Vidyayāmruthamashnuthe

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical & Electronics Engineering

Autonomous 2024 Scheme & Syllabus

B.N.M Institute of Technology

An Autonomous Institution Under VTU

Department of Electrical and Electronics Engineering

Proposed 2024 Scheme for Autonomous Program

Summary of Semester wise Credits

Sl. No.	Semester	Credits
1	1	20
2	2	20
3	3	22
4	4	20
5	5	22
6	6	23
7	7	16
8	8	17
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	24MAE131	Fourier Series, Transforms and Statistical Techniques	Mathematics	2	2	--	--	4	**3**	50	50	100
2	PCC	24EEE132	Generation, Transmission and Distribution	EEE	2	2	--	--	4	**3**	50	50	100
3	PCC	24EEE133	Network Analysis	EEE	2	2	--	--	4	**3**	50	50	100
4	PCI	24EEE134	Transformers and Induction Motors	EEE	3	--	2	--	5	**4**	50	50	100
5	PCI	24EEE135	Analog and Digital Electronics	EEE	3	--	2	--	5	**4**	50	50	100
6	PBL	24EEE136	Data Structures Using C	EEE	--	2	1	1	4	**2**	50	50	100
7	HSS	24CIP137	Constitution of India and Professional Ethics	HSS	1	--	--	--	1	**1**	100	--	100
8	AEC	24SFT138	Soft Skills -1	T & P	--	2	--	--	2	**1**	100	--	100
9	IPL	24EEE139	Innovative Project Lab (Social Concern)	EEE	--	--	--	2	2	**1**	100	--	100
			Total		13	10	5	3	31	**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.

Bridge Course: All lateral entry students have to register and complete the course **Fundamentals of C programming** and submit the assignment to the concerned teacher handling the course **Data structures using C**.

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	24MAE141	Complex Analysis, Probability and Random Process	Mathematics	2	2	--	--	4	**3**	50	50	100
2	PCC	24EEE142	Electromagnetic Fields and Wave Theory	EEE	2	2	--	--	4	**3**	50	50	100
3	PCI	24EEE143	Electrical Motors and Synchronous Machines	EEE	3	--	2	--	5	**4**	50	50	100
4	PCI	24EEE144	Linear Control Systems	EEE	3	--	2	--	5	**4**	50	50	100
5	PBL	24EEE145	ARM processors and Applications	EEE	--	2	1	1	4	**2**	50	50	100
6	PCC	24EEE146	Data Base Management System	EEE	1	2	--	--	3	**2**	50	50	100
7	INT	24EEE147	Internship-1/Innovative Project Lab	EEE	--	--	2	2	4	**1**	100	--	100
8	AEC	24SFT148	Soft Skills - 2	T & P	--	2	--	--	2	**1**	100	--	100
			Total		11	10	7	3	**31**	**20**	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 (CIA) 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	24EEE151	AI & ML applications in Electrical systems	EEE	2	2			4	**3**	50	50	100
2	PCC	24EEE152	Digital Signal Processing	EEE	2	2	--	--	4	**3**	50	50	100
3	PCI	24EEE153	Real Time Operating System	EEE	2	--	4	--	6	**4**	50	50	100
4	PCI	24EEE154	Power Electronic Devices and Circuits	EEE	3	--	2	--	5	**4**	50	50	100
5	PBL	24EEE155	Design of digital controllers using Programmable Logic Controller	EEE	--	2	1	1	4	**2**	50	50	100
6	POE	24EEE156X	Open Elective course	EEE	2	2	--	--	4	**3**	50	50	100
7	AEC	24EEE157	Employability Skills -1 (Technical)	T & P	--	2	--	--	2	**1**	100	--	100
8	INT	24EEE158	Internship- 2	EEE	--	--	4	--	4	**2**	100	--	100
			Total		11	10	11	1	33	**22**	500	300	800

