction of signal flow graph for electrical networks, Block diagrams Masons gain formula to find the overall transfer function. Illustrative examples.	**Apply**	**8**
Module-3: Time Domain Analysis	**RBT**	**Hrs**
Standard test signals, time response of second order systems, Time domain specifications, steady state errors and static error constants. Dynamic error constants, their importance. Illustrative examples	**Apply**	**8**
Module-4: Stability analysis using Root locus and Routh Hurwitz techniques	**RBT**	**Hrs**
Routh Stability criterion: Definitions of stability terms. BIBO stability, Necessary conditions for stability, Routh stability criterion difficulties in formulation of Routh table, applications of Routh stability criterion. **Root locus technique:** Introduction, root locus concepts, construction of root loci, rules for the construction of root locus. Stability analysis using Root locus techniques	**Apply**	**8**

Module-5: Stability analysis in the Frequency domain.	RBT	Hrs
Frequency domain specifications. Co-relation between time and frequency response – 2^{nd} order systems. Illustrative examples. ***Bode plots***: Definitions of gain margin, phase margin. General procedure for constructing bode plots, computation of gain margin and phase margin, reverse bode plots. Illustrative examples.	**Apply**	**8**

Reference Books

1. A Anand Kumar, **"**Control systems", PHI learning private limited, New Delhi
2. Benjamin C Kuo, Farid Golnaraghi, "Automatic Control System", Wiley, 9th edn, 2010
3. Ashfaq Husain, Haroon Ashfaq, "Control Systems", Dhanpat Rai & Co.,1st edn, reprint 2017
4. M. Gopal, "Control Systems: Principles and Design", McH, 4th Edn, 2012
5. S. Salivahanan et.al, "Control System Engineering", Pearson, 1st Edn, 2015.
6. D.Ganesh Rao and K.Channavenkatesh. "Control Engineering"', Publisher-Sanguine Technical Publishers,2008.

Semester: IV	
Electrical Motors and Synchronous Machines (PCI) **Course Code: 22EEE143**	
Teaching Hours/Week (L:T:P:J): (3:0:2:0)	**CIE Marks:** 50
Credits: 4	**SEE Marks:** 50
Hours: 40 Hours Theory+ 10 Lab Sessions	**SEE Duration:** 03 Hours

Course Learning Objectives:

- To understand the working of DC Motors, Stepper motor, and synchronous machines
- To understand the performance of DC motors and synchronous machines
- To understand the characteristics, starting methods, speed control of DC Motors and synchronous motors
- To understand the concept of parallel operation and voltage regulation of alternators

Pre-Requisites:

- Knowledge of Electromagnetic Induction
- Knowledge of three phase AC circuits
- KCL & KVL

Course Outcomes: After the completion of the course the students will be able to:

- Explain the construction and working of DC Motors, Stepper motor, and synchronous machine
- Determine the performance parameters and characteristics of DC Motors and synchronous motor through load and no-load tests
- Explain the performance, starting methods and speed control of DC Motors and synchronous motors
- Predetermine the voltage regulation of alternators by EMF, MMF, ZPF and slip test
- Explain the concept of parallel operation of alternators

Module-1: DC Motors	RBT	Hrs
DC Motors: Construction and working principle, Back E.M.F and its significance, Torque equation, Classification, Characteristics of shunt, series & compound motor, Losses in DC motors, power flow diagram, efficiency, condition for maximum efficiency. Speed control of shunt motor and series motor by armature and field control, Applications of motors. Illustrative examples	**Apply**	**8**
Module-2: Starters and Testing of DC Motors	**RBT**	**Hrs**
Starters: need for starters, 3-point starter, starters for Series motors, **Testing of DC Motors:** performance curves of shunt and series DC motor Direct load test, Swinburne's test, Hopkinson's test, Fields Test on dc series machines, merits, and demerits of tests. Illustrative examples,	**Apply**	**8**
Module-3: Stepper motor and Synchronous Generators	**RBT**	**Hrs**
Stepper motor - Construction, Principle of operation of Variable Reluctance (VR), permanent magnet and hybrid stepper motors, applications. **Synchronous Generators:** Types of Construction, principle of operation, frequency of induced emf, winding factors, EMF equation, Armature reaction, Synchronous reactance, Equivalent circuit. Phasor diagram of non-salient type alternator, Illustrative examples	**Apply**	**8**
Module-4: Voltage Regulation of Non-salient & Salient pole alternators	**RBT**	**Hrs**

Voltage Regulation of Non-salient pole alternators: EMF, MMF, ZPF methods. Illustrative examples **Salient pole alternators:** Two reaction analysis, experimental determination of X_d and X_q by slip test**,** voltage regulation, phasor diagrams on load, Illustrative examples	**Apply**	**8**
Module-5: Parallel operation of alternators & Synchronous Motors	**RBT**	**Hrs**
Parallel operation of alternators – Need, requirements for parallel operation, Methods of synchronization of 3-phase alternators, synchronizing current, power & torque, effect of increasing excitation, load sharing between two alternators, illustrative examples (on synchronizing power, torque & load sharing only) **Synchronous Motor:** Principle of operation, effect of load, effect of change in excitation on armature current and power factor (V and inverted V curves), equivalent circuit, phasor diagrams, power developed, power flow, hunting and its suppression, Methods of starting, Illustrative examples	**Apply**	**8**

Laboratory Experiments:

1. Swinburne's Test and Speed control of DC shunt motor
2. Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics
3. Fields Test on dc series machines.
4. Retardation test on dc shunt motor.
5. Regenerative test on dc shunt machines.
6. Voltage regulation of an alternator by EMF, MMF and ZPF methods.
7. Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.
8. V & inverted V curves of synchronous motor
9. Synchronization of alternator by dark lamp method
10. OCC Characteristics of DC Shunt Generator and determination of its critical resistance

Reference Books

Electrical Machinery, J.B.Gupta, S K Kataria & Sons
Electric Machines, D P Kothari, I J Nagrath, TMH
Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Co. Publications
Electrical Technology, B L Theraja and A K Theraja

Web links and Video Lectures:

https://nptel.ac.in/courses/108106071
https://archive.nptel.ac.in/courses/108/105/108105155/
https://nptel.ac.in/courses/108106072
https://archive.nptel.ac.in/courses/108/105/108105131/
https://archive.nptel.ac.in/courses/108/102/108102146/

Semester: IV	
Course Name: Power Electronic Devices and Circuits [PCI] **Course Code: 22EEE144**	
Teaching Hours/Week (L:T:P:J): (3:0:2:0)	**CIA Marks: 50**
Credits: 4	**SEA Marks: 50**
Hours: 40 hours Theory + 10 Lab sessions	**SEA Duration: 03 Hours**

Course Learning Objectives:

- To study the operation, steady state and switching characteristics of solid state switches and their ratings.
- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics.
- To analyze different types of Thyristors, their gate characteristics and gate control requirements.
- To understand the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC-DC, DC -AC converters and Voltage controllers.
- To analyze the block diagrams of Power electronic converters used in UPS, Laptop and Electric Traction systems

Pre-requisite:

- Working principle of Semiconductors devices
- Electrical & Electronic Circuit analysis

Course outcomes: At the end of the course the student will be able to

- Demonstrate the steady state, switching characteristics, ratings, and operation of ideal and practical solid state switches
- Analyze the speed control of DC Motor and stepper motor
- Interpret the significance of gate drive, protection and isolation circuits
- Demonstrate the operation of single phase and three phase rectifiers and AC Voltage controllers feeding R and RL loads
- Design Buck, Boost and Buck-boost switched mode regulators
- Analyze the waveforms of single phase and three phase inverters using step mode and SPWM techniques and their applications in home and Industrial appliances.

Module-1: Introduction & Applications of Power Electronics	RBT	Hrs
Introduction: Ideal and real switches, static performance and dynamic performance, Temperature rise-use of heat sink, **Power Diodes:** available rating, types of diode, Junction structure, packing, reverse recovery characteristics, effect of reverse recovery transient, Schottky diodes andsnubber circuits **Applications of Power Electronics:** Types of Power Electronic Converter Circuits and their applications, Peripheral Effects of Power Electronic Converters	**Understand**	**8**
Module–2: BJT Family	**RBT**	**Hrs**
Power Bipolar Junction Transistors: Types, ratings, Junction structure, static characteristics, proportional drive, safe operating area, switching times, base drive circuit for power transistors, switching aid circuits **Power MOSFET and IGBT:** types, comparison with BJT, Junction structure, Principleof operation, output characteristics, safe operating area, Gate electrode capacitance, Power MOSFET switching times, switching aid circuits, Gate drive circuits for power MOSFET, IGBT Comparison with BJT and MOSFET, Junction Structure, Principle ofworking, Switching times, Gallium Nitride and Silicon Carbide power semiconductor switches.	**Understand**	**8**
Module–3: Thyristors	**RBT**	**Hrs**
Thyristors: Junction structure, Packaging, circuit symbol, operating states of Thyristor, turn	**Understand**	**8**

on switching, two transistor Analogy **(derivation for relationship between gate current and anode current)**, problem in Turn-off by reverse gate pulse,rate of rise of forward voltage, switching characteristics, Thyristor classification according to Switching times and Thyristor selection according to Converter types, **Gate circuit requirement for Thyristor:** Timing control and firing of Thyristors, Thyristor ratings and protection, Gate Turnoff Thyristors, Gate control circuit of GTO, TRIAC, Thyristor Firing Circuits, Unijunction Transistor.		
Module–4: Controlled Rectifiers & AC Voltage Controllers	**RBT**	**Hrs**
Controlled Rectifiers: Introduction, Single-Phase Full Converters feeding R and RL Load (Highly Inductive load), Three- Phase Full Converters feeding R load, Illustrative Examples. **AC Voltage Controllers:** Introduction, Single-Phase Full-Wave Controllers with Resistive Loads, Single-Phase Full-Wave Controllers with Inductive Loads, Illustrative Examples.	**Apply**	**8**
Module–5: Switched mode regulators & Inverters	**RBT**	**Hrs**
Switched mode regulators: **Elements of switching mode regulators,** Buck Regulator, Boost Regulators, Buck-Boost Regulators (derivations for voltage gain, peakripple currents, peak ripple voltages, and problems**)** **DC-AC converters**: Introduction, principle of operation single phase full bridge Inverters feeding R load, Single phase inverter using SPWM technique, Three-phase bridge inverters for 180° conduction	**Apply**	**8**

Sl.No	Experiments
1	Static Characteristics of SCR
2	Static Characteristics of MOSFET and IGBT
3	Characteristic of TRIAC
4	SCR turn on circuit using synchronized UJT relaxation oscillator
5	SCR digital triggering circuit for a single-phase controlled rectifier and ac voltage regulator
6	Single phase controlled full wave rectifier with R load and R –L load
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads
8	Speed control of stepper motor
9	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper
10	Single-phase MOSFET/IGBT-based PWM inverter

Reference Books			
Power Electronics, Principles and applications	Joseph Vithayathil	Tata Mc Graw Hill Edition	Third reprint-2011 ISBN-13: 978-0-07-070239-4
Power Electronics: Circuits Devices and Applications	Mohammad H Rashid,	Pearson	4th Edition, 2014
Power Electronics: Converters, Applications and Design	Ned Mohan et al	Wiley	3rd Edition, 2014
Power Electronics	Daniel W Hart	McGraw Hill	1st Edition, 2011
Power Electronics	M.S. Jamil Asghar	PHI	Fifth print ISBN-978-81-203-2396-4

Semester: IV	
Course Name: Simulation of Electrical & Electronic Circuits [PBL] **Course Code: 22EEE145**	
Teaching Hours/Week (L:T:P:J): (0:0:2:2)	**CIA: 50**
Credits: 2	**SEA: 50**
Hours: 30	**SEA Duration: 03 Hours**

Course objectives:

- ❖ To use software package to simulate and understand the working of Electrical & Electronics circuits.
- ❖ To simulate and verify circuit theorems for AC and DC circuits.
- ❖ To simulate and explore the behavior of the RLC circuit when excited by Sinusoidal signal and Step input.
- ❖ To simulate and explore the Op-Amp linear applications.
- ❖ To simulate and explore the Op-Amp non-linear applications.
- ❖ To design and build an application for a given requirement.

Pre-requisites: Concept of Electrical Circuit Analysis & Analog Electronic Circuits using Op-Amp.

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

- ❖ Use software package for simulation of Electrical & Electronic Circuits.
- ❖ Simulate DC & AC Circuits to verify circuit theorems.
- ❖ Explore the behavior of RLC circuit excited by sinusoidal and step input.
- ❖ Design and simulate Op-Amp-based non-linear applications.
- ❖ Design and simulate Op-Amp-based linear applications.
- ❖ Design and build a circuit for a given application

Sl. No.	**Experiments**
1	Verification of KCL & KVL for DC and AC Circuits
2	Verification of Thevenin's theorem and Maximum Power Transfer Theorem
3	Study the characteristics of series and parallel resonance for (i) Variable frequency (ii) Variableinductance and (iii) Variable capacitance.
4	Obtain time response of an RLC circuit due to step excitation
5	Testing of (i) Diode clipping (Single/Double ended) circuits for peak clipping, peak detection (ii) Clamping circuits: positive clamping /negative clamping
6	Design & Verification of inverting and non-inverting amplifiers using Op-Amp for (i) Time Response (ii) Frequency Response
7	Design and verification of (i) Inverting Comparator (ii) Non-inverting Comparator & (iii) Window detector using Op-Amp
8	Design and verification of (i) Inverting Schmit Trigger (ii) Non-inverting Schmit Trigger using Op-Amp
9	Design & Verification of Square/Rectangular waveform Generation using Op-Amp Astable Multi-vibrator
10	Generate Pulse Width Modulation (PWM) Signal using 555 Timer IC

Sl. No.	List of indicative Projects
1	Design, Simulation and Implementation of Variable Regulated power supply
2	Design, Simulation and Implementation of Overvoltage and undervoltage protection circuit
3	Design, Simulation and Implementation Solar Battery Charger Circuit
4	Simulation and Implementation LED Dimmer using PWM Technique
5	Simulation and Implementation of DC Motor Speed Controller Circuit Using PWM Technique
6	Design, Simulation and Implementation of PID controller for an application
7	Dark Activated 220V Automatic Evening Lamp using LDR & IC 555
8	Temperature Deviation Indicator Using OP-AMP 741
9	Over Heat Detector with Auto Cut-Off System using Op-Amp
10	Automatic Water Pump Switch ON-OFF Circuit with 555
Reference Books	
"Engineering Circuit Analysis," William H. Hayt, Jr. et all, McGraw Hill,8th Edition	
Op-amp and Linear Integrated Circuits, Ramakant A Gayakwad, PHI Learning Pvt. Ltd. New Delhi, 4th Edition	

Semester: IV	
Course Name: Electronic Instrumentation and Measurements **Course Code: 22EEE146**	
Teaching Hours/Week (L:T:P:J): (2:0:0:0)	**CIA Marks: 50**
Credits: 2	**SEA Marks: 50**
Hours: 25	**SEA Duration: 03 Hours**

Course Learning Objectives:

- To know the necessity of different measuring instruments and their design principle
- To understand the working principle of different measuring instruments and technical solutions to handle different errors.
- To understand the functional elements of instrumentation/measurement systems.
- To impart the basic concepts of digital instruments, oscilloscope and signal generators.
- To illustrate the principle, design and working of transducers for the measurement of displacement, strain and temperature.

Pre-requisite: Basic Principles of Electrical Engineering (Circuit Theory), Basic Digital and Analog Electronics

Course outcomes: At the end of the course the student will be able to

- Apply their knowledge to measure electrical quantities using standard Electronic measuring instruments.
- Explain the principle and working of digital instruments, Recorders function generators and Analyzers
- Discuss the principle, construction and working of transducers for the measurement of displacement, strain and temperature.
- Explain the principle and working of Bio-Medical Instruments

Module–1: Digital Voltmeters, Digital Multimeters and Frequency Meters	**RBT**	**Hrs**
Introduction, Ramp technique & ramp type DVM, Dual slope integrating type DVM, Successive approximation DVM, Resolution and sensitivity of digital meters. Digital multimeters, Digital frequency meter-Block Diagram and principle of operation	**Understand**	**5**
Module–2: Recorders	**RBT**	**Hrs**
Strip Chart Recorders and its applications, XY recorders, Magnetic Recorders, Frequency Modulation Recording, Digital data Recording	**Understand**	**5**
Module–4: Signal Generation and Analysis	**RBT**	**Hrs**
Pulse and Square wave generation, Function Generation, Wave Analyzers, Harmonic Distortion Analyzers, Spectrum Analyzers.	**Understand**	**5**
Module-5: Transducers	**RBT**	**Hrs**
Introduction to sensors & Transducers, Strain gauge, LVDT, Hall-effect transducers, Proximity sensor.	**Understand**	**5**
Module-5: Bio-Medical Instrumentation	**RBT**	**Hrs**
Biometrics, Bio-potential, Principle of operation of Electrocardiogram (ECG), electroencephalogram (EEG), Blood pressure and Blood flow measurement, Magnetic resonance Imaging (MRI), Computed Tomography Imaging (CT SCAN)	**Understand**	**5**

Reference Books

1. Electronic Instruments and Measurement Techniques, Cooper, W.D. Halfrick, A.B. PHI Learning, New Delhi, latest edition
2. Electronic Instruments, H.S. Kalsi, Tata Mc-Graw hill.
3. Electrical and Electronic Measurements, Sawhney, A.K. Dhanpat Rai, New Delhi, latest edition
4. Electronic Instrumentation and Measurements, David, Bell, PHI New Delhi, latest edition

Web links and Video Lectures:

1. https://nptel.ac.in/courses/108105153
2. https://nptel.ac.in/courses/108105064
3. https://www.youtube.com/watch?v=As5kzxkyT24

BNM Institute of Technology

Syllabus for Softskills-2

SEMESTER – IV

Subject Name	Softskills-2 (Aptitude Quantitative & Logical)	**Weekly Assessment Marks**	10
Subject Code	22SFT147	**Internal Assessment Marks**	60
Number of Contact Hours/Week	3	**Company Simulation Tests Marks**	30
Total Number of Contact Hours	36	**Credits**	1

Module 1 (Quantitative Aptitude - 1)	**Number System** - Classification of Numbers, Multiple and factors, Divisibility Rules
	HCF & LCM, Squares and Cubes.
	Profit & Loss - Concepts of SP, CP, Profit, Loss, Gain or Loss %.
	Profit & Loss - Marked Price & Discount problems, Successive Discount.
	Percentages – Percent To Decimal Or Fraction Conversion, Inverse Case – Value From Percentage, relative Percentage
	Averages - Understanding Averages & solving problems.
Module 2 (Quantitative Aptitude - 2)	**Ratios -** Duplicate and Triplicate Ratio, Direct and Indirect variation
	Proportion - Direct Indirect proportion and relation.
	Simple Interest - Simple Interest, Basic Difference b/w both the Interests
	Compound Interest - CI with a Fractional Rate, to find Instalments.

	Speed Time & Distance - Important formulas, Relative Speed.
	Speed Time & Distance - Understanding Units & Conversion of units
Module 3 (Quantitative Aptitude - 3)	**Time & Work -** Introduction and Concept, Important Time and Work Formula, Work Done
	Time & Work - Rate of Work, Time Taken, If a piece of work is done in x number of days
	Data Interpretation - Bar Graph, Tabular Form, Line Chart, case let Form
	Data Interpretation - Pie Chart, Radar/Web, and Missing Data Interpretation.
	Probability – Understanding concepts and important formulas.
	Probability – Understanding types of problems on probability
Module 4 (Logical - 1)	Problems on Syllogisms
	Problems on Assumptions
	Logical Puzzles - K-level thinking
	Logical Puzzles - Arithmetic Puzzles
	Stick Puzzles
	Series Completion - Basics of Next no, Missing no and Wrong no and problems on that.
	Solving various types of Letter series and understanding different types.
Module 5 (Logical - 2)	**Problem on Ages -** Understanding concepts and basic formula along with solving different types of problems.
	Problem on Ages - Tips and Tricks to Solve Problems on Ages

	Blood Relation - Generation Tree, Family Tree Problems.
	Blood Relation - Statement Based Questions, Coded Blood Relation Question.
	Coding & Decoding - Concept of EJOTY, Opposite Letter, Reversing thealphabets.
	Coding & Decoding - Jumbling of Letter, Finding Codes of Derivatives.
Module 6 (Logical - 3)	**Clocks –** Understanding concepts and basic formula along with solving differenttypes of problems.
	Calendar - Understanding concepts and basic formula along with solvingdifferent types of problems.
	Image Analysis - Paper cutting & Folding, Mirror & Water Image, Cubes andDice, Analogy, Find the odd one out, Rule Detection
	Odd Man Out - Following certain patterns and groups.
	Identifying the errors/odd one in the group.
	Seating Arrangement - Linear and Circular seating Arrangements as well as problems of sitting around Square and Rectangular.
	Distance & Direction - Distance and Displacement between any two points aswell as puzzles based on that, Concept of Shadows.

Semester : IV	
Course Name: Internship-1/Innovative Project Lab **Course Code: 22EEE148**	
Teaching Hours/Week (L:T:P:J): (0:0:2:2)	**CIA: 100**
Credits: 1	**SEA: -**
Hours: 15	**SEA Duration: -**

Course Objectives:

- To encourage independent learning and innovative attitude of the students
- To inspire team working
- To expand Intellectual capacity, Credibility and Judgement.
- To develop Interactive attitude, Communication skills, Time management & Presentation skills.

All the students registered to II year of BE shall have to undergo mandatory internship of 4 weeks during II semester or III semester vacation. Semester End Assessment will be conducted in IV semester and the prescribed credit will be included. Internship shall be considered as a head of passing and shall be considered for the award of degree.

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

- Acquire practical experience in the field of the internship.
- Apply skills learned during the internship to implement in future work.
- Execute the project in the field of internship.
- Develop oral and written communication skills.
- work as an individual and team member with time constraints.

Department of Electrical and Electronics Engineering

Semester: V	
Course Name: Power System Analysis and Stability (Professional Core Course) **Course Code: 22EEE151**	
Teaching Hours/Week (L:T:P:J) : (2 : 2 : 0 : 0)	**CIA Marks: 50**
Credits: 3	**SEA Marks: 50**
Hours: 40	**SEA Duration: 3 Hours**

Course Learning Objectives:

- To understand the representation of power systems for further analysis.
- To study the behaviour of the symmetrical short circuit currents of an alternator and to understand the art of selection of circuit breakers.
- To understand the tool symmetrical components for its application for unsymmetrical fault studies.
- To analyse the unsymmetrical faults on an alternator and on power systems for designing the protection schemes.
- To understand the stability aspects of a synchronous machines under fault conditions.

Pre-Requisites: Equivalent circuits of Synchronous Machines and Transformers, complex number calculations

	Bloom's Level	Hours
Module-1: Representation of Power Systems.		
Single line diagram. Modelling of alternators, transformers, transmission lines and loads. The impedance and reactance diagrams. Per-unit quantities. Selection of base for Per-unit quantities. Per-unit impedance of three winding transformers. Advantages of per-unit computations. Illustrative examples.	**Apply**	**08**
Module-2: Symmetrical three-phase faults on Synchronous Machines		
Introduction. Types and Classification of faults. Transients in R-L series circuits. Short-circuit currents and the reactances of Synchronous Machines. Need of fault study. Selection of circuit breakers. Illustrative examples.	**Apply**	**08**
Module-3: Symmetrical Components		
Introduction. Analysis of symmetrical components. Opertors. Symmetrical components of unsymmetrical phasors. Power in terms of symmetrical components. Sequence impedances. Positive, negative and zero sequence networks of generators, transformers and transmission lines. Illustrative examples.	**Apply**	**08**
Module-4: Unsymmetrical Faults.		
Unsymmetrical fault analysis on an unloaded alternator, power systems. Interconnection of sequence networks for representing various unsymmetrical faults on an alternator and in power systems. Faults through impedance. Illustrative examples.	**Apply**	**08**
Module-5: Power System Stability		
Introduction. Steady state stability, transient stability, Steady stat stability limit, transient state stability limit-definitions. Power angle equation of cylindrical and salient pole synchronous machines and the power angle curves. Swing equation. Equal are criterion of stability. Critical clearing angle and time. Illustrative examples.	**Apply**	**08**

Course Outcomes: After the completion of the course the students will be able to:

1. Represent the power system with the parameters expressed in pu for further analysis.
2. Explain the behaviour of a synchronous machine when subjected to a sudden three phase fault and the art of selection of circuit breakers.
3. Apply the concepts of symmetrical components to simulate and study the various types of faults on alternators and on

power systems.

4. Analyse the stability aspects of an alternator connected to an infinite bus.

Reference Books:

1. Electrical Power Systems. Ashfaq Hussain. CBS Publishers. 5th Ed.
2. Elements of Power System Analysis. William D Stevenson, McGraw-Hill Pub. 2nd. Ed.
3. Modern Power System Analysis. D.P.Kothari, I.J.Nagrath. McGraw Hill Pub. 4th Ed.
4. Electrical Power Systems. C.L.Wadhwa. New Age International Publishers. 7th Ed.

Semester: V

Course Name: Electromagnetic Fields and Wave Theory
(Professional Core Course)
Course Code: 22EEE152

Teaching Hours/Week (L:T:P:J) : (2 : 2 : 0 : 0)	**CIA Marks: 50**
Credits: 3	**SEA Marks: 50**
Hours: 40	**SEA Duration: 3 Hours**

Course Learning Objectives:

- To understand the concept of EMC and EMI in circuits
- To study different coordinate systems for understanding the concept of gradient, divergence and curl of a vector.
- To study the application of Gauss Law for electric fields produced by different charge configurations.
- To evaluate the energy and potential due to a system of charges.
- To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
- To study the magnetic fields and magnetic materials.
- To study the time varying fields and propagation of waves in different media.

- **Pre-Requisites:** Vector calculus Properties and behavior of passive elements

	Blooms Level	Hours
Module-1: Electromagnetic Compatibility and Interference, Vector Analysis		
Electromagnetic Compatibility and Interference: Introduction, designing for EMC, Typical noise path, use of network theory, Methods of noise coupling, Methods of eliminating Interference EM radiation effect of appliances and its effect on environment and human kind **Vector Analysis:** Vector algebra, dot and cross products, Cartesian, Cylindrical and spherical coordinate systems, differential line, area and volume, Coordinate system transformations, del operator on scalar and vectors, scalar and vector fields, Problems.	**Apply**	**8**
Module-2: Electrostatics, Energy and Potential		
Electrostatics: Gauss law and its applications. Gauss law in point form or Maxwell's first equation. Divergence theorem. Gauss divergence theorem, Problems. **Energy and Potential:** Definition of potential and potential difference, The potential field of a point charge and of a system of charges, Boundary conditions, Boundary between Conductor-dielectrics and dielectric-dielectric interfaces, capacitance calculations, capacitance due to cylindrical geometry, problems	**Apply**	**8**
Module-3: Poisson's and Laplace equations, Poisson's and Laplace equations		
Poisson's and Laplace equations: Derivations and problems, Uniqueness theorem. **Steady magnetic fields:** Biot - Savart's law, Ampere's circuital law. The Curl. Stokes theorem. Magnetic flux and flux density. Scalar and vector magnetic potentials. Problems.	**Apply**	**8**
Module-4: Magnetic forces, Magnetic materials and magnetism		
Magnetic forces: Force on a moving charge and differential current element. Force between differential current elements. Force and torque on a closed circuit. Problems. **Magnetic materials and magnetism:** Nature of magnetic materials, magnetization and permeability. Magnetic boundary conditions. Magnetic circuit, inductance and mutual inductance. Problems	**Apply**	**8**

Module-5: Time varying fields and Maxwell's equations, Uniform plane wave		
Time varying fields and Maxwell's equations: Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Problems. **Uniform plane wave:** Wave propagation in free space and in dielectrics, Propagation in good conductors, skin effect, Pointing vector and power considerations, Problems.	**Apply**	**8**

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

1. Identify the methods of eliminating Electromagnetic interference in circuits
2. Explain the concept of gradient, divergence and curl of a vector using Cartesian cylindrical & spherical coordinate systems.
3. Determine electric fields by using Gauss Law, energy, potential and capacitance effect produced by different charge configurations.
4. Determine the magnetic fields and magnetic flux density produced by circuit geometry
5. Discuss the behavior of magnetic fields, magnetic force, magnetic materials and magnetic circuits
6. Assess time varying fields and propagation of waves in free space & dielectric media

Reference Books:

Engineering Electromagnetics, William H Hayt et al, McGraw Hill, 8th Edition, 2014
Noise Reduction techniques in Electronic Systems, Henry W. Ott, Wiley, Second edition.
Engineering Electromagnetics, C.L. Wadhwa, New Age International Publishers.
Electromagnetic Fields, T.V.S. Arun Murthy, S. Chand publications.
Electromagnetic Field Theory, S Salivahanan,S Karthie, Vikas publications,2016.
Elements of Electromagnetic Fields, S.P Seth, Dhanpat Rai & Co.
Electromagnetic Field Theory, Rohit Khurana, Vikas publications, 1st Edition,2014.
Electromagnetics, J. A. Edminister, , McGraw Hill, 3rd Edition, 2010

Department of Electrical and Electronics Engineering

Semester: V	
Course Name: Introduction to AI & ML (Professional Course Integrated) **Course Code:22EEE153**	
Teaching Hours/Week (L: T: P: J): (3:0:2:0)	**CIA Marks: 50**
Credits :4	**SEA Marks: 50**
Hours: 40 hours Theory +10 lab sessions	**Exam Hours: 03**

Course Learning Objectives: This course will enable students to

- To explain importance of data and its analytics, big data, statistics for data analytics
- To explain univariate and multivariate statistical methods for data analytics.
- To discuss data preparation, data quality issues, converting data to different scales, reducing dimensionality.
- Gain a historical perspective of AI and familiar with basic principles
- Understand the basic theory underlying ML and differentiate supervised, unsupervised and reinforcement learning
- Understand the basic concepts of learning and decision trees.

	Bloom's Level	Hours
Module-1:		
Data and Descriptive statistics: Introduction to Data, Data analytics and taxonomy of data analytics and concept of Big data, Big data architecture, and Small data, Types of data and uses, KDD, CRISP-DM methods of data analytics, Descriptive univariate analysis, statistical measures used, Descriptive bivariate analysis, Visualization of data Reference Book 1: Chapter 1	**Apply**	**8**
Module-2:		
Descriptive Multivariate statistics, Data quality & Preprocessing: Multivariate frequencies, visualization, Multivariate visualization**,** Multivariate statistics, word cloud, infographics, Data quality issues, Data conversion to different scale type, Data conversion to different scale type, transformation of data, Dimensionality reduction **Reference Book 1:** Chapter 2,3,4	**Apply**	**8**
Module-3:		
Introduction to AI: Artificial Intelligence problems, Underlying assumptions, AI problems, What is an AI technique, Level of the model, Criteria for success, **Problems, Problem Spaces and Search:** Defining the problem as a State Space Search, Production systems, Problem characteristics, Production system characteristics, Issues in the design of search programs. **Reference Book 2:** Chapter 1 and 2	**Apply**	**8**
Module-4:		
Machine learning Landscape: Machine Learning concepts, uses of ML, Types of ML systems, Main challenges of ML. Reference Book 3: Chapter 1 and 2	**Apply**	**8**
Module-5:		
Decision Tree Learning: Introduction, Decision Tree Representation, Appropriate Problem for Decision Tree Learning, The Basic Decision Tree Learning Algorithm, Issues in Decision Tree Learning.	**Apply**	**8**

Reference Book 4: Chapter 3		

Course outcomes:

The students will be able to

1. Understand data, descriptive univariate analytics of data
2. Apply multivariate analysis, data preparation, transformation and reducing
3. Apply the knowledge of AI to write simple algorithm and to solve problems on search algorithm
4. Understand the concepts of Machine Learning
5. Understand and apply the problems on Decision tree.

Text Books /Reference Books:

1. Joao Mendes Moreira, Andre C.P.L.F. De Carvalho, Tomas Horvath, "A general introduction to Data Analytics", Wiley, 1st Edition 2019.
2. Kevin Knight, Elaine Rich, B. Nair, "Artificial Intelligence", Tata McGraw Hill Education Private Limited, 3rd Edition, 2010.
3. Aurelien Geron, "Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly Media, 2nd Edition, 2019
4. Tom Mitchell, Machine Learning, McGraw Hill, 2017.
5. Yuxi (Hayden) Liu, "Python Machine Learning by Example", Packet Publishing Limited, 2017.
6. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2011.

PRACTICAL COMPONENT	
Sl.No	**Experiments**
1	Write a Python program to analyze and visualize the data using NumPy and matplotlib Modules
2	Write a Python Program to represent and analyze data using the Scikit-learn package.
3	Write a Python Program to Implement a Breadth-First Search algorithm.
4	Write a python program to predict home prices using Linear Regression method.
5	Write a python program to predict the weather condition using linear regression.
6	Write a python code to implement an automated customer information system to direct the customer to correct department based on preference using Decision Trees algorithm.
7	Write a python program to decide whether a company's budget is exceeding or not with decision trees, with a sample dataset.
8	Implement python code to decide whether the person will be able to pay the insurance monthly or not using the decision trees algorithm.
9	Using KNN algorithm for linear regression, Develop a python code to get the fertilizer response for an agricultural experiment where the crop yield is tested against fertilizers. The response from crops is the variable.
10	Write a Python program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

Semester: V			
Course: Digital Signal Processing (Professional Course Integrated) **Course Code: 22EEE154**			
Teaching Hours/Week (L:T:P:J) : (3:0:2:0)	**CIA**	**:**	**50**
Credits:03	**SEA**	**:**	**50**
Hours: 40 Hours Theory + 10 Lab Sessions	**SEA Duration**	**:**	**03 Hours**

Course Learning Objectives: The students will be able to

- To understand the mathematical operations on signals and properties of Linear time Invariant System.
- To understand Discrete Fourier transform and its properties.
- To study Fast Fourier Transform properties for both time and frequency domain signals.
- To understand the design of FIR filters and IIR filters with their realization.
- To understand the features of Digital Signal Processors and their applications.

Prerequisites: Fundamental concepts of Mathematics that includes trigonometric functions, complex numbers, complex analysis, linear algebra and Fourier Representation of Discrete Time signals, Elementary programming skills using MATLAB.

	Bloom's Level	**Hours**
Module-1: Time Domain Representations of a Linear Time Invariant System		
Introduction to signals and systems, Classification of signals, , problems only on Odd-Even signals, Periodic and Non-periodic signals, Power & Energy Signals, Properties of System (Linearity, Time Invariance, Causal, Stable & Memory) with examples, Determine Impulse response of a LTI system using Convolution Integral and Convolution sum.	**Apply**	**8**
Module-2: Discrete Time Fourier Transform (DTFT)		
Properties of DFT: Periodicity, Linearity, Symmetry, Multiplication of two DFTs, Circular Time Shift, Time Reversal, Circular Frequency Shift with examples, Circular Convolution (using Tabular Array, Circular Array and DFT-IDFT Methods only) , Linear Filtering of DFT using Overlap ADD and Overlap SAVE methods (only).	**Apply**	**8**
Prerequisite Knowledge to be covered for Understanding this Module, But not included for Evaluation: Basic Operations on signals (Dependant and Independent variables), Sketch signals , Properties of LTI systems: Commutative, associative & distributive properties.		
Module-3: Fast Fourier Transforms Algorithms		
Efficient Computation of DFT: FFT Algorithms: Direct Computation of DFT, Radix – 2 FFT Algorithm (4-point and 8-point only), Decimation in time Radix -2 FFT, Decimation in frequency Radix-2 FFT, Comparison of DIT and DIF Radix -2 FFT, Inverse DIT and DIF Radix -2 FFT.	**Apply**	**8**
Module-4: Design of Digital IIR Filters		
Mathematical aspects of Conversion from Analog to Digital IIR Filters, Design of Digital: Butterworth and Chebyshev IIR Filters using Impulse invariance and Bilinear Transformation (Low Pass filters only), Numerical Examples. Realization of Digital IIR filters using Direct form I and II, Cascade and Parallel structures.	**Apply**	**8**
Module-5: Design of Digital FIR Filters		

Design of Symmetric-Linear Phase FIR Filters using Rectangular, Hamming, Hanning & Blackman Windows, Numerical Examples. Realization of Digital FIR filters using Direct form and Cascade structures. **Digital Signal Processor TMS320C67x Processor**: Introduction, Features, Internal architecture, Applications of DSP: Digital Audio system, Speech Coding and Compression, Compact-Disc recording system, Interference cancellation in electrocardiography, DTMF generation and detection.	**Apply**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Time Domain Representation and Analysis of Linear Time Invariant System.
2. Compute the Discrete Fourier transform of a given signal using its properties with linear filtering.
3. Compute signal decimation in time domain and frequency domain using Fast Fourier Transform algorithm.
4. Formulate FIR filters for Rectangular, Hamming, Hanning & Blackman windows based on desired frequency response and its digital realization.
5. Formulate IIR filters using Butterworth and Chebyshev filters for a system using given analog / digital specification and its digital realization.
6. Explicate the features of Digital Signal processors and their applications.

Reference Books

1. Signals and Systems", Simon Haykin and Barry Van Veen, Wiley India, 2nd Edition, 2018.
2. "Signals and Systems", Dr. D. Ganesh Rao and Satish Tunga, Cengage India Private Limited, 2017,
3. ISBN: 978-81-315-3362-8
4. Digital Signal Processing", John G. Proakis, Dimitris. G. Manolakis, Pearson Education India, 4th Edition, 2017.
5. "Digital Signal Processing", A. Nagoorkani, McGraw Hill,3rd Edition, 2021.
6. "Digital Signal Processing", S. Salivahanan, McGraw Hill 4th Edition, 2019.
7. "Digital Signal Processing – A Computer based approach", Sanjit K Mitra, Tata McGraw Hill,4th Editin,2013.
8. "Digital Signal Processing", Jhonny R. Jhonson, Pearson, 1st Edition, 2016.
9. "Digital Signal Processing using MATLAB", Vinay K Ingle. John G. Proakis, CL Engineering, 2nd Edition

Sl. No.	Experiments
Experiments using MATLAB	
1	To sketch Odd and Even parts of a given signal
2	To obtain Impulse response of a given system
3	To perform linear convolution sum of given two discrete time sequences.
4	To perform circular convolution of given sequences
5	Computation of N – point DFT and to plot the magnitude and phase spectrum.
6	Calculation of DFT and IDFT by FFT
7	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)
8	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions
Experiments using DSP Trainer Kit	
9	Linear convolution of two given sequences
10	Circular convolution of two given sequences

11	Computation of N- point DFT of a given sequence
12	Design and Implementation of FIR Low Pass filter for the given specifications.