Open Elective Course			
24EEE1561	Energy Audit and Energy Management System	24EEE1563	Fundamentals of Hybrid and Electric Vehicles
24EEE1562	Non-Conventional Energy Resources	24EEE1564	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 CIE 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	24EEE161	Object Oriented Programming using Java	EEE	2	2	--	--	4	**3**	50	50	100
2	PCI	24EEE162	Computer Techniques in Power System	EEE	2	2	2	--	6	**4**	50	50	100
3	PCI	24EEE163	High Voltage & Power System Protection	EEE	3	--	2	-	5	**4**	50	50	100
4	PBL	24EEE164	Simulation of Electric vehicle and Alternate energy systems	EEE	--	--	2	2	4	**2**	50	50	100
5	PEC	24EEE165X	Professional Elective Course	EEE	3	--	--	--	3	**3**	50	50	100
6	PEC (Online Courses)	24EEE166X	Professional Elective (online Courses)	EEE	3	--	--	--	3	**3**	50	50	100
7	POE	24EEE167X	Open Elective course	EEE	2	2	--	--	4	**3**	50	50	100
8	AEC	24EEE168	Employability Skills – 2 (Technical)	T & P	--	2	--	--	2	**1**	100	--	100
			Total		15	8	6	2	31	**23**	450	350	800

Professional Elective Courses			
24EEE1651	Renewable Energy Sources	24EEE1655	Introduction to UNIX Programming
24EEE1652	Energy Audit and Energy Management System	24EEE1656	Fuzzy Logic and its applications
24EEE1653	Fundamentals of Electric and Hybrid Electric Vehicles	24EEE1657	Strategic Management
24EEE1654	Embedded Systems		

Professional Elective Courses (Online Courses)			
24EEE1661	DC Microgrids and Control	24EEE1665	Cyber Security and Privacy
24EEE1662	Industrial Automation and Drives	24EEE1666	Data Mining
24EEE1663	Advanced Power electronics Design	24EEE1667	Digital Marketing
24EEE1664	Industrial Internet of Things		

Open Elective Courses			
24EEE1671	PLC and SCADA	24EEE1673	Industrial Motor control and Automation
24EEE1672	Fuel Cell Technology	24EEE1674	Solar Photo Voltaic Systems

Semester: VII 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	24EEE171	Engineering project Management and Finance	EEE	3	--	--	--	3	**3**	50	50	100
2	PEC	24EE172X	Professional Elective Course	EEE	3	--	--	--	3	**3**	50	50	100
3	PEC (Online Courses)	24EEE173X	Professional Elective (online Courses)	EEE	3	--	--	--	3	**3**	50	50	100
4	AEC	24EEE174	Research Methodology and IPR	EEE	1	2	--	--	3	**2**	50	50	100
5	PPW	24EEE175	Main Project- Phase 1	EEE	--	--	--	10	10	**5**	50	50	100
			Total		10	2	--	10	22	**16**	250	250	500

Professional Elective Courses			
24EEE1721	Electrical Estimation and Costing	24EEE1725	Data Visualization
24EEE1722	Utilization of Electrical Power	24EEE1726	ANN and its applications to Electrical Systems
24EEE1723	Advanced Techniques in Electric Vehicles	24EEE1727	Accounts & Financing for Engineers
24EEE1724	Digital Design through Verilog		

Professional Elective Courses (Online Courses)			
24EEE1731	Advances in UHV Transmission and Distribution	24EEE1735	Big Data Computing
24EEE1732	Digital Control systems for Industrial applications	24EEE1736	Deep Learning
24EEE1733	Charging Infrastructure	24EEE1737	Operations and Supply Chain Management
24EEE1734	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)	24EEE181X	Professional Elective (online Courses)	EEE	3	--	--	--	3	**3**	50	50	100
2	INT	24EEE182	Internship-3	EEE	--	--	8	--	8	**4**	50	50	100
3	PPW	24EEE183	Main Project Work- Phase 2	EEE	--	--	--	20	20	**10**	50	50	100
			Total		3	--	8	20	31	**17**	150	150	300