Department of Electrical and Electronics Engineering

Semester: V

COURSE: ARM Processors and Applications (Project Based laboratory)

Course Code: 22EEE155

Teaching Hours/Week (L:T:P:J) : (0:0:2:2)	**CIA Marks: 50**
Credits: 2	**SEA Marks: 50**
Hours: 30	**SEA Duration: 03 Hours**

Course Learning Objectives: The students will be able to

- Understand the architecture, register, memory system of ARM cortex M3
- Understand the Instruction set and Interrupts of ARM cortex M3 processor
- Understand the fundamentals of IoT and the various wireless technologies
- Write assembly level program using ARM cortex M3
- Develop an IoT Applications using ESP32, sensors and actuators
- Use Bluetooth and wi-fi to monitor and control various actuators and sensors.
- Interface ARM cortex M3 processor with external devices for various applications

Pre-requisites:

- Basic of Computer and Digital system
- Programming Concepts

	Bloom's Level	Hours
Module-1: Introduction to ARM Cortex Processors		
Cortex -M processor family, Advantages of Cortex -M processors, Applications, Background and history, inside typical ARM microcontrollers, Technical Overview: Processor Architecture, features of M3 and M4 processors	Understand	**5**
Module-2: Architecture		
Introduction to the architecture, Programmer's model, APSR, Memory system, Exception and interrupts, System control block, Debug, Reset	Understand	**5**
Module-3: Instruction Set		
Comparison of the instruction ser in ARM Cortex- M processors, Instruction set	Understand	**5**
Module – 4 : Memory System		
Overview of memory system features, memory map, connecting the processor to memory and peripherals, memory requirements	Understand	**5**
Module – 5: Exceptions and Interrupts and Low Power and system control features		
Overview of exceptions and interrupts, Exception types, overview of interrupt management, definition of priority, vector table and vector table relocation. Low power designs, Low power features.	Understand	**5**

Course Outcomes: After completing the course, the students will be able to

1. Understand the architecture, technical overview, registers and Instruction set of ARM cortex M3 Processor.
2. Understand the memory system, Exceptions and Interrupts of ARM cortex M3 Processor.
3. Write assembly language program using ARM instructions.
4. Interface Switch, Stepper motor, DC Motor, DAC, LCD with ARM Processor.
5. Build projects using microcontrollers for a real-life problem.

Reference Books

1. Andrew N Sloss, Dominic Symes and Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman Publisher, 1st Edition, 2008.

2. Joseph Yui, "The Definitive Guide to ARM Cortex – M3 and Cortex – M4 Processors", Newnes Publishers, 3rd Edition, 2014.

Sl.No	Experiments
1	Write an ALP to i) multiply two 16-bit binary numbers. ii) Add two 64-bit numbers.
2	Write an ALP to i) find the sum of first 10 integer numbers. ii)Add an array of 16-bit numbers and store the result in an internal RAM.
3	Write an ALP to find the largest/smallest number in an array of n- numbers.
4	Write an ALP to arrange a series of 32-bit numbers in ascending/descending order.
5	Interface a simple Switch and display its status through Relay, Buzzer and LED.
6	Interface a DAC and generate Triangular and Square waveforms.
7	Interface and control the speed of a DC Motor.
8	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
9	Display the given text message using Internal UART.
10	Interface a 4X4 keyboard and display the key code on an LCD.

Department of Electrical and Electronics Engineering

Semester: V		
COURSE: Energy Audit and Energy Management System (Open Elective) **Course Code:22EEE1561**		
Teaching Hours/Week (L:T:P:J) : (3:0:0:0)	**CIA Marks:** 50	
Credits: 3	**SEA Marks:** 50	
Hours: 40	**SEA Duration: 0**3 Hours	
Course Learning Objectives: The students will be able to ❖ Understand the energy scenario, environmental aspects of electrical energy generation ❖ Understand the concept of energy conservation and methods of energy auditing ❖ Understand the need and methods for demand-side management ❖ Understand the deregulation of electric energy and cogeneration		
Pre-Requisites: ---		
	Bloom's Level	**Hours**
Module-1: Energy Scenario & Load curve		
Introduction: Electrical energy sources, Energy scenario in India, Indian Electricity act 2003, Indian Energy conservation act 2001. **Load and Load curves**: Maximum Demand, Group Diversity factor, Peak Diversity factor, Load factor, Capacity factor, Utilization factor, Type of load, Load duration curve, Base load and peak load plants, effect of voltage & frequency on loads.	Understand	8
Module–2: Energy Conservation		
Environmental Aspects of Electrical Energy Generation, Energy conservation: Introduction, Principles of Energy Conservation, Energy Conservation planning, Energy conservation in Large and Medium Industries, Energy conservation in Small scale industries.	Understand	8
Module–3: Energy Audit		
Energy Conservation and Impact: Aim of Energy Audit, Energy flow diagram, Strategy for Energy Audit, Energy management team, Considerations in implementing Energy conservation programs, Periodic progress review for optimization of energy use. Instruments for Energy Audit. Energy Audit for illumination system, Electrical system, HVAC, Compressed air system, and Buildings, Certifying agencies in India.	**Apply**	**8**
Module–4: Demand Side Management		
Scope of Demand Side Management (DSM), DSM planning and implementation, Load management as DSM strategy, Application of load control, Issues, Tariff options for DSM. Customer acceptance and implementation issues, Energy efficient motors and Availability based tariff	**Understand**	**8**
Module–5: Electricity Deregulation and Cogeneration		

Electricity deregulation: Need for electricity deregulation, power planners, metering for deregulated marker, energy billing in deregulated regime, revenue sharing, value added network, fault repair service, benefits of deregulation, power sector reforms and restructuring in India. **Cogeneration:** Definition and scope, Topping and bottoming cycle, Cogeneration techniques, industries suitable for cogeneration, electrical power plant reject heat, agricultural use of waste heat, use of power plant reject heat for waste water treatment, potential of cogeneration in India.	**Understand**	**8**

Course Outcomes: After completing the course, the students will be able to

1. Understand the current energy scenario in India and the factors affecting power generation.
2. Understand the environmental impact of electric power generation and energy conservation
3. methodology and measures
4. Understand methodology for energy auditing, audit process for industries, illumination system, HVAC, Electrical system
5. Understand the principles of DSM and the tariff options to promote DM
6. Understand electricity deregulation and cogeneration using waste heat.

Reference Books

1. B R Gupta, “Generation of Electrical Energy”, S Chand, 7th edition, 2017.
2. Umesh Rathore, “Energy Management”, S K Kataria and Sons, 2nd edition, 2019
3. Sonal Desai, “Handbook on Energy Audit”, McGraw Publications, 1st edition, 2005
4. www.beeindia.gov.in/en/programmes

Semester: V		
Course Name: Non-Conventional Energy Resources (Open Elective) **Course Code: 22EEE1562**		
Teaching Hours/Week (L: T: P: J): (3 : 0 : 0 : 0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 hours**	
Course Learning Objectives:		
❖ To discuss energy resource and its classification ❖ To explain sun – earth geometric relationship, Earth – Sun Angles and their Relationships and solar thermal applications. ❖ To discuss wind turbines, wind resources, site selection for wind turbine ❖ To discuss geothermal systems, their classification and geothermal based electric power generation ❖ To discuss biomass production, types of biomass gasifiers, properties of producer gas. ❖ To discuss tidal energy resources, energy availability, power generation. ❖ To explain principles of ocean thermal energy conversion and production of electricity		
Pre-Requisites: Basic knowledge of Physics		
	Bloom's Level	**Hours**
Module-1: Introduction to Energy Sources		
Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable energy – Worldwide renewable energy availability, Renewable energy in India, Introduction to solar energy, wind power, tidal power, ocean thermal energy, geothermal energy, Biomass energy. **R1: Chapter 1 (1.5, 1.6, 1.7, 1.9, 1.12)**	**Understand**	**08**
Module-2: Energy from the Sun		
Sun-Earth geometric Relationship, Earth-sun angles, and their relationships – Hour angle, equation of time, declination angle, Latitude angle, Solar altitude angle, Solar elevation angle, Surface azimuth angle, Relationship between different sun-earth angles, Relationship Between Different Sun–Earth Angles, Sunrise, Sunset, and Day length Equations, Solar Time, Direct thermal applications, illustrative problems. R1: Chapter 2 (2.1, 2.3, 2.5.3)	**Understand**	**08**
Module-3: Wind Energy		
Energy availability in the wind, Considerations and guidelines for site selection, Wind Turbine Power Output Variation with Steady Wind Speed, Classification and description of wind machines, Principle of wind energy conversion, Mathematical model of extraction of energy from the wind, illustrative problems. R1: Chapter 6 (6.3, 6.5.2 – 6.5.3, 6.6, 6.7, 6.8)	**Understand**	**08**
Module-4: Biomass energy & Tidal energy		

Biomass energy - Biomass production, Biomass gasification, Theory of gasification, Gasifier and their classifications, Fluidized bed gasification. **Tidal energy** - Tidal energy Resource, Tidal energy Availability, Tidal power basin – single basin system, two-basin system, co-operating two basin systems (Excluding problems). **R1: Chapter 9 (9.1, 9.3, 9.4, 9.5, 9.10), Chapter 11 (11.2, 11.3, 11.7)**	**Understand**	**08**
Module-5: Geothermal & Ocean thermal energy systems		
Geothermal energy - Geothermal systems, Geothermal-Based Electric Power Generation – Dry steam based, flash geothermal, binary-cycle based, electrical and mechanical features, operation of geothermal plants. **OTEC** - Principle of Ocean Thermal Energy Conversion, Ocean thermal energy conversion plants, Closed cycle, Open cycle and Hybrid cycle OTEC plant **R1: Chapter 7 (7.1, 7.5), Chapter 13 (13.2, 13.3, 13.5)**	**Understand**	**08**

Course Outcomes: After the completion of the course the students will be able to:

1. Discuss the energy resource and its classification
2. Discuss sun – earth geometric relationship, Earth – Sun Angles and their Relationships and solar thermal applications
3. Discuss the production of wind energy, advantages, disadvantages, and applications.
4. Discuss the production of energy from biomass, tidal energy resources, energy availability and power generation
5. Discuss the generation of power from geothermal & ocean thermal energy

Reference Books

1. "Non-conventional energy Resources", Shobh Nath Singh, Pearson, 1st Edition, 2015
2. "Non-conventional energy resources", B.H.Khan, TMH, 3nd edition.
3. " Renewable Energy; power for a sustainable future" Godfrey Boyle,Oxford, 3rd Edition, 2012

Web links and Video Lectures:

- https://archive.nptel.ac.in/courses/121/106/121106014/
- https://www.coursera.org/specializations/renewable-energy

Semester: V		
Course Name: Fundamentals of Hybrid and Electric Vehicles (Open Elective) **Course Code: 22EEE1563**		
L:T:P:J: 3 : 0 : 0 : 0	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 hours**	
Course Learning Objectives:		
❖ To Understand the fundamental laws and vehicle mechanics. ❖ To Understand the working of Electric Vehicles and recent trends. ❖ To understand the working of DC and AC motors used in Electric Vehicles. ❖ To understand different energy storage systems used in electric vehicles		
Pre-Requisites:		
	Bloom's Level	**Hours**
Module-1: Fundamentals of Electric and Hybrid Vehicles		
Introduction, Electric Vehicles, Hybrid Electric Vehicles, Electric and Hybrid Vehicle components, Electric Motor and Engine ratings, Recent EVs and HEVs, EV/ICEV Comparison, Electric Vehicle Market **Vehicle Dynamics**: Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion power, Force-Vehicle Characteristics, Maximum Gradability, Velocity, and acceleration Constant, Level Road, Vehicle profile, Distance traversed, Tractive power Energy requirement (Excluding Derivations)	**Understand**	**08**
Module-2: Electric and Hybrid Electric Vehicles		
Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption. Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains (Excluding classification)	**Understand**	**08**
Module-3: Energy storage for EV and HEV		
Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, Proton Exchange Membrane Fuel Cell (PEMFC) and its operation, Modelling of PEMFC, Supercapacitors.	**Understand**	**08**
Module-4: Electric Propulsion		
Introduction, DC motor Drives, the principle of operation, speed control using armature voltage, and field control method. Special Electric Motors: Permanent Magnet BLDC Motor Drives, Basic principles of BLDC Motor Drives, BLDC Machine Construction, and Classification, introduction to SRM Motor Drives.	**Understand**	**08**
Module-5: Design of Electric and Hybrid Electric Vehicles		
Series Hybrid Electric Drive Train Design: Introduction, Operating patterns, control strategies, Maximum State of Charge of Peaking Power Source Control Strategy, Engine On–	**Understand**	**08**

Off or Thermostat Control Strategy, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS **Parallel Hybrid Electric Drive Train Design:** Control strategies of parallel hybrid drive train, Maximum SOC-of-PPS Control Strategy, Engine On–Off (Thermostat) Control Strategy, Constrained Engine On–Off Control Strategy, Fuzzy Logic Control Technique.		

Course Outcomes: After the completion of the course the students will be able to:

1. Explain the roadway fundamentals, laws of motion, vehicle mechanics and propulsion system design.
2. Explain the working of electric vehicles and hybrid electric vehicles in recent trends.
3. Model batteries, Fuel cells, PEMFC and supercapacitors.
4. Explain the working of DC and AC motors used for electric vehicle applications.

Reference Books:

1. Electric and Hybrid Vehicles: Design Fundamentals Iqbal Husain CRC Press, Third Edition.
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design M. Ehsani, Y. Gao, S.Gay and Ali Emadi CRC Press 2005.

Web links and Video Lectures:

- https://nptel.ac.in/courses/108106170

Semester: V			
Course Name: Sensors and Transducers (Open Elective) **Course Code: 22EEE1564**			
Teaching Hours/Week (L:T:P:J) : (3:0:0:0)	**CIA: 50**		
Credits: 3	**SEA: 50**		
Hours: 40	**SEA Duration:**	**03Hours**	
Course Learning Objectives: The students will be able to ❖ Understand various Transducers, their construction, applications and principles of operation, standards and units of measurement. ❖ Discuss the basics of signal conditioning and signal conditioning equipment ❖ Discuss the configuration of the Data Acquisition System and data conversion ❖ Explain the measurement of various non-electrical quantities ❖ Discuss recent trends in sensor technology and their selection. ❖ Develop basic skills in the design of electronic equipment			
Pre-Requisites: ---			
		Bloom's Level	**Hours**
Module-1: Introduction, Passive Electrical Transducers			
Introduction to transducers-Classification, Advantages, Disadvantages, Actuating mechanisms. **Passive Electric Transducers**-Resistance Transducers-Linear and angular motion potentiometers, Thermistors and resistance thermometers, Variable Inductance Transducers-Self generating type and passive type, Capacitive Transducers-Capacitive thickness transducers, Capacitive displacement transducers, Proximity transducers, Capacitive Strain transducers.		**Understand**	**8**
Module-2: Active Electrical Transducers			
Thermo-Electric Transducers- Common thermoelectric phenomena, Common thermos-couple systems. **Piezoelectric Transducers**-Piezo electric materials-desirable properties, Working, Advantages and disadvantages, and piezoelectric accelerometer. **Hall-effect transducers**-working principle, Applications **Electromechanical Transducers**-Tachometers		**Understand**	**8**
Module-3: Developments in sensors Technology			
Smart sensors-Definition and configuration, **Microsensors**-micro size microphone, inertial sensors, Hall Effect sensor, **IR radiation Sensors**-Basics, Thermal Detectors, Quantum detectors, IR thermometry. **Ultrasonic sensors**-Basics, Sensing system, Ultrasonic flow meters, Doppler flowmeter. **Biosensors**- structure, composition, Quartz crystal microbalance.		**Understand**	**8**
Module-4: Signal conditioning and DAQ systems			
Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers, Fluid Amplifiers, Optical Amplifiers, Electrical and Electronic Amplifiers.		**Understand**	**8**

Data Acquisition Systems and Conversion: Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.		
Module-5: Measurement of Non – Electrical Quantities		
Pressure Measurement, Temperature Measurement, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Flow Metes. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level. Measurement of viscosity.	**Understand**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Explain the need for transducers, their classification, advantages, and disadvantages
2. Explain the working of various transducers and sensors.
3. Outline the recent trends in sensor technology and their applications.
4. Analyze the signal conditioning and signal conditioning equipment
5. Illustrate different configurations of the Data Acquisition System and data conversion.
6. Explain the measurement of non-electrical quantities -temperature, flow, speed, force, torque, power, and viscosity

Reference Books:

1. D.V.S. Murty, “Transducers and Instrumentation”, Prentice Hall India
2. Electrical and Electronic Measurements and instrumentation , R.K Rajput, S.Chand,3rd Edition, 2013.
3. D. Patranabis, ―Sensors and Transducers‖, 2nd Edition, Prentice Hall of India, 2010.
4. Shawhney A. K. "A Course In Electrical and Electronics Measurements and Instrumentation”, Dhanpat Rai& Sons, 11th Ed., 1999
5. A course in electronics and electrical measurement and instrumentation, J.B Gupta, Katson books, 13th edition,2008

Web links and Video Lectures:

1. https://archive.nptel.ac.in/courses/108/108/108108147/
2. https://alison.com/course/application-of-sensors-in-mechatronics

Department of EEE

Semester: V	
Course Name: Internship -2 **Course Code: 22EEE158**	
L:T:P:J 0:0:4:0	**CIA: 100**
Credits: 02	**SEA: --**
Hours: --	**SEA Duration: --**

Course Learning Objectives:

Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc.

The objectives are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing.