Professional Elective Courses (Online Courses)			
24EEE1811	Smart Grid	24EEE1815	Blockchain and its Applications
24EEE1812	Computer-Aided Design of Electrical Machines	24EEE1816	Natural Language Processing
24EEE1813	Battery Technology and Battery Management System	24EEE1817	Business Analytics for Management Decision
24EEE1814	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**	
24EEE1651	Renewable Energy Sources (Professional Elective Course)	24EEE1655	Introduction to UNIX Programming (Professional Elective Course)
24EEE1661	DC Microgrids and Control (MOOC)	24EEE1665	Cyber Security and Privacy (MOOC)
24EEE1721	Electrical Estimation and Costing (Professional Elective Course)	24EEE1725	Data Visualization
24EEE1731	Advances in UHV Transmission and Distribution (MOOC)	24EEE1735	Big Data Computing (MOOC)
24EEE1811	Smart Grid (MOOC)	24EEE1815	Blockchain and its Applications (MOOC)
II. Industrial Automation and Drives: IAD		**VI. AI & ML stream: AI**	
24EEE1652	Energy Audit and Energy Management System (Professional Elective Course)	24EEE1656	Fuzzy Logic and its applications (Professional Elective Course)
24EEE1662	Industrial Drives and Automation (MOOC)	24EEE1666	Data Mining (MOOC)
24EEE1722	Utilization of Electrical Power (Professional Elective Course)	24EEE1726	ANN and its applications to Electrical Systems (Professional Elective Course)
24EEE1732	Digital Control systems for Industrial applications (MOOC)	24EEE1736	Deep Learning (MOOC)
24EEE1812	Computer-Aided Design of Electrical Machines (MOOC)	24EEE1816	Natural Language Processing (MOOC)
III. Electric vehicle stream: EV		**VII. Management Stream:**	
24EEE1653	Fundamentals of Electric and Hybrid Electric Vehicles (Professional Elective Course)	24EEE1657	Strategic Management (Professional Elective Course)
24EEE1663	Advanced Power electronics Design (MOOC)	24EEE1667	Digital Marketing (MOOC)
24EEE1723	Advanced Techniques in Electric Vehicles (Professional Elective Course)	24EEE1727	Accounts & Financing for Engineers (Professional Elective Course)
24EEE1733	Charging Infrastructure (MOOC)	24EEE1737	Operations and Supply Chain Management (MOOC)
24EEE1813	Battery Technology and Battery Management System (MOOC)	24EEE1817	Business Analytics for Management Decision (MOOC)
IV. **VLSI and Embedded Systems: VES**			
24EEE1654	Embedded Systems and IoT (Professional Elective Course)		
24EEE1664	Industrial Internet of Things (MOOC)		
24EEE1724	Digital Design through Verilog (Professional Elective Course)		
24EEE1734	Drone Systems and Control (MOOC)		
24EEE1814	VLSI Design (MOOC)		

Open Elective -1 (V semester)			**Open Elective – 2 (VI semester)**
24EEE1561	1. Energy Audit and Energy Management System	24EEE1671	1. PLC and SCADA
24EEE1562	2. Non-Conventional Energy Resources	24EEE1672	2. Fuel Cell Technology
24EEE1563	3. Fundamentals of Electric and Hybrid Vehicles	24EEE1673	3. Industrial Motors and Control
24EEE1564	4. Sensors and Transducers	24EEE1674	4. Solar Photo Voltaic Systems

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: 24MAE131 (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: $y = ax+b$, $y = ax^2 + bx + c$ **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: Apply the knowledge of correlation and regression analysis to fit a suitable mathematical model for the statistical data.

CO 2: Apply Laplace transform technique to find the transformation from 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: Apply the knowledge of Fourier transform and Z-transform to illustrate discrete / continuous function arising in wave and heat propagation, signals and systems.

CO - PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2			2							
CO 2	3	2			2							
CO 3	3	2			2							
CO 4	3	2			2							
CO 5	3	2			2							

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.

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 (Professional Core Course) **Course Code: 24EEE132**		
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

	Bloom's Level	Hours
Module-1: Power Generation		
Introduction: Importance of electricity, Generation of electrical energy, Sources of energy, **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 ***Self study component***: Comparison of energy sources.	**Understand**	**8**
Module-2: Electrical Supply System		
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). ***Self study component***:Smart insulators with embedded sensors for condition monitoring	**Apply**	**8**
Module-3: Transmission Line Parameters		
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).	**Apply**	**8**

Self study component: Advantages of single circuit and double circuit lines.		
Module-4: Performance of Transmission Lines and Underground Cables		
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. High voltage testing and diagnostics (Very Low Frequency) ***Self study component:*** Time Domain Reflectometry testing, Partial Discharge testing for UG cables	**Apply**	**8**
Module-5: Distribution Systems		
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. ***Self study component:*** Requirements and design consideration of Distribution System	**Understand**	**8**

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

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

Reference Books:

1. Principles of Power System,V.K. Mehta & Rohit Mehta, S. Chand Technical Publications. 2022 Revised Edition
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 (Professional Core Course) **Course Code: 24EEE133**		
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

	Bloom's Level	Hours
Module-1: Fundamentals of Network Theory		
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. Illustrative examples. ***Self study components: Super loop and super node methods. Illustrative examples.***	**Apply**	**8**
Module–2: Network Theorems		
Integro-differential equations on loop and node basis of circuits with R, L and C. Superposition theorem, Thevenin's and Norton's theorems, Millman's theorem, and Maximum power transfer theorem. Illustrative examples (dependent sources excluded). ***Self study components: Duality in electric networks.***	**Apply**	**8**
Module–3: Initial conditions and Resonance in networks.		
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. ***Self study components: Application of resonance in radio transmission, voltage and current magnification, oscillator circuits and induction heating.***	**Apply**	**8**
Module–4: Laplace transform		
Definition, properties, importance, and applications. Laplace transforms of various parameters, Standard input signals (impulse, step, ramp, and parabolic) and their LTs. LT of periodic signals and waveform synthesis, Inverse Laplace transformations, Partial fraction expansions. Applications of Laplace transformations for Analysis of simple R-L, R-C, and R-L-C series parallel circuits excited by DC sources. Illustrative examples. ***Self study components: LT of periodic signals, Initial value and final value theorems, illustrative examples.***	**Apply**	**8**

Module-5: Two port Network parameters and Three phase circuits.		
Two port Network parameters Two-port network modeling through Z, Y 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. ***Self study components: Applications of three-port and four port networks in communication and EV models.***	**Apply**	**8**

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

1. Analyse the given circuit (both single phase and three phases) using network reduction & other network solution methods.
2. Solve the given electric circuit by applying the concept of network theorems.
3. Analyze the behaviour of the electrical network under initial, steady state condition and variation of parameters.
4. Analyse electric circuits using Laplace transformations.
5. Model the given two port networks in terms of network parameters (Z, Y, h and T)
6. To explain the applications of three port networks, duality, electrical resonance.

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.
4. Network Analysis and Synthesis by Ravish R Singh. McGraw Hill Education (India) Private Limited. ISBN (13): ISBN (10):