Pre-Requisites: ---

Course Outcomes: After the completion of the course the students will be able to:

- Acquire practical knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills

Internship: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident

BNM Institute of Technology

Syllabus for Employability Skills-1
SEMESTER – V

Subject Name	Employability Skills-1 (Technical)	**Weekly Assignments (6 tests)**	Max 10 Min 4
Subject Code	22XXX157	**Company Simulation Tests (6 tests)**	Max 15 Min 6
Number of Contact Hours/Week	2	• **Domain Specific, Programing & Coding - 90 minutes** ▪ 40 marks of MCQ's which should include Technical & Programing Questions (60 questions each of 1 mark. Students can answer any 40) ▪ 10 Marks of Coding Test *(on coding platform)* 2 programs given. Student must answer one question. Marks 50, Reduced to 25	Max 25 Min 10
Total Number of Contact Hours	24	**Credits**	1

Module	Topics to be covered
General Technical Training (12 hrs) **(All Branches)**	**Programming Languages** C, Java, Python (Platforms to be used Hacker Rank, Leet Code and Github)
Technical Training (12 hrs)	**CSE, ISE & AIML** Algorithms, Data Structures, DBMS, Computer Organisation, Computer Networks, Network Security, Operating Systems, UI/UX, Web technologies & AIML.
	ECE, EEE & ME Introduction to the following IT topics : Computer Organisation, Data Structures, Operating Systems, DBMS, Computer Networks, Network Security, AIML

Domain Specific Training to be given by Departments	**<u>Electronics & Communication Engineering</u>** MATLAB, SCADA, System Verilog, VLSI, & Embedded Systems,
	<u>Electrical & Electronics & Engineering</u> Power Electronics, Power Systems, Introduction to Robotic Process Automation (RPA) & EV Vehicles.
	<u>Mechanical Engineering</u> Thermodynamics, Aerodynamics, Automobile & Engines, Solidworks, Ansys, Industrial Automation, Mechatronics, & EV Vehicles

29/07

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical and Electronics Engineering

VI Semester Syllabus

B.N.M. Institute of Technology

An Autonomous Institution under VTU, Approved by AICTE

Department of Electrical and Electronics Engineering

Semester: VI		
Course Name: Switchgear & Protection (Professional Core Course) **Course Code: 22EEE161**		
Teaching Hours/Week (L:T:P:J) : (2:2:0:0)	**CIA Marks: 50**	
Credits:3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 Hours**	
Course Learning Objectives:		
❖ To explain over current protection using static and numerical relay protective schemes. ❖ To discuss construction, operating principles and performance of various differential relays for differential protection. ❖ To discuss effect of arc resistance, power swings, line length and source impedance on performance of distance relays. ❖ To discuss protection of generators, motors, Transformer and Bus Zone Protection. ❖ To explain the principle of circuit interruption and operation of circuit breakers. ❖ To discuss Protection of transmission line and substations against lightning. ❖ To discuss recent trends in power system protection		
Pre-Requisites: Fundamentals of Mathematics, Electrical and Electronics Engineering and Power Systems.		
	Bloom's Level	**Hours**
Module-1: Introduction to Power System Protection		
Introduction to Power System Protection: Need for protective schemes, Nature and Cause of Faults, Types of Faults, Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Performance of Protective Relaying, Components of a Protection System, Classification of Protective Relays. **Relay Construction and Operating Principles:** Introduction, Static Relays, Numerical Relays Merits and Demerits of Static Relays, Comparison between Static Relays and Numerical Relays.	**Understand**	**8**
Module-2: Overcurrent Protection & Distance Protection		
Overcurrent Protection: Introduction, Time Current Characteristics, Current Setting, Time Setting (with Numerical), Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel and Ring Main Feeders, Earth Fault and Phase Fault Protection, Directional Earth Fault Relay, Block diagram of Static and Numerical Overcurrent Relays. **Distance Protection:** Introduction, Impedance Relay - Operating Principle, Characteristics, Characteristics of three-zone impedance relays with directional unit, Protective Scheme Using Impedance Relays, Static Impedance Relay Using an Amplitude Comparator, Static Impedance Relays Using a Phase Comparator, Microprocessor-based Impedance Relay, Reactance Relay - Static Reactance Relay Using an Amplitude Comparator , Static Reactance Relay Using a Phase Comparator,	**Understand**	**8**

Microprocessor based Reactance Relay, Mho Relay- Static MHO Relay Using Amplitude Comparator, Static MHO Relay Using a Phase Comparator, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Effect of Power Surges (Power Swings) on Performance of Distance Relays.		
Module-3: Differential Protection, Generator, Transformer and Buszone Protection		
Differential Protection: Introduction, Simple Differential Protection - Behaviour of Simple Differential Protection during Normal, External Fault & Internal Fault Conditions, Characteristics of Simple Differential Protection Scheme (Internal & External Fault only), Percentage or Biased Differential Relay (with Numerical). **Generator Protection:** Introduction, Protection of Generators (Stator and Rotor Protection schemes only), Numerical. **Transformer and Bus zone Protection:** Introduction to Transformer Protection, Percentage Differential Protection (with Numerical), Buchholz Relay Bus zone Protection, Frame Leakage Protection	**Understand**	**8**
Module-4: Circuit Breakers		
Circuit Breakers: Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Resistance Switching, Current Chopping (with Numerical) Classification of Circuit Breakers, Air Break Circuit Breakers, Oil Circuit Breakers, Air Blast Circuit Breakers, SF6 Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers.	**Understand**	**8**
Module-5: Protection against Overvoltage & Modern Trends in Power System Protection		
Protection against Over voltages: Causes of Overvoltages, Lightning phenomena, Wave Shape of Voltage due to Lightning, Klydonograph and Magnetic Link, Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub Stations from Direct Strokes, Surge arresters. Modern Trends in Power System Protection: Introduction, gas insulated substation/switchgear (GIS), Field Programmable Gate Arrays (FPGAs) based relays.	**Understand**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Discuss the principle of operation and construction of numerical and static relays.
2. Explain the working principle of Overcurrent, Distance and Differential protection schemes.
3. Discuss the protection of generators, motors, transformers and Bus Zone Protection
4. Explain the principle of circuit interruption & construction of air, oil, vacuum and SF6 circuit breakers Describe the Gas Insulated Substation (GIS) and FPGA-based relays.

Reference Books:

1. Bhuvanesh Oza Nirmal Kumar Nair Rashesh Mehta Vijay Makwana, "Power system protection & Switchgear", McGraw-Hill Education, 1st edition, 2010.
2. Y.G.Paithankar, S.R. Bhide, "Fundamentals of Power System Protection", PHI, 1st Edition, 2009
3. J Badariram& D.N Vishwa Kharma, "Power system protection & Switchgear", McGraw Hill, 2nd Edition

Department of Electrical and Electronics Engineering

Semester: VI		
Course Name: Computer Techniques in Power System (Professional Course Integrated) **Course Code: 22EEE162**		
Teaching Hours/Week (L:T:P:J) : (2 : 2 : 2 : 0)	**CIA Marks: 50**	
Credits: 4	**SEA Marks: 50**	
Hours: 40 Hours Theory + 10 lab sessions	**SEA Duration: 3 Hours**	
Course Learning Objectives: ❖ To introduce the concept of Graph theory and its terminologies ❖ To explain Incidence matrices, Bus Incidence Matrix, and Primitive network. ❖ To compute the Bus Incidence matrix for a given system ❖ To solve load flow problems for a given power system using Gauss-Siedel, Newton Raphson and Fast decoupled load flow methods. ❖ To evaluate optimal generation scheduling with and without losses ❖ To formulate Z-Bus using Z-bus building algorithm. To explain numerical solution of swing equation for multi-machine stability.		
Pre-Requisites: Power system Analysis, Network Theory		
	Bloom's Level	**Hours**
Module-1: Network Topology		
Introduction, Graphs, terminologies of Graph Theory, Introduction to Incidence Matrices, Bus Incidence Matrix, Primitive Networks – Impedance and Admittance forms, Formation of Y-Bus using Inspection Method and Singular Transformation Method, Problems.	**Apply**	**08**
Module-2: Load Flow Studies		
Introduction, Power flow Equations, Types of Buses, operating constraints, Data for Load Flow Studies, Solution technique, Gauss- Siedel (G-S) Method – Algorithm and Flow chart for Load flow solution using G-S Method, Acceleration Factor, Illustrative examples.	**Apply**	**08**
Module-3: Load Flow Studies		
Newton Raphson (N-R) Method for Load flow solution (Rectangular and Polar co-ordinates), Fast Decoupled Load flow (FDLF) studies, Problems, Flow chart and Algorithm for N-R method and FDLF method, Comparison of Load Flow Methods. Illustrative examples.	**Apply**	**08**
Module-4: Economic Operation of Power System		
Introduction, Economic generation scheduling neglecting losses, Economic generation scheduling considering losses and generator limits, Lambda Iterative method – Algorithm, Derivation of Transmission loss formula, Illustrative examples.	**Apply**	**08**
Module-5: Z-bus Formation and Power System Stability		
Z-Bus formation using Z-Bus Building Algorithm (Both the addition of Branch and Link). Illustrative examples. Numerical Solution of Swing Equation by Point-by-Point method. Illustrative examples. Factors affecting Transient Stability.	**Apply**	**08**

Course Outcomes: After the completion of the course the students will be able to:

1. Develop network matrices and models for solving load flow problems.
2. Solve steady state power flow of power system networks using Gauss-Seidel, Newton-Raphson and Fast decoupled iterative methods.
3. Evaluate Optimum Generation scheduling of Power System.
4. Compute Z-bus matrix using Z bus building algorithm
5. Solve swing equation by Point-by-Point method and Runge - Kutta method.

Reference Books:

1. "Computer Methods in Power System Analysis", Glenn W. Stagg, Ahmed H Ei-Abiad, MEDTECH, Scientific International Pvt. Ltd., 1st Edition, 2019
2. "Modern Power System Analysis", D P Kothari, I J Nagrath, Tata McGraw Hill, 4th Edition, 2011.
3. "Computer Techniques in Power System Analysis", M.A. Pai, McGraw Hill, 2nd Edition, 2012.
4. "Power System Analysis", Hadi Saadat, McGraw Hill, 2009

Web links and Video Lectures:

List Of Experiments

1	Formation of Y-Bus for power systems using Inspection Method. - CO1
2	Formation of Y-Bus for power systems using Singular Transformation Method – CO1
3	Formation of Z-Bus using Z-Bus Building Algorithm . CO4
4	Determination of Line Current, Line power flow, Bus Current, Bus Power, and losses for a given Power system. – CO2
5	Load Flow Analysis using Gauss-Siedel Method. Considering only P-Q Buses. – CO2
6	Symmetrical and Unsymmetrical fault analysis on a power system using MiPower software package. -CO6
7	Determination of critical clearing time and critical clearing angle for a single machine connected to Infinite Bus using MiPower software package. - CO5
8	Load Flow Analysis using MiPower software package. – CO2
9	Fault analysis in a single transmission line system using MiPower software package. – CO6
10	Economic Operation on power plants using MiPower software package. – CO3

Experiments 1 to 5 are conducted using MATLAB

Department of Electrical and Electronics Engineering

Semester: VI		
Course Name: High Voltage Engineering (Professional Course Integrated) **Course Code: 22EEE163**		
Teaching Hours/Week (L:T:P:J): (3:0:2:0)	**CIA Marks: 50**	
Credits: 4	**SEA Marks: 50**	
Hours: 40 Hours Theory+10 Lab sessions	**SEA Duration: 03 hours**	
Course Learning Objectives:		
❖ To discuss conduction and breakdown in gases, liquid dielectrics. ❖ To discuss the breakdown in solid dielectrics. ❖ To discuss generation of high voltages and currents and their measurement. ❖ To discuss the overvoltage phenomenon and insulation coordination in electric power systems ❖ To discuss high-voltage testing of electric apparatus ❖ To explain the impact of high voltage systems on society		
Pre-Requisites: Basic Electrical Engineering, Transmission and Distribution		
	Bloom's Level	**Hours**
Module-1: Conduction and Breakdown in Dielectrics		
Conduction and Breakdown in Gases: Gases as Insulating Media, Collision Process, Ionization Processes, Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges. **Conduction and Breakdown in Liquid Dielectrics:** Introduction, Definition of Pure Liquids and Commercial Liquids, Conduction and Breakdown in Commercial Liquids. **Breakdown in Solid Dielectrics:** Introduction, Electromechanical Breakdown, Thermal Breakdown, Internal Discharge	**Understand**	**8**
Module-2: Generation of High Voltage and Current		
Generation of HVDC: Half and full wave rectifier, voltage doubler, Cockcroft-Walton voltage multiplier circuit, Van de Graaff generator **Generation of HVAC**: Cascaded transformer, Resonant Transformers, High frequency AC high voltages generator **Generation of Impulse Voltage and Current:** Standard impulse waveshape, Wave shape control, Marx circuit, Generation of switching surges, Impulse current generation, Tripping and control of impulse generator.	**Understand**	**8**
Module-3: Measurement of High Voltage and Current		
Measurement of HVDC: Series resistance microammeter, Resistance potential divider, Generating voltmeter, Electrostatic Voltmeter **Measurement of HVAC and Impulse Voltages:** Series impedance voltmeter, Series Capacitance voltmeter, Capacitance potential divider and Capacitive voltage transformer, Peaking reading AC voltmeter. **Measurement Impulse Voltages:** Spark gap measurement, Resistance potential divider, Capacitance voltage divider, Pure capacitance divider, Mixed RC divider, Different connection employed with potential divider, LV arm of the measuring system.	**Understand**	**8**

Module-4: Overvoltage phenomenon and insulation coordination in electric power systems		
Overvoltage phenomenon: Natural Causes: Charge formation on clouds, Mechanism of lightning stroke, Mathematical model for lightning, Travelling waves on transmission lines, Reflection and Transmission of waves at Transition points, Reflection lattice of travelling wave, **Insulation Coordination:** Introduction to Switching and Power Frequency Overtages, Protection against lightning over voltages and switching surges of short duration, Principles of insulation coordination, on high voltage and extra high voltage power system, surge diverters, Insulation coordination in EHV and UHV system.	**Understand**	**8**
Module-5: High voltage testing of electrical apparatus		
Non-Destructive Testing: Introduction, Measurement of dielectric constant and loss factor, Schering Bridge arrangement for power frequency method, grounded capacitor, high charging current and dissipation factors, Partial discharge measurement using straight and balanced detector. **Destructive Testing:** Introduction, Testing of insulators and bushings, Testing of isolators and circuit breakers, Testing of cables, and Testing of transformers.	**Understand**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Describe the breakdown phenomenon of gaseous, liquid and solid dielectrics.
2. Explain the equivalent circuit models of the generation of high voltage direct current voltages, high alternating voltages, impulse voltages, impulse currents and impulse generators.
3. Explain the measurement of HVDC, HVAC, impulse voltage and impulse current.
4. Discuss the causes of over voltages, switching surges, system faults and principles of insulation co-ordination in high voltage and extra voltage power systems.
5. Discuss non-destructive testing of materials and high voltage testing of electrical apparatus.
6. Explain the impact of high voltage systems on society

Reference Books:

1. High Voltage Engineering, M.S. Naidu and Kamaraju, McGraw Hill, 5th Edition, 2013.
2. High Voltage Engineering Fundamentals, E.Kuffel, W.S Zaengl, J. Kuffel, Newness, 2nd Edition, 2000
3. High Voltage Engineering, C.L. Wadhwa, New Age International, 3rd Edition, 2012
4. High-Voltage Test and Measuring Techniques, Wolfgang Hauschild, Eberhard Lemke, Springer, 1st Edition, 2014
5. High Voltage Engineering, Farouk A.M. Rizk, CRC Press, 1st Edition, 2014

Web links and Video Lectures:

1. NPTEL course on "High Voltage Engineering" coordinated by IIT Kanpur, https://archive.nptel.ac.in/courses/108/104/108104048/ (accessed on 31st of July 2023).
2. NPTEL course on "Advances in Ultra High Voltage Transmission and Distribution" coordinated by IISc Bangalore, https://archive.nptel.ac.in/courses/108/108/108108099/# (accessed on 31st of July 2023

List of lab experiments
1. Protection of Transformer using Differential Relay (Merz Price Protection)
2. Operation of Negative Sequence Relay using REF601
3. DMT and IDMT characteristics of over current and earth fault protection of feeders using SPAJ 140C relay
4. DMT and IDMT characteristics of over voltage and under voltage using microprocessor (REU610) based relay
5. IDMT Characteristics of Over-Current Electromechanical type Relay (ICM21)
6. Over current and earth fault protection of motors using SPAM 150C relay.
7. Spark-Over Characteristics of Air Insulation for HVAC
8. Spark-Over Characteristics of Air Insulation for HVDC
9. Measurement of HVAC and HVDC using Standard Sphere Gap Assembly

10. Measurement of Break Down Strength, Flash and Fire Point of Transformer Oil
11. Measurement of Viscosity of Transformer Oil *(Extra Experiment)*

Department of Electrical and Electronics Engineering

Semester: VI		
Course Name: Simulation of Electric vehicle and Alternate energy systems (Project Based Laboratory) Course Code: 22EEE164		
L:T:P:J: 0 : 0 : 2 : 2	**CIA Marks: 5 0**	
Credits: 2	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 Hours**	
Course Learning Objectives:		
❖ Understand Modulation Techniques for Inverters ❖ Learn Fundamentals of Electric Vehicles and Hybrid Electric Vehicles ❖ Explore Energy Storage Systems ❖ Apply Simulink in Renewable Energy Technologies ❖ Develop Practical Skills in Power Electronics and Renewable Energy Systems		
Pre-Requisites: Power Electronics, Simulink tool		
	Bloom's Level	**Hours**
Module-1: Voltage control of inverters		
Single-pulse-width modulation, Multiple-pulse-width modulation, Sinusoidal pulse-width modulation, Modified sinusoidal pulse-width modulation, Phase-displacement control.	**Apply**	**05**
Module-2: Basics of Electric Vehicles		
Fundamentals: Introduction to electric vehicles and hybrid electric vehicles, electric and hybrid vehicle components. Vehicle mechanics: roadway fundamentals, laws of motion, vehicle kinetics, dynamics of vehicle motion, propulsion power.	**Analyze**	**05**
Module-3: Energy storage systems - Batteries		
Historical overview, battery systems-general definitions, battery design, battery characteristics, Constant current, constant voltage and constant current and voltage charging methods.	**Understand**	**05**
Module-4: Application of Simulink in Renewable Energy Technology - Solar energy basics		
Solar Photovoltaics, Mathematical Model of PV Cell, PV Panel Design from Solar Cell, PV Panel Design with PV Array.	**Evaluate**	**05**
Module-5: Application of Simulink in Renewable Energy Technology - Wind energy basics		
Wind Turbine, Model Wind Turbine-Based Generator in Simulink, Case Study: Grid-Connected Wind Turbine Generator.	**Evaluate**	**05**
Course Outcomes: After the completion of the course the students will be able to: 1. Implement PWM Techniques for Voltage Control in Inverters 2. Analyze and Model Electric Vehicle Dynamics 3. Understand Basics of Battery Systems and Charging Methods 4. Develop and Validate Simulink Models for Renewable Energy Systems 5. Design and Simulate Power Electronic Converters and Battery Charging Circuits		

Reference Books:

5. Eklas Hossain - MATLAB and Simulink Crash Course for Engineers (2022)
6. Wireless Power Transfer Technologies for Electric Vehicles, Xi Zhang, Chong Zhu, Haitao ,Song, Year:2022, Publisher:Springer
7. 2021Electric and Hybrid Vehicles Design Fundamentals by Iqbal Husain.