Department of Electrical and Electronics Engineering

Semester: III		
Transformers and Induction Motors (Professional Core Integrated) **Course Code: 24EEE134**		
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 transformers ❖ To understand the characteristics, starting methods, and speed control of three-phase IMs ❖ To understand the performance of three-phase IMs and single-phase IM		
-Prerequisites: Electromagnetic Induction, Single-phase and three-phase AC circuits, KCL & KVL		
	Bloom's Level	**Hours**
Module 1: Single-Phase Transformers		
Single-Phase Transformers: Necessity of transformer, principle of operation, Types (core & shell) and construction, EMF equation, Operation of practical transformer under no-load and on-load with phasor diagrams, equivalent circuit, Transformer losses, efficiency, and conditions for maximum efficiency, voltage regulation, and all-day efficiency. Illustrative examples ***Self-study component:*** *working of isolation, power & distribution transformers and their applications*	**Apply**	**8**
Module 2: Testing, Parallel operation and special transformers		
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 single-phase similar and dissimilar transformers; Illustrative examples **Self-study component:** Special Transformers - working of Instrument transformers (CT, PT) and pulse transformers and their applications	**Apply**	**8 hours**
Module 3: Three-phase Transformers and Auto Transformers		
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 autotransformers, saving of conductor material, comparison of autotransformers and two-winding transformers, Illustrative examples **Self-study component:** phase shifting transformer - principle, working & applications	**Apply**	**8 hours**
Module 4: Three-Phase Induction Motor		
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	**Apply**	**8 hours**

Maximum torque, Equivalent circuit, Losses and efficiency, power flow diagram, Phasor diagram of induction motor on no load and loaded conditions. (numerical as applicable), applications **Self-study component:** Modern applications in robotics, electric vehicles, and renewable energy.		
Module 5: Testing, Starters and Speed Control of 3-phase IM & Single-Phase IM		
Tests on three-phase induction motors: brake test, no-load, and blocked rotor tests determine the performance of the motor from the equivalent circuit—illustrative examples (excluding circle diagram). **Starters and Speed Control for 3-Phase IMs:** Need for a Starter. Direct online (DOL), star-delta and rotor resistance starting & control, modern starters— soft starters, variable frequency drives, and advanced speed control methods (field-oriented control and V/F 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) **Self-study component:** autotransformer starting of 3-phase IM	**Apply**	**8 hours**

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

1. Explain the construction, working principles, and types of transformers and induction motors. (Bloom's Level: Understand)
2. Explain the starting methods and speed control techniques of three-phase induction motors. (Bloom's Level: Understand)
3. Determine the performance parameters of single-phase transformers and three-phase transformers through load and no-load tests (Bloom's Level: Apply)
4. Apply standard testing procedures to assess the performance and characteristics of single-phase and three-phase induction motors. (Bloom's Level: Apply)
5. Analyze the performance characteristics and test data of transformers and induction motors to evaluate efficiency, voltage regulation, and torque-speed relationships under various operating conditions. (Bloom's Level: Analyze)

Laboratory Experiments:

1. Open-circuit and short-circuit tests on single-phase transformers 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's connection with balanced and unbalanced loads
5. Separation of hysteresis and eddy current losses in single-phase transformers.
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 motors 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 a single-phase induction motor
10. Performance characteristics of an Induction Generator
11. Load test on single-phase transformer

Reference Books

1. Electrical Technology, B L Theraja and A K Theraja, 24th Edition, 2024
2. Electric Machines, D P Kothari, I J Nagrath, TMH, 5th edition, 2017
3. Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Co. Publications, 3rd edition, 2016
4. Electrical Machinery, J.B. Gupta, S K Kataria & Sons, Reprint 2013

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 (Professional Core Integrated) **Course Code: 24EEE135**		
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		
	Bloom's Level	**Hours**
Module-1: Introduction to Digital Circuits and Combinational circuits		
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], **Self study component:** Design Code convertors [BCD to Excess-3, BCD to 7-segment code]	**Apply**	**8**
Module-2: Combinational circuits and Introduction to sequential circuits		
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. **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. **Self study component: Encoders:** Implementation of 4:2, 8:3 encoders	**Apply**	**8**
Module-3: Sequential circuits		
Registers: Types of registers, Shift registers, 4-bit PIPO, PISO, SISO, SIPO registers, Universal shift registers, **Counters:** Binary ripple counters, Synchronous Binary counters, Design of Synchronous counters **Self study component:** Counters based on registers	**Apply**	**8**
Module-4: Operational Amplifier Applications		
Op-Amp Non-Linear Applications: ZCD, Schmitt Trigger [Analysis and Design] **Waveform generation:** Phase shift oscillator, Triangular wave generation using comparator **Filters:** Advantage of active filter, First order Butterworth Low pass, High pass, [Analysis and Design] **Self study component: Comparator -** Non-inverting and inverting comparator.	**Apply**	**8**
Module-5: Linear IC applications		
D/A and A/D convertors: Introduction to D/A and A/D convertors, R-2R D/A convertor, Successive approximation A/D convertors	**Apply**	**8**

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, **Self study component:** Adjustable voltage regulators using LM317		

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

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
11	Design of random sequence counter using JK flip flop.

Department of Electrical and Electronics Engineering

Semester: III		
Data Structures using C (PBL) **Course Code: 24EEE136**		
Teaching Hours/Week (L:T:P:J): (0:2:1:1)	**CIE Marks:** 50	
Credits: 2	**SEE Marks:** 50	
Hours: 30 hours	**SEE Duration: 0**3 Hours	
Course Learning Objectives: The students will be able to		
❖ Explain fundamentals of data structures and their applications essential for programming/problem solving. ❖ Illustrate linear and non-linear representation of data structures: Stack, Queues, Lists and Trees. ❖ Demonstrate sorting and searching algorithms. ❖ Find suitable data structure during application development/Problem Solving		
Pre-Requisites: C programming		
	Bloom's Level	**Hours**
Module-1: Introduction to Data Structures		
Introduction: Data Structures, Classifications (Primitive & Non-Primitive), Data structure Operations, Structures, Self-Referential Structures, and Unions. Pointers and Dynamic Memory Allocation Functions. **Recursion** - Factorial, Tower of Hanoi. **Self study component**: Fibonacci Sequence,	**Apply**	**5**
Module-2: Arrays and Strings		
Array Operations: Inserting, display, searching, and sorting. Multidimensional Arrays **Strings:** Pattern Matching algorithm: Brute force method. **Self-study component:** Strings Basic Terminology,	**Apply**	**5**
Module-3: Stacks		
Stacks: Definition, Stack Operations, Array Representation of Stacks, Stack Applications: Polish notation, Infix to postfix conversion, **Self study component:** Evaluation of postfix expression	**Apply**	**5**
Module-4: Queues		
Queues: Definition, Array Representation, Queue Operations, **Self-study component**: Dequeues	**Apply**	**5**
Module-5: Linked List and Trees		
Linked List: Linked Lists: Definition, Representation of linked lists in Memory, Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists **Trees:** Terminology, Binary Trees, Properties of Binary trees, linked Representation of Binary Trees, Binary Search Tree and Traversals - Inorder, postorder, **Self-study component:** preorder.	**Apply**	**5**
Course outcomes: At the end of the course the student will be able to CO1: Understand the concepts of linear and non-linear data structures and apply basic concepts such as pointers, structures, unions and recursion to write efficient programs. CO2: Apply pattern matching, searching and sorting techniques on array data structure CO3: Make use of various Data structures like stacks, queues, linked list and trees for problem solving		

CO4: Apply and analyze the concepts of various data structures on real world applications.

Reference Books

1. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures with C, 2nd Edition, Universities press,2014
2. Seymour Lipschutz, Data Structures Schaum's Outlines, Revised 1st Edition, McGraw Hill,2014
3. Gilberg & Forouzan, Data Structures: A Pseudo-code approach with C, 2nd Ed, Cengage Learning.2014.
4. Reema Thareja, Data Structures using C, 3 Ed, Oxford press, 2012.
5. Jean-Paul Tremblay & Paul G. Sorenson, An Introduction to Data Structures with Applications, 2nd Ed, McGraw Hill, 2013
6. A M Tenenbaum, Data Structures using C, PHI, 1989
7. Robert Kruse, Data Structures and Program Design in C, 2 Ed, PHI, 1996.