Web links and Video Lectures:

List Of Experiments

1	Develop Simulink model to implement SPWM technique for single phase and three phase inverters. **CO1**
2	Design and develop a Simulink model for single phase rectifier circuit. **CO5**
3	Design and develop a Simulink model for single phase inverter. **CO1, CO5**
4	Design and develop a Simulink model for buck converter, boost converter and buck boost converter.**CO5**
5	Develop a vehicle dynamic simulation model. **CO2**
6	Design and develop a charging circuit for li ion batteries **CO3, CO5**
7	Develop a Simulink mathematical model of the solar PV cell and compare with inbuilt model. **CO4**
8	Develop a wind turbine -based generator in Simulink. **CO4**

Semester: VI		
Renewable Energy Sources (Professional Elective Course) **Course Code: 22EEE1651**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIE Marks:** 50	
Credits: 3	**SEE Marks:** 50	
Hours: 40	**SEE Duration:** 03 Hours	
Course Learning Objectives:		
❖ To discuss the conventional and non-convectional energy sources ❖ To explain sun – earth geometric relationship, Earth – Sun Angles and their Relationships, solar energy reaching the Earth's surface ❖ To discuss types of solar collectors, their configurations, and their applications, components of a solar cell system, equivalent circuit of a solar cell, its characteristics, and applications. ❖ To discuss the production of hydrogen energy, biomass energy, biogas ❖ To discuss the availability of wind energy, geothermal energy, tidal energy and OTEC ❖ To discuss the various types of renewable energy-based power generation		
Pre-Requisites: Nil		
	Bloom's Level	**Hours**
Module-1: Introduction to Energy Sources & Solar radiation and its measurement		
An Introduction to Energy Sources: Energy consumption as a measure of Prosperity, commercial or conventional energy sources, non-conventional sources, energy plantation, advantages of renewable energy. Energy scenario world & India **Solar radiation and its measurement:** Introduction, Solar Constant, Solar Radiation at the Earth's Surface, Solar Radiation Geometry, Local Solar Time, (excluding derivation) illustrative problems	**Understand**	**8**
Module-2: Solar Energy Collectors, Solar Cells and applications		
Solar Energy Collectors: Introduction, Flat-Plate Collectors, Concentrating Collector: Focusing Type, Advantages and Disadvantages of Concentrating Collectors Over Flat-Plate collectors **Solar Cells:** Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic panels (series and parallel arrays). **Applications of Solar Energy:** Solar Water Heating Systems, Active Solar Space Cooling, Solar Dryers, Crop Drying, Solar Cookers	**Understand**	**8**
Module-3: Wind, Geothermal and Hydrogen Energy		
Wind Energy: Introduction, Basic Principles of Wind Energy Conversion, Site Selection Considerations, Basic components of WECS, Advantages and Disadvantages of WECS **Geothermal Energy:** Introduction, Geothermal Sources, Hydrothermal (Convective) Resources, Advantages and Disadvantages of Geothermal Energy over other Energy Forms, Applications **Hydrogen Energy:** Introduction, Hydrogen Production (thermochemical & electrolysis process only), Hydrogen Storage, Utilization of Hydrogen Gas	**Understand**	**8**
Module-4: Energy from Biomass		

Energy from Biomass: Introduction, Biomass Conversion Technologies, Biogas Generation, Floating Dome Type Plant -KVIC digester, Advantages & disadvantages of floating drum type, Fixed Dome Type Plant – Deenabhandu biogas plant, Advantages & disadvantages of fixed drum type, Biomass as a Source of energy – Introduction, Classification of Biomass Gasifiers, Pyrolysis	**Understand**	**8**
Module-5: Energy from Ocean, Tides and Ocean Waves		
Energy from Tides: Introduction, Basic principle of Tidal Power, Components of Tidal Power, single basin & double basin arrangement, Advantages, and limitations of Tidal Power **Energy from Ocean Waves:** Introduction, Advantages and Disadvantages of Wave energy, Wave energy conversion Devices, OTEC – open type & closed type OTEC System	**Understand**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Explain conventional and non-convectional energy sources
2. Understand the sun – earth geometric relationship, Earth – Sun Angles and their Relationships, solar energy reaching the Earth's surface
3. Explain types of solar collectors, their configurations, and their applications, components of a solar cell system, equivalent circuit of a solar cell, its characteristics, and applications.
4. Understand the different forms of production of hydrogen energy, biomass energy, and biogas & their applications
5. Explain the availability of wind energy, geothermal energy, tidal energy, OTEC and their types, classification, and power generation.

Reference Books

1. "Non- conventional Energy Sources" / G.D. Rai / Dhanpat Ral and Sons. 6th Edition
2. "Nonconventional Energy Resources," Shobh Nath Singh Pearson 1st Edition, 2015
3. "Nonconventional Energy Resources," B.H. Khan McGraw Hill 3rd Edition
4. "Renewable Energy Sources" Twidell & Weir / Taylor and Francis / 2nd Special Indian Edition.
5. "Renewable Energy Sources and Emerging Technologies" D.P. Kothari, K.C. Singal Rakesh Ranjan
6. "Renewable Energy Resources" Tiwari and Ghosal Narosa.

Semester: VI		
Course: Sensors and Transducers (Professional Elective Course) **Course Code: 22EEE1652**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA : 50**	
Credits: 03	**SEA : 50**	
Hours: 40	**SEA Duration : 03 Hours**	
Course Learning Objectives: The students will be able to ❖ Understand various Transducers, their construction, applications, and principles of operation, standards, and units of measurement. ❖ Discuss the basics of signal conditioning and signal conditioning equipment ❖ Discuss the configuration of the Data Acquisition System and data conversion ❖ Explain the measurement of various non-electrical quantities. ❖ Discuss recent trends in sensor technology and their selection ❖ Develop basic skills in the design of electronic equipment		
Pre-Requisites: Nil		
	Bloom's Level	**Hours**
Module-1: Introduction to transducers and Resistive transducers		
Introduction to transducers-Classification, Performance Characteristics, Errors in Measurement, Calibration, and Standards. **Resistive Transducers**- Resistance thermometers, Hotwire resistance transducers, Resistive displacement transducers, Resistive strain transducers, Resistive pressure transducers, and Resistive moisture transducers.	**Understand**	**8**
Module-2: Inductive, capacitive transducers, signal conditioning & Data acquisitions		
Inductance Transducers-Self generating type and passive type. **Capacitive Transducers**-Using a change in the area of plates, change in distance between the plates. Capacitive tachometers. **Signal Condition, Data Acquisition Systems, Conversions:** Functions of Signal Conditioning Equipment, Objectives and Configuration of Data Acquisition System, Data Conversion.	**Understand**	**8**
Module-3: Active Electrical Transducers		
Thermoelectric Transducers-Common thermoelectric phenomena, Common thermos-couple systems. **Piezoelectric Transducers**-Piezo electric materials-Phenomenon, Materials, Piezoelectric Force Transducers, Piezoelectric Strain Transducers Piezoelectric Torque Transducers, Piezoelectric Pressure Transducers, Piezoelectric Acceleration Transducers. **Hall-effect transducers**-Principle, Applications, **Photoelectric transducers**-Phenomenon, Photoconductive Transducers, Photovoltaic Transducers, Photo Emissive Transducers.	**Understand**	**8**
Module-4: Developments in sensors technology		
Smart sensors-Definition and configuration, **Microsensors**-micro size microphone, inertial sensors, Hall Effect sensor, **IR radiation Sensors**- Basics, Thermal Detectors, Quantum detectors, IR thermometry. **Ultrasonic sensors**-Basics, Sensing system, Ultrasonic flow meters, Doppler flowmeter. **Chemical sensors**-Introduction Semiconductor Gas detectors, Ion selective electrodes,	**Understand**	**8**

Conductometer sensors, Mass sensors.		
Module-5: Measurement of Non – Electrical Quantities		
Pressure Measurement, Temperature Measurement, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Flow Metes. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level. Measurement of viscosity.	**Understand**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Explain the need for transducers, their classification, advantages, and disadvantages
2. Explain the working of various transducers and sensors.
3. Outline the recent trends in sensor technology and their selection.
4. Analyze the signal conditioning and signal conditioning equipment
5. Illustrate different configurations of the Data Acquisition System and data conversion.
6. Explain the measurement of non-electrical quantities -temperature, flow, speed, force, torque, power, and viscosity

Reference Books:

1. D.V.S. Murty, "Transducers and Instrumentation", Prentice Hall India
2. Electrical and Electronic Measurements and instrumentation, R.K Rajput, S.Chand,3rd Edition, 2013.
3. D. Patranabis, ―Sensors and Transducers‖, 2nd Edition, Prentice Hall of India, 2010.
4. Shawhney A. K. "A Course in Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai& Sons, 11th Ed., 1999
5. A course in electronics and electrical measurement and instrumentation, J.B Gupta, Katson books, 13th edition,2008

Semester: VI		
Course Name: Fundamentals of Electric and Hybrid Electric Vehicles (Professional Elective Course) **Course Code: 22EEE1653**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 hours**	
Course Learning Objectives: ❖ To Understand the fundamental laws and vehicle mechanics. ❖ To Understand working of Electric Vehicles and recent trends. ❖ Ability to analyze different power converter topology used for electric vehicle application. ❖ Ability to develop the electric propulsion unit and its control for application of electric vehicles ❖ To understand different energy storage systems used in electric vehicles.		
Pre-Requisites:		
	Bloom's Level	**Hours**
Module-1: Fundamentals of Electric and Hybrid Vehicles		
Introduction: Electric Vehicles, Hybrid Electric Vehicles, Electric and Hybrid Vehicle components, Electric Motor and Engine ratings, Recent EVs and HEVs, EV/ICEV Comparison, Electric Vehicle Market. **Vehicle Dynamics**: Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion power, Force-Vehicle Characteristics, Maximum Gradability, Velocity, and acceleration Constant, Level Road, Vehicle profile, Distance traversed, Tractive power Energy requirement.	**Understand**	**08**
Module-2: Electric and Hybrid Electric Vehicles		
Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption. Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains (Excluding classification).	**Understand**	**08**
Module-3: Energy storage for EV and HEV		
Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, Proton Exchange Membrane Fuel Cell (PEMFC) and its operation, Modelling of PEMFC, Supercapacitors.	**Understand**	**08**
Module-4: Electric Propulsion		
Introduction, Dc motor Drives, the principle of operation, speed control using armature voltage, and field control method, and Chopper control of DC motors. Induction motor drives, basic operation principles of induction motors, constant volt/Hertz control. Permanent Magnet BLDC Motor Drives, Basic principles of BLDC Motor Drives, BLDC Machine Construction, and Classification.	**Understand**	**08**
Module-5: Design of Electric and Hybrid Electric Vehicles		

Series Hybrid Electric Drive Train Design: Introduction, Operating patterns, control strategies, Maximum State Of Charge of Peaking Power Source Control Strategy, Engine On–Off or Thermostat Control Strategy, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS **Parallel Hybrid Electric Drive Train Design:** Control strategies of parallel hybrid drive train, Maximum SOC-of-PPS Control Strategy, Engine On–Off (Thermostat) Control Strategy, Constrained Engine On–Off Control Strategy, Fuzzy Logic Control Technique	**Understand**	**08**

Course Outcomes: After the completion of the course the students will be able to:

1. Explain the roadway fundamentals, laws of motion, vehicle mechanics, and propulsion system design.
2. Explain the working of electric vehicles and hybrid electric vehicles in recent trends.
3. Model batteries, Fuel cells, PEMFC, and supercapacitors.
4. Analyze DC and AC drive topologies used for electric vehicle applications.
5. Develop the electric propulsion unit and its control for the application of electric vehicles.

Reference Books:

1. Electric and Hybrid Vehicles: Design Fundamentals Iqbal Husain CRC Press, third Edition.
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design M. Ehsani, Y. Gao, S.Gay and Ali Emadi CRC Press 2005

Web links and Video Lectures:

- https://nptel.ac.in/courses/108106170

Semester: VI			
Course: Embedded Systems (Professional Elective Course) **Course Code: 22EEE1654**			
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA**	**:**	**50**
Credits: 03	**SEA**	**:**	**50**
Hours: 40	**SEA Duration**	**:**	**03 Hours**

Course Learning Objectives: The students will be able to

- Understand fundamental concepts of design principles of embedded system
- Learn about the software aspects of Embedded systems.
- Learn about the Hardware aspects of Embedded systems.
- Under the RTOS-based design of the embedded system.

Prerequisites: --

	Bloom's Level	Hours
Module-1: Introduction to Embedded System		
Definition of Embedded Systems, Embedded Systems Vs General Computing Systems, History and Classification of Embedded Systems, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems. Embedded System-Application and Domain-Specific case studies.	**Understand**	**8**
Module-2: The Typical Embedded System		
The core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Interfacing techniques, Memory Shadowing, Memory shadowing, Memory selection for Embedded Systems, Communication Interface: Onboard and External Communication Interfaces, Other system components: Reset Circuit, Brown-out Protection circuit, Real-Time clock, Watch-dog timer, Sensors and Actuators	**Understand**	**8**
Module-3: Embedded Firmware Design and Development		
Embedded Firmware Design, Embedded Firmware Development Languages, Hardware Software Co-design and Program Modelling: Fundamental Issues, Computational Models in Embedded Design. Introduction to unified Modelling Language (UML), Programming in Embedded C, hardware-software trade-offs	**Understand**	**8**
Module-4: RTOS-Based Embedded System Design		
Operating System basics, Types of Operating Systems, Tasks, Processes, Threads, Multiprocessing and Multi-tasking, Task Scheduling, Threads-Processes-Scheduling putting them together, Task Communication, Task Synchronization, Device Drivers, how to choose an RTOS, Qualities of good RTOS	**Understand**	**8**
Module-5: Testing, Debugging Techniques, and Tools		
Integration and testing of embedded hardware, Testing Method, Debugging Techniques, Laboratory Tools, and Target hardware Debugging. Design Case Studies: Battery-operated smart card reader, Automated meter reading system, Digital camera.	**Understand**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Understand the fundamental concepts of embedded system
2. Understand the various hardware components used in embedded systems.
3. Apply software aspects and programming concepts to the design of Embedded System.
4. Understand different concepts of RTOS, sensors, memory interface, communication interface
5. Discuss testing, debugging, and tools used in embedded systems.
6. Case studies on embedded design and development for real-world applications

Reference Books:

1. Introduction to Embedded Systems, Shibu K V ,Tata McGraw Hill Education Private Ltd, New Delhi, Sixth Reprint,2012.
2. Embedded Systems: Architecture, Programming and Design, Raj Kamal, Third Edition, Tata McGraw Hill Education Private Ltd, New Delhi.
3. Embedded Systems: An integrated approach, Lyla B Das, Pearson India, Education Services Pvt.Ltd,2017.

Semester: VI			
Course: Introduction to UNIX Programming (Professional Elective Course) **Course Code: 22EEE1655**			
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA**	**:**	**50**
Credits: 03	**SEA**	**:**	**50**
Hours: 40	**SEA Duration**	**:**	**03 Hours**
Course Learning Objectives: The students will be able to ❖ Interpret the features of UNIX and basic commands. ❖ Demonstrate different UNIX files and permissions. ❖ Implement shell programs. ❖ Explain UNIX process, IPC and signals			
Prerequisites:			
	Bloom's Level		**Hours**
Module-1: Introduction			
Introduction, Brief history. Unix Components/Architecture. Features of Unix. The UNIX Environment and UNIX Structure, Posix and Single Unix specification. The login prompt. General features of Unix commands/command structure. Command arguments and options. Understanding of some basic commands such as echo, printf, ls, who, date, passwd, cal, Combining commands. Meaning of Internal and external commands. The type command: knowing the type of a command and locating it. The man command knowing more about Unix commands and using Unix online manual pages.	**Understand**		**8**
Module-2: Unix files.			
Unix files. Naming files. Basic file types/categories. Organization of files. Hidden files. Standard directories. Parent child relationship. The home directory and the HOME variable. Reaching required files- the PATH variable, manipulating the PATH, Relative and absolute pathnames. Directory commands – pwd, cd, mkdir, rmdir commands. The dot (.) and double dots (..) notations to represent present and parent directories and their usage in relative path names. File related commands – cat, mv, rm, cp, wc and od commands. File attributes and permissions and knowing them. The ls command with options.	**Understand**		**8**
Module-3: The vi editor			
The vi editor. Basics. The .exrc file. Different ways of invoking and quitting vi. Different modes of vi. Input mode commands. Command mode commands. The ex mode commands. Illustrative examples Navigation commands. Repeat command. Pattern searching. The search and replace command. The set, map and abbr commands. Wild cards and file name generation. Removing the special meanings of wild cards. Three standard files and redirection. Connecting commands: Pipe. Splitting the output: tee. Command substitution	**Understand**		**8**
Module-4: Shell programming			
Shell programming. Ordinary and environment variables. The .profile. Read and read only commands. Command line arguments. exit and exit status of a command. Logical operators for	**Understand**		**8**

conditional execution. The test command and its shortcut. The if, while, for and case control statements. The set and shift commands and handling positional parameters. The here (<<) document and trap command. Simple shell program examples.		
Module-5: Meaning of a process.		
Meaning of a process. Mechanism of process creation. Parent and child process. The ps command with its options. Executing a command at a specified point of time: at command. Executing a command periodically: cron command and the crontab file. Signals. The nice and nohup commands. Background processes. The bg and fg command. The kill command. The find command with illustrative example. Structure of a perl script. Running a perl script. Variables and operators. String handling functions. Default variables - $_ and $. – representing the current line and current line number.	**Understand**	**8**

Course Outcomes: After completing the course, the students will be able to

1. Explain Unix Architecture, File system and use of Basic Commands
2. Illustrate Shell Programming and to write Shell Scripts
3. Categorize, compare and make use of Unix System Calls
4. Build an application/service over a Unix system.

Reference Books

1. Sumitabha Das., Unix Concepts and Applications., 4thEdition., Tata McGraw Hill (Chapter 1,2 ,3,4,5,6,8,13,14)
2. W. Richard Stevens: Advanced Programming in the UNIX Environment, 2nd Edition, Pearson Education, 2005 (Chapter 3,7,8,10,13,15)
3. Unix System Programming Using C++ - Terrence Chan, PHI, 1999. (Chapter 7,8,9,10)
4. M.G. Venkatesh Murthy: UNIX & Shell Programming, Pearson Education.
5. Richard Blum , Christine Bresnahan : Linux Command Line and Shell Scripting Bible, 2ndEdition, Wiley,2014.

Department of Electrical and Electronics Engineering

Semester: VI	
Course Name: Principles of Fuzzy Logic (Professional Elective Course) **Course Code: 22EEE1656**	
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA Marks: 5 0**
Credits: 3	**SEA Marks: 50**
Hours: 40	**SEA Duration: 3 Hours**

Course Learning Objectives:

- To understand the fundamentals of Neural Network
- To understand the fundamentals of Fuzzy Logic
- To understand the implementation of Artificial Intelligence for distance protection in Transmission systems and maximum power tracking in PV system
- To understand the application of Artificial Intelligence in Electric Vehicles

Pre-Requisites: Fundamental concepts of Mathematics, logical operators, familiarity with classical set theory, decision making for conditions with uncertainty, programming skills(MATLAB).

Course Outcomes: After the completion of the course the students will be able to:

- To discuss the fundamentals of Fuzzy set theory, Operations and Membership functions.
- To explain the various Fuzzy arithmetic operators and Fuzzy relations
- To discuss the functioning of Fuzzy Inference System
- To explain the working of Mamdani, Larsen and Tsukamoto Fuzzy Learning Models.

	Bloom's Level	Hours
Module-1: Fundamentals of Fuzzy set theory and Operations		
Introduction to Fuzzy system theory, Real Life Applications of Fuzzy System. Block diagram of Fuzzy system, Transition from Classical set to Fuzzy set, Comparison Classical set and Fuzzy set, mathematical representation of Fuzzy sets, Representation of Fuzzy sets with suitable examples. Fundamental commands used in Fuzzy set theory, normal and sub-normal fuzzy set, normalization of a fuzzy set, Definition of terminologies of fuzzy set theory, Properties of Fuzzy sets	**Understand**	**08**
Module-2: Fuzzy Membership functions		
Basics of fuzzy membership functions, various type of membership functions, triangular membership function, trapezoidal membership function, Gaussian membership function, Sigmoid membership function, S-shaped membership function, Illustration with suitable example, MATLAB program code for implementing triangular, trapezoidal, Gaussian and Sigmoid membership function.	**Understand**	**08**
Module-3: Fuzzy arithmetic operators and Fuzzy relations		
Fuzzy numbers- addition, subtraction, Multiplication and Division, complement of Fuzzy sets, Sugeno's and Yager's class of complement, operator of fuzzy sets: T-norm, S-norm. Representation from Crisp to Fuzzy Relation with suitable example, operators of Fuzzy relation: Union, Intersection, Complement and Containment, properties of Fuzzy relations: Law of Contradiction, Law of Excluded Middle, Law of Idempotency, Involution, Absorption of Complement, Commutativity, Associativity and Distributivity.	**Understand**	**08**

Module-4: Fuzzy Inference System		
Introduction to Fuzzy Inference system, Fuzzification and De-Fuzzification, Fuzzy reasoning: Single rule with single antecedent, Single rule with multiple antecedent, Multiple rule with multiple antecedent.	**Understand**	**08**
Module-5: Fuzzy Learning Models		
Classification of Fuzzy rule based models, Mamdani Fuzzy model, Larsen Fuzzy model, Tsukamoto Fuzzy Model, Max-Min composition for Single rule with single antecedent, Single rule with multiple antecedent, Multiple rule with multiple antecedent.	**Understand**	**08**

Course Outcomes: After the completion of the course the students will be able to:

1. To Understand the fundamentals of Fuzzy set theory, Operations and Membership functions.
2. To understand various Fuzzy arithmetic operators and Fuzzy relations
3. To understand the working of Fuzzy Inference System
4. To understand the working of Mamdani, Larsen, and Tsukamoto Fuzzy Learning Models.