Lab Experiments (08 Lab Sessions)	
Sl. No.	**Experiments**
1	Write a C program to implement **structures** to read, write and compute average marks and the students scoring above and below the average marks for a class of N students.
2	Implement **Recursive function** for finding factorial of a given number.
3	Develop a program to sort the given set of N numbers using **Selection sort**
4	Implement a Program in C to check whether the pattern string **(PAT)** present in main string **(STR).** Report suitable messages in case **PAT** does not exist in **STR.**
5	Design, Develop and Implement a menu driven Program in C for the following operations on **STACK** of Integers (Array Implementation of Stack with maximum size **MAX**) a. ***Push*** an Element on to Stack b. ***Pop*** an Element from Stack c. **Display** the status of the Stack
6	Design, Develop and Implement a menu driven Program in C for the following operations on **QUEUE** of Integers (Array Implementation of QUEUE with maximum size **MAX**) a. **Insert** an Element on to Queue b. **Delete** an Element from Queue c. **Display** the status of the Queue
7	Implement Stack using **Singly Linked List**.
8	Design, Develop and Implement a menu driven Program in C for the following operations on **Binary Search Tree (BST)** of Integers a. Create a BST of **N** Integers: 6, 9, 5, 2, 8, 15, 24, 14, 7, 8, 5, 2 b. Traverse the BST in In-order, Preorder and Post Order

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Semester: III		
COURSE: CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS		
Course Code: 24CIP137	**L:T:P:J: 1:0:0:0**	**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.

	Bloom's Level	Hours
MODULE 1: Introduction to Indian Constitution		
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		
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		
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		
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		
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" by Cengage Learning India Private Limited, Latest Edition – 2018.

5. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice –Hall of India Pvt. 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 Name: Innovative Project Lab (Social Concern) **Course Code: 24EEE139**	
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. Continuous Internal 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

Syllabus

Semester: IV		
Course: Complex Analysis, Probability and Random Process **Course Code: 24MAE141 (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 – Students's t-distribution. 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.

CO - PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2			2							
CO 2	3	2			2							
CO 3	3	2			2							
CO 4	3	2			2							
CO 5	3	2			2							

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. B. V. Ramana: "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill, 2010.
7. 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/

Semester: IV		
Course Name: Electromagnetic Fields and Wave Theory (Professional core course) **Course Code: 24EEE142**		
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. ***Self-study component:*** *EM radiation effect of appliances and its effect on environment and human kind*	**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 ***Self-study component:*** *Definition of potential and potential difference*	**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. ***Self-study component:*** *Magnetic flux and flux density. Scalar and vector magnetic potentials*	**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	**Apply**	**8**

permeability. Magnetic boundary conditions. Magnetic circuit, inductance and mutual inductance. Problems ***Self-study component:*** Nature of magnetic materials, inductance and mutual inductance		
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. ***Self-study component:*** Faraday's law, Maxwell's equations	**Apply**	**8**

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

- ❖ Identify the methods of eliminating Electromagnetic interference in circuits
- ❖ Explain the concept of gradient, divergence and curl of a vector using Cartesian cylindrical & spherical coordinate systems.
- ❖ Determine electric fields by using Gauss Law, energy, potential and capacitance effect produced by different charge configurations.
- ❖ Determine the magnetic fields and magnetic flux density produced by circuit geometry
- ❖ Discuss the behavior of magnetic fields, magnetic force, magnetic materials and magnetic circuits
- ❖ 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