Reference Books:

1. Ross, T. J. (2005), "Fuzzy logic with engineering applications," John Wiley & Sons.
2. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing" Prentice Hall.

Web links and Video Lectures:

https://onlinecourses.nptel.ac.in/noc22_ee21/preview
https://www.youtube.com/playlist?list=PLFW6lRTa1g81F7CJ-CdlsyWKKAa43T62j

Semester: VI		
Course: STRATEGIC MANAGEMENT (Professional Elective Course) **Course Code: 22EEE1657**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA : 50**	
Credits: 03	**SEA : 50**	
Hours: 40	**SEA Duration : 03 Hours**	

Course Learning Objectives: The students will be able to

- To provide a framework for students to understand strategic management concepts and conduct external analysis for competitive advantage.
- To help students understand the different strategy options available for organizations in a complex and dynamic environment
- To acquaint students with essential factors in strategy implementation
- To provide basic understanding of how to establish and exert strategic control

Prerequisites: Nil

	Bloom's Level	Hours
Module-1: Introduction		
Module-1: Introduction to Strategic Management and External Analysis Meaning and Characteristics of Strategic Management; The Strategic Management Process. **External Analysis**– PESTLE analysis, Environment Threat and Opportunity Profile (ETOP); Industry Analysis –Porter's Dominant Economic Features, Porter's Five Forces Model, Strategic Group Mapping; Industry Key Success Factors, Key Performance Indicators and Key Result Areas.	Understand	8
Module-2: Internal Analysis		
Strategic Vision, Mission, Goals, Long-Term and Short-Term Objectives and their Value to the Strategic Management Process; Organizational Capability Profile – Resource Based View of the firm (RBV) and VRIN; Business Portfolio Analysis – BCG / Growth Share Matrix, GE 9 Cell Model; Balanced Score Card, SWOC Analysis, Value Chain Analysis, Benchmarking.	Understand	**8**
Module-3: Strategy Formulation		
Corporate Strategies: Growth Strategies – Internal Growth, External Growth (Integration, Diversification, Mergers, Joint Ventures, Strategic Alliances), Product/Market Expansion grid / Ansoff's Matrix; Stability Strategies – No Change, Profit and Proceed with Caution.	Understand	**8**
Module-4: Strategy Implementation		
Facilitators for implementation of the strategy: Organisational Structures – matching structure to strategy, McKinsey's 7S, Changing structure and processes (Business Process Reengineering, Six Sigma); Strategic Leadership; Organisational Culture – Learning organizations, MBO, TQM.	Understand	**8**
Module-5: Strategic Control		
Focus of Strategic Control, Establishing Strategic Controls (Premise Control, Strategic Surveillance, Special Alert Control, Implementation Control), and Exerting Strategic Control (through Competitive Benchmarking, Performance and Formal and Informal Organisations).	Understand	**8**

Course Outcomes: After completing the course, the students will be able to

1. Understand strategic management concepts and how to conduct external analysis for competitive advantage
2. Apply selected models of internal analysis to evaluate an organization.

3. Understand and analyze the different strategy options available for organizations in a complex and dynamic environment.
4. Appreciate the essential factors in strategy implementation
5. Understand how to establish and exert strategic control.
6. Understand and analyse blue and red ocean strategies crafted and executed by Organizations

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Crafting and Executing Strategy: The Quest for Competitive Advantage – Concepts and Cases	Arthur A. Thompson Jr. Margaret A. Peteraf John E. Gamble A. J. Strickland III Arun K. Jain	McGraw Hill Education	19th Ed, 2017
2	Contemporary Strategy Analysis	Robert M Grant	Wiley	11th Ed, 2021
3	Contemporary Strategic Management	Robert M Grant	Wiley	India 6th Ed, 2011
4	Strategic Management: A South Asian Perspective	Michael A. Hitt R. Duane Ireland Robert E. Hoskisson S. Manikutty	Cengage Learning	9th 2016
5	Strategy: Theory & Practice	Stewart Clegg,Chris Carter Marting Kornberger Jochen Schweitzer	Sage Publications	3rd Ed, 2020
6	Strategy Management: Theory & Practice	John Parnell	Biztantra	2004
7	Strategic Management: Planning for Domestic and Global Competition	John A. Pearce	Robinson McGraw Hill Education	14th Ed, 2015

Semester: VI		
Course Name: PLC and SCADA (Open Elective) **Course Code: 22EEE1671**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 03 Hours**	

Course Learning Objectives: The student should be able to

- Gain the Knowledge of various skills necessary for Industrial applications of Programmable logic controller (PLC)
- Understand the basic programming concepts and various logical Instructions used in Programmable logic controller (PLC)
- Solve the problems related to I/O module, Data Acquisition System and Communication Networks using Standard Devices.
- Design and analysis of general structure of an automated process for real time applications using Programmable logic controller (PLC) and SCADA

Pre-Requisites:

	Bloom's Level	**Hours**
Module-1: Programmable logic controllers (PLCs): An Overview		
Introduction, Definition and history of the plc, Manufacturing and Assembly processes, PLC advantages and disadvantages, overall PLC system, CPUs and programmer/monitors, PLC input and output modules, PLC as a computer, the central processing unit, solid state memory, the processor, I/O modules(Interfaces), power supplies.	**Understand**	**8**
Module-2: PLC Programming procedures and devices		
Programming Equipment, Programming Formats, Proper construction of PLC Ladder diagrams, Process Scanning considerations, PLC operation faults PLC input instructions, Output: Coils, Indicators and others, Operational Procedures, Contacts and coils Input / Output programming Examples, A look at fail-safe circuits, Ladder diagram and sequence listing, Large Process Ladder diagram construction, Flowcharting as a Programming method	**Understand**	**8**
Module-3: Number systems and conversion functions		
PLC Addition and subtraction, PLC repetitive clock, PLC multiplication, Division and square root, PLC trigonometric and Log functions, PLC basic comparison functions and its applications, PLC advanced comparison functions**,** Decimal, Binary and BCD, PLC Conversion between decimal and BCD, Octal and Hexadecimal Numbering systems.	**Understand**	**8**
Module-4: Ladder diagram: Digital gates, Timer and Counter Functions		
PLC timer functions, Examples of Timer Functions Industrial Applications, Industrial Process Timing Application, PLC counters, Examples of counter function Industrial Applications Digital Logic gates, Boolean Algebra PLC programming, Conversion Examples	**Understand**	**8**
Module-5: SCADA SYSTEMS		
Introduction, definition and history of Supervisory Control and Data Acquisition, typical SCADA System Architecture, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture (First generation- Monolithic, Second Generation-		

Distributed, Third Generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System and Chemical Plant	**Understand**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Understand the basic knowledge of Programmable Logic Controller domain on Various Advanced Logical Instruction, I/O Module, Sensor, Actuator, Communication and Measurement System.
2. Understand the basic knowledge of Programmable Logic Controller programming and ladder diagram procedures
3. Understand the basic programming concepts, various logical Instructions and conversion systems used in Programmable logic controller (PLC).
4. Compute the extent and nature of electronic circuitry in Programmable logic controller (PLC) and SCADA including monitoring and control circuits for Communication and Interfacing.
5. Design and analyze the general structure of an automated process for real time industrial applications

Reference Books:

1. John W Webb, Ronald A Reis,"Programmable Logic Controllers : Principles and Application", PHI Learning, New Delhi, 5 th Edition
2. Ronald L Krutz, "Securing SCADA System", Wiley Publication
3. John R Hackworth, Frederick D Hackworth, "Programmable Logic Controllers ", Pearson Eduction,
4. Gary Dunning,"Introduction to Programmable Logic Controllers", Thomson, 2nd Edition
5. Madhu chhandan Gupts and SamarjitSen Gupta "PLC and Industrial application",pernram international publication. (Indian) Pvt. Ltd., 2011
6. Stuart A Boyer, "SCADA Supervisory Control and Data Acqusition", ISA, 4 th Revised edition.

Web links and Video Lectures:

1. https://www.udemy.com/course/scada-from-scratch-to-hero-indusoft-and-tia-portal/
2. https://instrumentationtools.com/
3. https://www.technicalsymposium.com/

Semester: VI			
Course Name: Fuel Cell Technology (Open Elective) **Course Code: 22EEE1672**			
Teaching Hours/Week (L:T:P:J): (3:0:0:0)		**CIA Marks: 5 0**	
Credits: 3		**SEA Marks: 50**	
Hours: 4		**SEA Duration: 3 Hours**	
Course Learning Objectives:			
❖ To understand the principle of operation of Fuel cells ❖ To understand the Fuel Cell modeling ❖ To understand the control strategy of Hybrid Fuel Cell Power system ❖ To study different types of Fuel Cells. ❖ To understand the control strategy and parametric design of Fuel cells ❖ To understand the Power Electronics Interface of Fuel Cell.			
Pre-Requisites:			
		Bloom's Level	**Hours**
Module-1: Fuel Cells			
Operation Principle of Fuel Cells, Electrode Potential and current- voltage curve, Fuel and oxidant consumption, Fuel cell system characteristics, Fuel Cell Technologies, Fuel Supply, Non-Hydrogen Fuel Cells. (R1)		**Understand**	**08 Hrs**
Module-2: Fuel Cells Energy Storage System			
Introduction to Fuel Cells, Fuel Cell Modeling, Hybrid Fuel Cell Energy Storage systems, Control Strategy of Hybrid Fuel Cell Power system. (R2)		**Understand**	**08 Hrs**
Module-3: Fuel Cells HEV Energy Storage System			
Introduction. Batteries: Ideal Model, Linear Model and Thevenin Model, Electrical Modeling of Ultracapacitors : Double Layer UC Model , Battery/UC Hybrid Model, Electrical Modeling of Flywheel Energy Storage Systems, Operating Principle of a Fuel Cell :Detailed Electrical Modeling of Renewable Fuel Cell Power Sources(R4)		**Understand**	**08**
Module-4: Fuel Cell Hybrid Electric Drive train Design			
Concept of HEV,Working Principle of an HEV Drive Train, Power train configuration, Power Component modeling, Fuel cell system, Concept of Fuel Cell Plug-in HEV – Architecture (R4) Configuration, Control Strategy, Parametric Design, Design Example (R1)		**Understand**	**08**
Module-5: Fuel Cell Applications			
Fuel Cells for Aircraft Applications, Fuel Cells for commercial, Military and Space Applications, Fuel cells capable of operating in Ultra-High Temperature environments and for Electric Power Plant Applications.		**Understand**	**08**
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the principle of operation of fuel cells. 2. Learn the different types of Fuel cells 3. Understand Fuel Cells HEV Energy Storage System and modelling 4. Understand the control strategy and parametric design of Fuel cell Hybrid Electric Vehicle			

5. Understand the applications of Fuel Cell Technology in the field of Air craft, Space, Military and Ultra High temperature environments.

Reference Books:

1. "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", Mehrdad Ehsani, Yimin Gao, Stefana Longo, Kambiz Ebrahimi, Third Edition, CRC Press, Taylor & Francis Group, 2018.
2. "Hybrid Electric Vehicles: Principles and applications with Practical Perspectives", Chris Mi, Abul Masrur David Wenzhong Gao, Wiley Publication,
3. "Fuel Cell Fundamentals", Ryan O'Hayke, Suk-won Cha, Whitney Colella, Fritz B Prinz, 3rd Edition, Wiley.
4. "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Sheldon S. Williamson, Springer, 2013.
5. 'Next-Generation Batteries and Fuel Cells for Commercial, Military and Space Applications", A. R.Jha, CRC Press, 1st Edition, 2012.

Department of Electrical and Electronics Engineering

Semester: VI		
Course Name: Industrial Motor control and Automation (POE) **Course Code: 22EEE1673**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 03 Hours**	
Course Learning Objectives: The student should be able to		
❖ To understand the safety in industrial workplace, grounding and electric symbols ❖ To analyze the DC and AC motor drive concepts ❖ To understand and analyze the operation of PLC and industrial automation		
Pre-Requisites: Fundamentals of magnetism, motors and digital logic circuits,		
	Bloom's Level	**Hours**
Module-1: Safety in the Industrial Workplace and understanding Electrical Drawings		
Protecting against Electrical Shock, Electrical Shock, Arc Flash Hazards, Personal Protective Equipment Grounding—Lockout—Codes, Grounding and Bonding, Lockout and Tagout, Electrical Codes and Standards Symbols—Abbreviations—Ladder Diagrams, Motor Symbols, Abbreviations for Motor Terms, Motor Ladder Diagrams	**Understand**	**8**
Module-2: Motor Terminal connections and DC motor drives		
Motor Terminal Connections, Motor Classification, DC Motor Connections, AC Motor Connections **Motor working principle,** Magnetism, Electromagnetism, Generators, Motor Rotation, Direct Current Motors, Permanent-Magnet DC Motor, Series DC Motor, Shunt DC Motor, Compound DC Motor, Direction of Rotation, Speed Regulation, Varying DC Motor Speed, DC Motor Drives	**Understand**	**8**
Module-3: AC motor drives, motor selection and motor installation		
Alternating Current Motor Drives: Variable-Frequency Drive, Inverter Duty Motor, **Motor Selection,** Mechanical Power Rating-Current, Code Letter, Design Letter, Efficiency, Energy-Efficient Motors, Frame Size, Frequency, Full-Load Speed, Load Requirements, Motor Temperature Ratings, Duty Cycle, Torque, Motor Enclosures, Metric Motors, **Motor Installation:** Foundation, Mounting, Motor and Load Alignment, Motor Bearings, Electrical Connections, Grounding, Conductor Size, Voltage Levels and Balance, Built-in Thermal Protection	**Understand**	**8**
Module-4: Programmable Logic Controllers and future of PLC		
Programmable Logic Controllers (PLCs), PLC Sections and Configurations, Ladder Logic Programming, Programming Timers, Programming Counters. **Future of PLC:** PLC-Based Automation, PLC and Programmable Automation Controller, Unified Human-Machine Interface, Plug and Play Solution, Wireless Link of PLC, Enterprise Resource Planning with PLC, Industrial Internet of Things and PLC	**Understand**	**8**
Module-5: Industrial process automation		
Industrial Process Automation: Definition of Process, Meaning of Automation and Control, Necessity and Evolution of Automation, Role of Automation in Process Industry, Architecture of Industrial Automation Network, Types of Automation Systems, Role of Information Technology in Process Automation, Process Automation with Smart and Intelligent Instruments, Challenges of Process Automation, Industry 1.0 to Industry 4.0	**Understand**	**8**
Course Outcomes: 1. Discuss the safety in industrial workplace, grounding and electric symbols		

2. Explain the motor terminal connections, motor working principle and speed control of DC motor drives
3. Explain the concept of AC drives, motor selection, installation
4. Analyze the operation of PLC and industrial internet of things
5. Analyze the industrial automation and Industry 4.0

Reference Books:

1. Electric Motors and Control Systems, Frank D. Petruzella, McGraw-Hill Education, 2016 **(Module 1, 2, 3 and 4)**
2. Industrial Automation Technologies, Chanchal Dey and Sunit Kumar Sen, 2020 Taylor & Francis Group, LLC CRC Press **(Module 4 and 5)**
3. Programmable Logic Controllers, Khaled Kamel & Eman Kamel, 2014 by McGraw-Hill Education

Web links and Video Lectures:

1. https://youtu.be/zsajTNtxfAE
2. https://youtu.be/DfW0qISkvqo
3. https://youtu.be/m5KS0fS1VNc
4. https://youtu.be/bNfZWqDLW0Q
5. https://youtu.be/Fj02iTrWUx0

Semester: VI		
Course Name: Solar Photovoltaic Systems (Professional Elective Course) **Course Code: 22EEE1674**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 hours**	
Course Learning Objectives:		
❖ To understand the position of Photovoltaics in World Energy Scenario ❖ To understand the concept, working of solar cells ❖ To discuss about the series and parallel connection of solar cells into modules and its repercussion onto mismatching ❖ To discuss about the connection of Photovoltaic system and its applications		
Pre-Requisites: Basic knowledge of Physics, Renewable Energy Sources, Power Electronics.		
Module-1: Place of PV in World Energy Scenario	**RBT**	**Hrs**
World energy requirement, Need for Sustainable Energy Sources, Sustainable Sun's Energy, Current Status of Renewable Energy Sources, Place of Photovoltaics in Energy Supply, World Production of Solar PV modules and cost **R1: PART I: Solar cell fundamentals (1.1 – 1.6)**	**Understand**	**08**
Module-2: Solar Radiation and Solar Cells	**RBT**	**Hrs**
Solar Radiation: The Sun and the Earth – extra-terrestrial solar radiation, solar spectrum at the earths surface, The Sun-Earth Movement **An Introduction to Solar Cells**: P-N Junction under illumination: Solar Cell – Generation of Photo voltage, Light generated current, I-V Equation of solar cells, Solar Cell characteristics **Design of Solar Cells**: Upper limits of Cell Parameters – Short Circuit current, Open circuit voltage, Fill Factor, Efficiency **R1: PART III: Solar Photovoltaic applications (12.1, 12.2),PART I: 4. An introduction to solar cells (4.4.1 – 4.4.4), 5. Design of solar cells (5.1).**	**Understand**	**08**
Module-3: Solar Photovoltaic Modules	**RBT**	**Hrs**
Solar PV Modules from Solar Cells – series and parallel connection of cells, mismatch in cell/module, Mismatch in series connection – hot spots in the module, bypass diode, Mismatching in parallel connection, Design and structure of PV Modules – number of solar cells in a module, wattage of modules, fabrication of PV modules, PV Module Power output – I-V equation of PV modules, rating of PV modules, I-V and power curve of module, effect of solar irradiation, effect of temperature **R1: PART III: 13. Solar Photovoltaic modules (13.1 – 13.5)**	**Understand**	**08**
Module-4: Balance of Solar PV Systems	**RBT**	**Hrs**
Batteries for PV System – lead acid batteries, Ni-CD batteries, Comparison of batteries, DC to DC Converters – Buck type, Boost type, Buck-boost type DC-DC Converters, Charge Controllers – commonly used set points, types of charge controllers, DC to AC Converter – single phase, three phase DC to AC Converter. **R1: PART III: 14. Balance of Solar PV systems (14.3, 14.4, 14.5, 14.6)**	**Understand**	**08**
Module-5: Photovoltaic System and Applications	**RBT**	**Hrs**
Introduction to Solar PV Systems, Stand-alone PV System Configuration – Type a,b,c,d,e, Wire sizing in PV Systems, Precise sizing of PV Systems, Hybrid PV Systems – Why hybrid systems?, types of Hybrid PV systems, issues with hybrid systems, Grid-Connected PV Systems **R1: PART III: 15. Photovoltaic system design and Applications (15.1, 15.2, 15.4, 15.5, 15.6,**	**Understand**	**08**

15.7)		

Course Outcomes: After the completion of the course the students will be able to:

1. Discuss about the requirement and production of Photovoltaic in world energy scenario
2. Understand the concepts on sun-earth angles, movement and will be able to study the characteristics of solar cells
3. Enumerate the connection of solar cells into modules
4. Understand the balance of system which includes all the components of a photovoltaic system with the exception of photovoltaic panels
5. Discuss difference between stand alone, grid connected PV system and its applications

Reference Books:

1.Chetan Singh Solanki, SOLAR PHOTOVOLTAICS Fundamentals, Technologies and Applications, PHI Learning, Pvt Ltd, Third Edition

2. Dr. Sundaravadivelu S , Solar Photovoltaic Power Systems : Principles Design And Applications, ISBN: 9781642497090

Web links and Video Lectures:

- https://archive.nptel.ac.in/courses/115/107/115107116/
- https://archive.nptel.ac.in/courses/117/108/117108141/

BNM Institute of Technology

Syllabus for Employability Skills-2

SEMESTER – VI

Subject Name	Employability Skills-2 (Technical)	**Weekly Assignments(6 tests)**	Max 10 Min 4
Subject Code	22XXX168	**Evaluation on Resume Building & Etiquettes**	Max 10 Min 4
Number of Contact Hours/Week	2	**Evaluation on Group Discussion & Personal Interviews**	Max 15 Min 6
		Final Company Specific Assessment	Max 15 Min 6
Total Number ofContact Hours	24	**Credits**	1
Industry Readiness hands on Courses (12 hrs)	Tableau and Power BI, Cloud Computing & AWS - fundamental AWS concepts related to compute, database, storage, networking, monitoring, and security with AWS hands-on course experiences		
	Industrial Automation 4.0		
	Competitive Coding		
Personality & Grooming Training (2hrs)	Dressing & Group Discussion Etiquettes, Interview Skills, Resume Building (should include introduction to Github, Hackerrank, LeetCode, Codechef), Email & Telephone Etiquettes, Social Media Etiquettes, & LinkedIn Profiling.		
Interview Preparation Training (2hrs)	**<u>Pre-Preparation Formalities</u>** • Training session on Pre-Preparation formalities of Campus Selection should be conducted Job Profiles analysis must be done. • Understanding the salary breakups & other perks, researching about the Company and the work culture through their websites & other digital platforms like Glassdoor & LinkedIn. • Rewriting resumes keeping the job profiles in view. Group Discussion & Personal Interview		

	• Pre-Placement Talk, Mock GD & Personal Interview training sessions for each individual student should be conducted by the Industry Experts and they should brief students on the area of improvements, presentation & behavioural skills required during the campus selection process.
MOCK RECRUITMENT PROCESS (2hrs)	Aptitude test, Coding test, Group Discussions, Personal Interviews by industry personnel,
	Feedback to be shared to each student,
	Shadowing done by students during interviews to learn better.

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical and Electronics Engineering

VII Semester Syllabus

B.N.M. Institute of Technology

An Autonomous Institution under VTU, Approved by AICTE

Department of Electrical and Electronics Engineering

Semester: VII		
Course Name: Engineering Project Management and Finance (Professional Core) **Course Code: 22EEE171**		
Teaching Hours/Week (L:T:P:J) : (3:0:0:0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 Hours**	
Course Learning Objectives: ❖ To provide basic knowledge of project planning and decision making in project management. ❖ To help students to understand the project risk assessment process. ❖ To facilitate students to develop their acumen in managing multiple project constraints ❖ To provide basic understanding of financial management. ❖ To acquaint students with various sources of project finance.		
❖ **Pre-Requisites: Nil**		
	Bloom's Level	**Hours**
Module-1: Project Planning		
Capital budgeting concepts, objectives and Phases, levels of decision making. Generation and screening of project ideas: Generation of ideas – monitoring the environment – regulatory framework for projects – corporate appraisal – preliminary screening – project rating index (Theory). **Self study:** Application of Artificial Intelligence (AI) or Data Analytics in Project Idea Generation and Capital Budgeting.	**Understand**	**8**
Module-2: Project Risk Assessment		
Types and measure of risk – simple estimation of risk – sensitivity analysis – scenario analysis – Monte Carlo simulation – Decision tree analysis – selection of projects under risk – risk analysis in practice. (Theory). **Self study:** Application of Real-Time Risk Assessment Using IoT.	**Apply**	**8**
Module-3: Multiple Project Constraints		
Constraints – methods of ranking – mathematical programming approach – linear programming model. Qualitative factors in capital budgeting. Judgmental, Behavioural, Strategic and Organizational Considerations. (Theory).). **Self study:** Use Excel Solver for Project Selection Under Budget and Resource Constraints.	**Apply**	**8**
Module-4: Introduction to Project Finance		
Meaning and objectives/ goals of Financial Management; Functions of Financial Management; Interface of Financial Management with other functional areas. Time value of money – Simple interest & Compound interest, Future value of cash flow; Present value of cash flows(Theory).	**Understand**	**8**
Module-5: Project Finance and Project Review		
Financial Analysis: Estimation of cost of project and means of financing, Project cash flows: Appraisal criteria: Net Present Value – benefit cost ratio – internal rate of returns urgency – payback period – accounting rate of returns – investment appraisal in practice. Project Review and Administrative Aspect of Project (Theory)	**Apply**	**8**

Self study: Create a 5-year cash flow model for an engineering project (e.g., solar plant, bridge construction) and use Excel to calculate NPV and IRR to assess project viability.		

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

1. Understand the project planning process.
2. Apply their understanding of project risk assessment into practice.
3. Demonstrate their acumen in managing multiple project constraints
4. Understand the fundamentals of Financial Management
5. Analyze the various sources of project finance
6. Apply the knowledge of financial aspects of project management and review.

Reference Books

Sl . No.	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Project Planning: Analysis, Selection, Implementation and Review	Prasanna Chandra	7/e, TMH	2011
2	Project Management and Control	Narendra Singh	HPH	2003
3	Project Management	Bhavesh M. Patel	Vikas Publication	2/e
4	Project Management for Business and Technology: Principles and Practice	Nicholas, John M	Pearson	2/e
5	Project Management: The Managerial Process	Gray& Larson	Tata McGraw-Hill	4/e, 2011.
6	Project Management	Choudhury	Tata McGraw-Hill	1/e

Department of Electrical and Electronics Engineering

Semester: VII		
Course Name: Electrical Estimation and Costing (Professional Elective Core Course) **Course Code: 22EEE1721**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA Marks:50**	
Credits:3	**SEA Marks:50**	
Hours:40	**SEA Duration: 03 hours**	
Course Learning Objectives:		
Course Learning Objectives: • To discuss the purpose of estimation and costing, market survey, estimates, purchase enquiries, tenders, comparative statement and payment of bills and Indian electricity act and some of the rules. • To discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories, fittings and fuses. • To discuss design of lighting points and its number, total load, sub-circuits, size of conductor. • To discuss different types of service mains and estimation of power circuits. • To discuss estimation of overhead transmission and distribution system and its components. • To discuss main components of a substation, their graphical representation and preparation of single line diagram of a substation.		
Pre-Requisites: Basic Electrical Engineering, Transmission and Distribution, Switch Gear and Protection		
	Bloom's Level	**Hours**
Module-1: Principles of Estimation		
Introduction to Estimation and Costing, Electrical Schedule, Catalogues, Market Survey and Source Selection, Recording of Estimates, Determination of Required Quantity of Material, Labour Conditions, Determination of Cost 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, Types of Tenders General Idea about IE Rule, Indian Electricity(IE) Act and ***Self-study component:*** IE Rules -29,30,45,46,47,50,51,54,55,77 and 79.	**Understand**	**8**
Module-2: Basics of Wiring & Estimation of House Wiring		
Basics of Wiring: Introduction, Distribution of energy in a Building, PVC Casing and Capping, Conduit Wiring, Desirabilities of 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. **House Wiring:** Design of Lighting Points, Number of Points, Determination of Total Load, Number of Sub –Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout. ***Self Study Component*** - General rules for wiring	**Apply**	**8**
Module-3: Estimation of Service Mains		

Introduction, Types, Estimation of Underground and Overhead Service Connections. Design and Estimation of Power Circuits: Introduction, Input Power, Input Current to Motors, Rating of Cables, Rating of Fuse, Size of Condit, Distribution Board Main Switch and Starter. ***Self Study Component -*** Important Considerations Regarding Motor Installation Wiring	**Apply**	**8**
Module-4: Estimation of Overhead Transmission and Distribution Lines:		
Cross Arms, Pole Brackets and Clamps, Guys and Stays, Conductors Configuration Spacing and Clearances, Span Lengths, Lightning Arrestors, Phase Plates, Danger Plates, Anti Climbing Devices, Bird Guards, Beads of Jumpers, Muffs,, Erection of Supports, Setting of Stays, Fixing of Cross Arms, Fixing of Insulators, Conductor Erection. Repairing and Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to Insulator s, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of Overhead Lines, Clearances of Conductor From Ground, Spacing Between Conductors, Important Specifications. ***Self Study Component -***Points to be Considered at the Time of Erection of Overhead Lines	**Apply**	**8**
Module-5: Estimation of Substations		
Main Electrical connection, Graphical Symbols for Various Types of Apparatus and Circuit Elements on Substation main Connection Diagram, Single Line Diagram of Typical Substations, Equipment for Substation, Substation Auxiliaries Supply, ***Self Study Component -*** Substation Earthing.	**Apply**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Explain the fundamental concepts of estimation and costing, wiring systems, service mains, transmission lines, and substations across various applications in electrical engineering.
2. Apply estimation techniques and procedures for electrical scheduling, house wiring systems, and power circuit installations.
3. Develop and implement estimates for overhead transmission lines and electrical substations using standard practices and specifications.
4. Analyze complete electrical installations, comparing material, cost, layout, and design alternatives for effective and efficient implementation.

Reference Books:

1. A Course in Electrical Installation Estimating and Costing J. B. Gupta Katson Books, 9th Edition, 2012
2. Electrical Design Estimating and Costing, K. B. Raina, New Age International Ltd.2017

Semester: VII		
Course Name: Utilization of Electrical Power ((Professional Elective)) **Course Code: 22EEE1722**		
L:T:P:J: (3:0:0:0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 Hours**	

Course Learning Objectives: The Students will be able to

- To discuss Electric heating and Electric welding techniques.
- To explain laws of Electrolysis, techniques of extraction, refining and deposition of metals.
- To discuss systems of electric traction, speed time curves.
- To discuss the motors used for electric traction and their control and braking.
- To discuss power supply for traction systems.

Pre-Requisites:

	Bloom's Level	**Hours**
Module-1: Electric Heating		
Introduction. Modes of transfer of heat. Classification of Electric Heating methods. Resistance heating. Arc furnaces. Induction heating. High-frequency eddy current heating. Dielectric heating. Industrial applications. Illustrative examples. **Self-study component**: Choice of frequency	**Understand**	**8**
Module-2: Electric Welding		
Introduction. Requirements of good weld. Resistance welding. Electric arc welding. Ultrasonic welding. Electron beam welding. Laser beam welding. Power supply for arc welding. AC and DC arc welding. Illustrative examples. **Self-study component:** Comparison between resistance and arc welding	**Understand**	**8**
Module-3: Electrolytic Processes		
Introduction. Principle of electrolysis. Faraday's laws of electro-deposition. Current efficiency. Energy efficiency. Extraction and refining of metals. Electro deposition. Electro plating. Electro typing. Electro facing. Electro polishing. Anodizing. Illustrative examples. **Self study component**: Power supply for electrolytic processes	**Understand**	**8**
Module-4: Electric traction systems		
Introduction. Different systems. Systems of Electric traction. Track electrification. **Electric Traction motors:** General features. From the traction point of view the DC series, shunt and AC series motors. Three-phase induction motors. Linear Induction motor. **Control of traction motors:** Starting and speed control, and braking of DC traction motors. **Self-study component**: Operating characteristics of traction motors.	**Understand**	**8**
Module-5: Power supply for electric traction		
Current collection systems. Overhead current collection for tramways and trolley buses and railways. Location of substations, feeding and distribution systems for traction service. Train movement and energy consumption: Typical speed-time curves, crest speed, average speed and schedule speed. Illustrative examples. Self-study component:Simplified speed-time curves.	**Understand**	**8**

Course Outcomes: After the completion of the course the students will be able to:

1. Explain Electric Heating and Welding processes and applications.

2. Explain the art of extraction, refining and electro-deposition of metals and applications.
3. Explain the systems of Electric traction, and analyse the speed-time curves.
4. Explain the various motors suitable for electric traction and the methods speed control and braking methods.
5. Explain the power supply techniques required for traction systems

Reference Books:

1. Utilization of Electric Power & Electric Traction by J.B Gupta. S K Kataria & Sons.
2. Utilization of Electrical Power by R.K.Pajput. Laxmi Publications Pvt. Ltd.
3. A Text book on Power System Engineering by A.Chakrabarti, M.L.Soni, P.V.Gupta, U.S.Bhatnagar. Dhanpat rai Pub.

Web links and Video Lectures:

SEMESTER : VII			
Course Name: ADVANCED TECHNIQUES IN ELECTRIC VEHICLES (Professional Elective) Course Code: 22EEE1723			
Teaching Hours/Week L:T:P:J: (3:0:0:0)		CIA Marks	50
Credits	03	SEA Marks	50
Hours: 40		Exam Hours	03

Course Learning Objectives:

- To explain IoT Based Battery Management System (BMS) and types of batteries for Hybrid Electric Vehicles (HEV)
- To explain advantages of AI, the use of brushless DC motor and its control in electric vehicle.
- To explain the optimization techniques and control strategies for active magnetic bearing (AMB) system for electric vehicle.
- To explain the modeling and analysis of power converters and hybrid energy storage system foe electric vehicles.

	Bloom's Level	Hours
Module-1		
IoT-Based Battery Management System for Hybrid Electric Vehicle: IoT-Based Battery Management System (BMS) for Hybrid Electric Vehicles (HEV): Introduction, Battery configuration, Types of batteries for HEV and Electric Vehicles (EV), Functional Blocks of Battery Management Systems, **Self study component: IoT-based BMS. Battery pack design for EV vehicles**	Understand	8
Module-2		
Brushless Direct Current Motor Drive Using Artificial Intelligence for Optimum Operation of the Electric Vehicle: Basics of Artificial Intelligence, Advantages of Artificial Intelligence in EV, Brushless DC Motor, Mathematical Representation Brushless DC Motor, Closed-Loop Model of BLDC Motor Drive, PID Controller, Fuzzy Control, Auto-Tuning Type Fuzzy PID Controller, Genetic Algorithm, Artificial Neural Network-Based Controller, BLDC Motor Speed Controller with ANN Based PID Controller, Analysis of Different Speed Controllers, **Self study component: Simulation types, steps involved in implementation of simulation tool for creating Fuzzy Logic Controller [FLC], FLC implemented for the speed control of DC drive.**	Understand	8
Module-3		
Optimization Techniques Used in Active Magnetic Bearing System for Electric Vehicles : Basic Components of an Active Magnetic Bearing (AMB), Active Magnetic Bearing in Electric Vehicles System, **Self study component: Control Strategies for AMB in EVs.**	Understand	8
Module-4		
Small-Signal Modeling Analysis of Three-Phase Power Converters for EV Applications: Introduction, Overall System Modeling, Mathematical Modeling and **Self study component: Analysis of Small Signal Modeling.**	Understand	8
Module-5		
Energy Management of Hybrid Energy Storage System (HESS) in PHEV With Various Driving Mode: Introduction, Problem Description, and Formulation, Modeling of HESS and its Analysis. **Self study component: Analysis of plots of battery and super capacitors**	Understand	8

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

1. Discuss IoT Based Battery Management System and type of batteries for Electric Vehicle [EV] and Hybrid Electric Vehicles [HEV].
2. Explain AI Based BLDC drive for optimum operation of EV
3. Discuss the optimization techniques used in Active Magnetic Bearing [AMB] system for EV
4. Model the three phase converters for EV applications
5. Model the Energy Management of Hybrid Energy Storage System [HESS] in plug in HEV
6. Analyze the series and parallel hybrid EV systems

Sl. No.	Title of the Book [Text Book]	Name of the Author/s	Name of the Publisher	Edition
1	Artificial Intelligent Techniques for Electric and Hybrid Electric Vehicles	Chitra A, P. Sanjeevikumar, and S. Himavathi	Wiley	2020
2	Electric and Hybrid Vehicles: Design Fundamentals 2	Iqbal Husain.	CRC Press,	Third Edition
3	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design	M. Ehsani, Y. Gao, S.Gay and Ali Emadi	CRC Press	2005

Department of Electrical and Electronics Engineering

Semester: VII		
Course Name: Industrial Internet of Things (Professional Elective) **Course Code: 22EEE1724**		
Teaching Hours/Week (L:T:P:J) : (3 : 0 : 0 : 0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 Hours**	
Course Learning Objectives:		
❖ Understand the design requirements and drivers of Industry 4.0 and IIoT ❖ Know the Prerequisites of IIoT ❖ Understand the sustainability assessment and smart business perspective. ❖ Understand the Industrial Internet systems, industrial sensing and processes. ❖ Understand the Business models and Reference architecture of IIoT ❖ Learn various Industrial Data transmission, their features and components. ❖ Understand the Industrial Data acquisition and IIoT Analytics ❖ Understand the advantages of Machine learning and Data science in Industries.		
Pre-Requisites: Internet of Things		
Course Outcomes: After the completion of the course the students will be able to: ❖ To Understand the design requirements and drivers of Industry 4.0 and IIoT for Industrial processes ❖ To Understand the Business models and reference Architecture of IIoT ❖ To Understand the Industrial Data transmission and their features. ❖ To Understand the advantages of using Data Analytics, Machine Learning, Data Science ❖ To understand the application of IIoT in Healthcare		
	Bloom's Level	**Hours**
Module-1: Overview of Industrial IoT and Industry 4.0		
Introduction and overview of Industry 4.0 and IIoT Industry 4.0: Basics – Introduction, Design requirements and Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Cybersecurity, Impacts of Industry 4.0. Industrial IoT: Basics – Industrial Internet systems, Industrial sensing, **Self-study:** Industrial processes,	**Apply**	**08**
Module-2: Business Models and Reference Architecture of IIoT		
Introduction to Business models, Definition of Business model, Business model of IIoT, Reference architecture of IIoT, Key performance indicators for Occupational safety and Health. **Self-study:** IIRA framework	**Apply**	**08**
Module-3: Industrial Data Transmission		
Introduction, Foundation Fieldbus, Profibus, HART, Interbus, Bitbus, CC-Link, Modbus, Batibus, DigitalSTROM, Controller Area Network, DeviceNet, LonWorks, ISA 100.11a, Wireless HART, LoRa and LoRaWAN. **Self-study:** Recent and upcoming technologies – Features and components	**Apply**	**08**
Module-4: Industrial Data Acquisition and IIoT Analytics		
Industrial Data Acquisition: Introduction, Distributed control system, PLC, SCADA	**Apply**	**08**

IIoT Analytics: Introduction, **Self-study**: IIoT Analytics.		
Module-5: Machine Learning and Data Science in Industries		
Introduction, ML, Categorization of ML, Applications of ML in Industries, Data science in Industries, Deep Learning application in Industries. **Self-study:** Applications of Healthcare in Industries	**Apply**	**08**

Reference Books:

1. "Introduction to Industrial Internet of Things and Industry 4.0", Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press, 2021.
2. "Industrial IoT – Challenges, Design Principles, Applications and Security", Springer, Edited by Ismail Butun, 2020.
3. "The Industrial IoT", Edited by Anandan, Suseendran Gopalakrishnan, Souvik Pal, Noor Zaman, Scrivener Publishing, 2022.

Web links and Video Lectures: SWAYAM NPTEL MOOC course "Introduction to Industry 4.0 and Industrial IoT", IIT Kharagpur.
https://www.youtube.com/watch?v=p7kYStiASLo&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR

Course Code	Description	Bloom's Cognitive level	POs/PSOs
21EEE1724.1	To Understand the design requirements and drivers of Industry 4.0 and IIoT for Industrial processes	Understand	
21EEE1724.2	To Understand the Business models and reference Architecture of IIoT	Understand	
21EEE1724.3	To Understand the Industrial Data transmission and their features.	Understand	
21EEE1724.4	To Understand the advantages of using Data Analytics, Machine Learning, Data Science	Understand	
21EEE1724.5	To understand the application of IIoT in Healthcare	Understand	

SEMESTER – VII

Course Name: Data Base Management System (Professional Elective)
Course Code:22EEE1725

Teaching Hours/Week (L:T:P:J) : (3 : 0 : 0 : 0)	**CIA Marks: 50**
Credits: 2	**SEA Marks: 50**
Hours: 40	**SEA Duration: 3 Hours**

Course Learning Objectives:

This course will enable students to:

- Provide a strong foundation in database concepts, technology, and practice.
- Practice SQL programming through a variety of database problems.
- Demonstrate the use of concurrency and transactions in database.
- Design and build database applications for real world problems.

	Bloom's Level	Hours
Module-1: Introduction to Database Systems		
Introduction to Databases: Introduction, Characteristics of database approach, Advantages of using the DBMS approach **Database System Concepts and Architecture:** Data Models, Schemas and Instances, Three-Schema Architecture and Data Independence, Database Languages and Interfaces, The Database System Environment **Data Modeling Using the Entity-Relationship (ER) Model:** Entitytypes-Entity sets-Attributes and Keys, Relationship types – Relationship Sets – Roles and structural Constraints, Weak Entity Types, ER diagrams, Examples	**Apply**	**8**
Module-2: Relational Database Model		
Database Design concepts: Steps in database design: requirements analysis, conceptual design, logical design, physical design, ER-to-relational mapping. **Relational Model:** Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, dealing with constraint violations.	**Understand**	**8**
Module-3: Structured Query Language (SQL)		
SQL Data Definition and Data Types, Specifying Constraints in SQL, Basic Retrieval Queries in SQL, INSERT – DELETE and UPDATE Statements in SQL, Additional features in SQL. Querying multiple tables: JOIN operations (inner, outer, cross), Nested queries, Aggregate functions and GROUP BY clause, Views.	**Apply**	**8**
Module-4: Functional Dependencies and Normalization		
Basics of Functional Dependencies and Normalization for Relational Database: Functional Dependencies, Normal forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce- Codd Normal Forms [BCNF], Multi-valued Dependency and Fourth Normal Form, Join Dependencies and fifth Normal Form.	**Apply**	**8**
Module-5: Transactions Processing and Concurrency control, NOSQL		
Introduction to Transaction Processing –Introduction to Transaction Processing, Desirable Properties on Transactions (ACID), Characterizing schedules based on recoverability, Characterizing schedules based on Serializability **Concurrency Control Techniques:** Two-Phase Locking Techniques for Concurrency Control, Concurrency control based on Timestamp ordering	**Understand**	**8**

NoSQL: Why NoSQL? : The Emergence of NoSQL Data Models : Relationships, Graph Database, Schemaless Database, Materialized View, Modelling for Data Access		

Text Books /Reference Books:

1. Ramez Elmasari, Shamkant B Navathe, "Fundamentals of Database Systems", Pearson,Seventh Edition 2017.
2. Pramod J Sadalage, Martin Fowler, "NOSQL Distilled", Pearson, 2013.

CO-PO Mapping

CO No.	Course Outcome Description	Bloom's Cognitive level	POs/PSOs
21EEE1725.1	Understand and apply the concept of structured database, database objects and data modeling for the Entity-Relationship (ER) Model	**Apply**	PO1, 2, 3,5,12
21EEE1725.2	Understand the concepts of database design and enforcing integrity constraints on a database using RDBMS.	**Understand**	PO1, 2, 3,12
21EEE1725.3	Apply Structured Query Language (SQL) for database manipulation	**Apply**	PO1, 2, 3, 4, 5, 6, 9,10,12
21EEE1725.4	Apply Functional Dependency concepts to normalize relation	**Apply**	PO1, 2, 3, 4, 5,12
21EEE1725.5	Understand and the concept of transaction processing and un-structured database	**Understand**	PO1, 2, 3,12

SEMESTER – VII	
Course Name: Artificial Neural Network (Professional Elective) **Course Code:22EEE1726**	
Teaching Hours/Week (L:T:P:J) : (3:0:0:0)	**CIA Marks: 50**
Credits: 3	**SEA Marks: 50**
Hours: 30	**SEA Duration: 3 Hours**

Course Learning Objectives:

This course will enable students to

1. Conduct a comparative analysis of biological and artificial neural networks, focusing on their distinct architectures and activation functions.
2. Design artificial neural network (ANN) models employing both supervised and unsupervised learning techniques.
3. Evaluate the performance of ANN models in the context of incomplete data and errors in test samples.
4. Develop various types of ANN models, including competitive networks, self-organizing maps, and both memory-based and memory-less architectures.
5. Identify and implement ANN models across different engineering disciplines.

	Bloom's Level	**Hours**
Module-1		
Introduction:: Fundamental concepts and Models of Artificial Neural systems, Biological Neural Networks, Typical Architectures, Setting the Weights, Common Activation Functions, Mc-Culloch –Pitts model- AND gate, OR gate, AND-NOT gate, **self-study component:** Mc-Culloch –Pitts model-XOR gate.	**Understand**	**8**
Module-2		
Fundamental Models of Artificial Neural Networks: Simple neural nets for Pattern Classification, Hebb net, examples, Single Layer Perceptron Classifiers, Single Layer Feedback Networks, examples, **Self-study component:** Perceptron learning	**Understand**	**8**
Module-3		
Associative memory networks: Pattern associations, applications, Training algorithm, Hebb rule, Classification of associative memory, Hetero associative neural net architecture, Examples with missing and mistake data, Auto associative net architecture, Examples with missing and mistake data, Storage capacity. **Self-study component:** Delta rule	**Understand**	**8**
Module-4		
Feed Back Networks: Recurrent linear auto associate, Examples, Discrete Hopfield net, Examples with missing and mistake data, Bidirectional associative net, architecture, Examples with missing and mistake data, Hamming distance, Fixed weight competitive nets, Architecture, **Self-study component:** applications.	**Understand**	**8**
Module-5		
Feed forward Network: Architecture, applications, examples of back propagation neural network (BPN),	**Understand**	**8**

Self-study component: Radial Basis Function Network (RBFN)		

Course outcomes:

The students will be able to

1. Compare biological and artificial neural network, different architectures and various activation functions.
2. Design ANN model using supervised and unsupervised techniques
3. Analyze the performances of ANN with respect to missing data and mistake in test samples
4. Develop competitive net, self organizing map, memory based and memory-less ANN models
5. Identify and apply of ANN model in different domains of engineering.

Text Books /Reference Books:

1. Laurene Fausett, 'Fundamentals of Neural Networks: Architecture, Algorithms and Applications', Person Education, 2004.
2. Simon Hayking, 'Neural Networks: A Comprehensive Foundation', 2nd Ed., PHI.
3. S.N Sivanandam, S Sumathi, S.N Deepa 'Introduction to Neural Net using Matlab 6.0', TMH, 2017

Semester: VII		
Course Name: Accounts & Financing for Engineers (Professional Core Elective) **Course Code: 22EEE1727**		
L:T:P:J: (3:0:0:0)	**CIA Marks: 50**	
Credits:3	**SEA Marks: 50**	
Hours: 40	**SEA Duration: 3 Hours**	
Course Learning Objectives:		
1.To explain fundamental accounting concepts, basic accounting vocabulary and accounting equation 2.To prepare basic entries for business transactions and present the data in an accurate and meaningful manner 3.To prepare financial statements of companies and explain the contents of the statements 4.To analyze a company's financial statements and come to a reasoned conclusion about the financial position of the company 5.To understand the fundamentals of financial management and concept of time value of money		
Pre-Requisites:		
	Bloom's Level	**Hours**
Module-1: Introduction to Financial Accounting		
Nature of Accounting, Branches of Accounting, Types of business ownership, Accounting Terminologies, Classification of Accounts, Accounting Concepts and Conventions, Accounting Standards, Accounting Equation	**Understand**	**8**
Module-2: Accounting Cycle		
Accounting Cycle, Analysing and interpretation of accounting transactions: Journalizing, Ledger posting, Preparation of Trial Balance. Preparation of Financial Statements of sole trading concerns – Profit and Loss Account and Balance Sheet	**Understand**	**8**
Module-3: Analysis of Financial Statements		
Meaning and Purpose of Financial Statement Analysis, Trend Analysis, Comparative Analysis, Financial Ratio Analysis	**Understand**	**8**
Module-4: Financial Management		
Meaning and objectives of Financial Management, Interface of Financial Management with other functional areas. Financial System, Financial Markets and Instruments; Sources of Financing	**Understand**	**8**
Module-5: Time Value of Money		
Meaning of Time value of money – Simple interest & Compound interest, Future value of single cash flow & annuity, present value of single cash flow and annuity	**Understand**	**8**
Self Study: Study of Annual Reports, Study of Indian Financial System,Group Assignment and Presentation		

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

CO1	Students will be able to explain accounting concepts and accounting equation
CO2	Students will be able to prepare profit and loss account and balance sheet
CO3	Students will be able to analyse financial statements and take decisions
CO4	Students will be able to understand the basic concepts of financial management
CO5	Students will be able to apply time value of money concept

Text/Reference Books

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Basic Accounting	B S Raman	Sapna Book House	1e, 2016
2	Financial Accounting	S.N.Maheshwari, Suneel K. Maheshwari, Sharad K. Maheshwari	Vikas Publishing House Pvt. Ltd.	6e, 2018
3	Financial Accounting	Tulsian P. C	Pearson Education	1e, 2002
4	Financial Management	Khan M. Y.& Jain P. K	TMH	7e, 2017

Semester: VII	
Course Name: Research Methodology and IPR (AEC) Course Code: 22EEE174	
L:T:P:J: (1 : 2 : 0 : 0)	**CIA Marks: 1 0 0**
Credits: 2	**SEA Marks: -**
Hours: 30	**SEA Duration: -**

Course Learning Objectives:

- To dwell into the overview of Research methodology and understand its process.
- To explain various research designs and their characteristics
- To explain the details of sampling designs, and also different methods of data collections
- To explain the art of writing research reports
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment

Pre-Requisites: Nil

	Bloom's Level	Hours
Module-1: INTRODUCTION TO RESEARCH METHODOLOGY		
Introduction, meaning of research, Objectives of research, Types of research, Research approaches, Research methods versus Methodology, Research process **Self-study component:** Problems encountered by researchers in India	**Understand**	**6**
Module-2: RESEARCH DESIGN		
Introduction, meaning of research design, Features of a good design, Important concepts relating to research design, Different research designs **Self-study component:** Basic principles of experimental designs	**Understand**	**6**
Module-3: SAMPLING DESIGN & MEASUREMENT TECHNIQUES		
Sampling Design: Introduction, Steps in sampling design, Characteristics of a good sample design, Different types of sample designs. Measurement Techniques: Introduction, Measurement scales, Sources of error in measurement **Self-study component:** Census and sample survey	**Understand**	**6**
Module-4: DATA COLLECTION & REPORT WRITING		
Data Collection: Collection of primary data, Collection of Secondary Data. Report Writing: Different steps in writing report, Layout of the research report **Self-study component:** Selection of appropriate method for data collection	**Understand**	**6**
Module-5: INTELLECTUAL PROPERTY RIGHTS		
Introduction, the concept, Intellectual property system in India, Patents act- 1970, Trademark act-1999, Protection of intellectual property under TRIPS, Copyright and related rights, Geographical indications, Industrial designs, Patents **Self-study component:** Role of IP in Economic and Cultural Development of the Society	**Understand**	**6**

Course Outcomes: After the completion of the course the students will be able to:

- Understand the criteria for selecting good research and appropriate method to implement the methodology
- Formulate the need & process of a well-planned Research design
- Understand the process of identifying & selecting a sample and use measurement techniques for all scientific investigations
- Collect data to gather relevant information for analysis and decision-making, solve problems, and contribute to the existing body of knowledge and there by formulating the same with a report
- Identify the need of IPR of research projects for economic growth and social benefits

Reference Books:

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International (P) Limited, Second Edition, 2019.
2. Research Methodology a step-by step guide for beginners, Ranjit Kumar, SAGE Publications Ltd., Fourth Edition, 2014.
3. Study material on Intellectual Property Rights-Law and Practice, The Institute of Company Secretaries of India, 2015.

Web links and Video Lectures:

- https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview
- https://onlinecourses.nptel.ac.in/noc23_ge36/preview

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical and Electronics Engineering

VIII Semester Syllabus

B.N.M. Institute of Technology

An Autonomous Institution under VTU, Approved by AICTE

Department of Electrical and Electronics Engineering

Semester: VIII	
Course Name: SMART GRID (PEC-MOOC)	
Course Code: 22EEE1811	
Teaching Hours/Week (L:T:P:J) : (3:0:0:3)	**CIA Marks : 50**
Credits:3	**SEA Marks : 50**
Hours: 40 Hours Theory	**SEA Duration : 3 Hours**

Course Learning Objectives:

The students will be able to

- Provide comprehensive understanding of the smart grid concept, its architecture, technologies, and applications.
- Explore the characteristics, performance metrics, and integration challenges of various energy storage devices
- Provide insights into advanced protection schemes, fault detection mechanisms, and the integration of cyber-security measures tailored to modern smart grid architectures.
- Focus on the principles of power flow, voltage and frequency control, and the integration of renewable energy sources and energy storage systems
- Understand the design, operation, and performance evaluation of AC, DC, and AC-DC hybrid microgrids through detailed case studies

Pre-Requisites:

- Foundational understanding of power systems, including generation, transmission, and distribution.
- Knowledge of control systems, renewable energy technologies, and basic communication or networking principles.
- Familiarity with simulation tools like MATLAB and basic programming skills will aid in analyzing and modeling of smart grid systems.

Module-1: **Introduction to Smart Grid**	**RBT**	**Hrs**
Introduction to Smart Grid, Architecture of Smart Grid system, Standards for Smart Grid system, Elements and Technologies of Smart Grid System, Self Study: Distributed Generation Resources	**Understand**	**8**
Module-2: **Introduction to Energy Storage Devices**	**RBT**	**Hrs**
Different types of energy storage technologies, Analytical modelling of energy storage devices, Optimal sizing and siting of storages, Battery management system (BMS), Self Study: Wide area Monitoring Systems	**Understand**	**8**
Module-3: **Smart Grid Protection**	**RBT**	**Hrs**
Digital Relays for Smart Grid Protection, Phasor Estimation, Islanding Detection Techniques, Modelling of storage devices and DC smart grid components Self Study: Modelling of storage devices (Battery Modelling)	**Understand**	**8**
Module-4:	**RBT**	**Hrs**

Operation and Control of AC Microgrid		
Need for Micro-grid control, General scheme of Micro-grid control, Hierarchical control methods, Virtual impedance based drop control, Demand side management of smart grid, Self Study: Demand Response Analysis of smart grid	**Apply**	**8**
Module-5: **Hierarchical Control Techniques in Hybrid AC-DC Microgrid**	**RBT**	**Hrs**
Demonstration of solar power generation, wind power generation, Battery Management System, EV charging system, Simulation and case study of AC Microgrid, DC Microgrid, Self Study: AC-DC Hybrid microgrid	**Analyze**	**8**

Course Outcomes: After the completion of the course the students will be able to:

- Explain the architecture, components, and key features of smart grid systems
- Identify appropriate energy storage technologies based on technical, economic, and environmental criteria for specific smart grid applications
- Explain the fundamentals of power system protection and their adaptation for smart grid environments.
- Apply advanced technologies for real-time monitoring and control, fostering sustainable and resilient energy systems.
- **Analyze and** Compare the operational characteristics, advantages, and challenges of AC, DC, and AC-DC hybrid microgrids based on real-world case studies

Reference Books

1. Smart Power Grids', A Keyhani, M Marwali, Springer, 2011.
2. 'Computer Relaying for Power Systems', ArunPhadk, James Thorp, 2nd edition, Wiley india, 2012.
3. 'Microgrids Architecture and Control', Nikos Hatziargyriou, Wiley-IEEE Press, 2014.
4. 'Microgrid Architectures, Control and Protection Methods (Power Systems)' 1st ed. 2020 Edition, Springer.
5. 'Fundamentals of Smart Grid Technology', Bharat Modi, Anu Prakash & Yogesh Kumar, S.K. Kataria & Sons, 2022
6. 'Renewable Energy Systems', Fang Lin Luo, Hong Ye, CRC Press, 2017

Web links and Video Lectures:

- https://onlinecourses.nptel.ac.in/noc25_ee79/unit?unit=17&lesson=25
- https://archive.nptel.ac.in/courses/108/107/108107113/

Semester: VIII	
Course Name: Internship-3 **Course Code: 22EEE182**	
Teaching Hours/Week (L:T:P:J) : (0:0:8:0)	**CIA Marks: 50**
Credits: 4	**SEA Marks: 50**
Hours: --	**SEA Duration: 3 Hours**

Course Learning Objectives:

Course Learning Objectives:

- Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc.

The objectives are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing,

Internship: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

• Present the seminar on the internship orally and/or through power point slides.
• Answer the queries and involve in debate/discussion.
• Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

• Gain practical experience within industry in which the internship is done.
• Acquire knowledge of the industry in which the internship is done.
• Apply knowledge and skills learned to classroom work.
• Develop a greater understanding about career options while more clearly defining personal career goals.
• Experience the activities and functions of professionals.
• Develop and refine oral and written communication skills.

Continuous Internal Assessment

CIA marks: 50 Marks

Based on the quality of report and presentation skill, participation in the question-and-answer session by the student. The Assessment will be done by the committee constituted for the purpose by the Head of the Department.

The committee shall consist of three faculty from the department with the senior most acting as the Chairman.

Semester End Assessment

SEE marks – 50 Marks based on presentation skill, participation in the question and answer session by the student to the examiners appointed by the Institution/University

Semester: VIII	
Course Name: Main Project Work-Phase 2	**Course Code: 22EEE183**
Teaching Hours/Week (L:T:P:J) : (0:0:0:20)	**CIA Marks: 50**
Credits: 10	**SEA Marks: 50**
Contact Hours per week: 2	**SEA Duration: 3 Hours**

Course Learning Objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources)
- clearly.
- To develop interactive, communication, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently,
- Enhance communication skill, involve in group discussion to present and exchange ideas

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism

Course outcomes:

At the end of the course the student will be able to:

1. Identify, define, and articulate engineering problems through literature review and domain analysis to develop a feasible project proposal.
2. Design and implement innovative solutions using appropriate engineering principles, tools, and technologies to address identified problems.
3. Conduct experiments, collect and analyze data, and interpret results to validate the effectiveness of the proposed solution.
4. Demonstrate effective project planning, time management, and teamwork skills in executing the project within defined constraints.
5. Communicate project outcomes effectively through technical reports and presentations, while adhering to ethical standards and societal responsibilities.

CIA procedure for Project Work Phase - 2:

(i)Single discipline: The CIA marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

(ii) Interdisciplinary: Continuous Internal Assessment shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIA marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

Semester End Assessment: SEA marks for the project (50 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session) as per the University norms by the examiners appointed Institution/University.