Semester: IV		
Electrical Motors and Synchronous Machines (Professional Course Integrated) **Course Code: 24EEE143**		
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 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		
Prerequisites: Knowledge of Electromagnetic Induction, Knowledge of three-phase AC circuits, KCL & KVL		
	Blooms Level	**Hours**
Module 1: DC Motors		
DC Motors: Construction and working principle, Back E.M.F and its significance, Torque equation, Classification, Characteristics of shunt, series & compound motors and their applications, Losses in DC motors, power flow diagram, efficiency, and conditions for maximum efficiency. Illustrative examples, construction, working principle, and applications of brushless DC motor for robotics and automation systems. **Self-study component:** permanent magnet DC motor - Construction, working principle and applications	**Apply**	**8**
Module 2: Starters, speed control and Testing of DC Motors		
Starters: need for starters, 3-point starter, starters for Series motors **Speed control**: speed control of DC shunt motor and series motor by armature and field control, illustrative examples **Testing of DC Motors:** Swinburne's test, Hopkinson's test, and Field's test on DC series machines, merits, and demerits of tests. Illustrative examples **Self-study component:** Direct load test	**Apply**	**8**
Module 3: Synchronous Generators		
Synchronous Generators: Types of Construction, Principle of Operation, Frequency of Induced EMF, Winding Factors, EMF Equation, Synchronous Reactance, Equivalent Circuit. Phasor diagram of non-salient type alternator, Illustrative examples *Self-study component: Armature Reaction*	**Apply**	**8**
Module 4: Voltage Regulation of Non-salient & Salient Pole Alternators		
Voltage Regulation of Non-salient Pole Alternators: EMF & MMF 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 **Self-study component:** ZPF method of finding leakage reactance	**Apply**	**8**
Module 5: Parallel operation of alternators & Synchronous Motors		

Parallel operation of alternators— need, conditions for parallel operation, Methods of synchronization of 3-phase alternators, load sharing between two alternators (simple illustrative examples) **Synchronous Motor:** Construction, principle of operation, Methods of starting, equivalent circuit, phasor diagrams, effect of change in excitation on armature current and power factor (V and inverted V curves), power developed, power flow, hunting and its suppression, Illustrative examples, Construction, working principle, and applications of permanent magnet synchronous motors for EV technology. **Self-study component:** factors (V, f, Zs) affecting load sharing	**Apply**	**8**

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

1. **Explain** the construction, working principles, and classification of DC motors and synchronous machines, including their starters and applications.
2. **Explain** the concepts of torque production, back EMF, armature reaction, and excitation control in DC and synchronous machines.
3. **Apply** testing methods such as load test, Swinburne's test, and slip test to evaluate the performance of DC and synchronous machines.
4. **Apply** standard procedures to compute voltage regulation of alternators using EMF, MMF, and ZPF methods and perform synchronization techniques for parallel operation.
5. **Analyse** the performance characteristics of DC motors and synchronous machines using performance curves, phasor diagrams, and V/inverted V curves to assess operational behaviour.

Laboratory Experiments:

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

Reference Books

1. Electrical Technology, B L Theraja and A K Theraja, 24th Edition, 2024
2. Electric Machines, D P Kothari, I J Nagrath, TMH, 5th edition, 2017
3. Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Co. Publications, 3rd edition, 2016
4. Electrical Machinery, J.B. Gupta, S K Kataria & Sons, Reprint 2013

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: IV		
Course Name: Linear Control Systems (Professional Course Integrated) **Course Code: 24EEE144**		
Teaching Hours/Week (L:T:P:J): (2:2:0:0)	**CIA Marks:** 50	
Credits: 3	**SEA Marks:** 50	
Hours: 40 Hours Theory+10 Lab Sessions	**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		
	Bloom's Level	**Hours**
Module-1: Modeling of control systems		
Introduction to Control systems, types, and Classification of control systems. **Mathematical modeling:** Modeling of mechanical systems, electrical systems, and Analogous systems, Illustrative examples DC Servomotors: Transfer function of armature-controlled and field-controlled servomotors. **Self Study Component: Transfer function of field-controlled servomotors.**	**Apply**	**8**
Module-2: Block Diagrams and Signal flow graphs		
Block diagrams: Block diagram of a closed loop system, block diagram reduction algebra to find the overall transfer function. Illustrative examples. **Signal flow graphs:** Definitions, construction of signal flow graph for electrical networks and Block diagrams Masons gain formula to find the overall transfer function. Illustrative examples. **Self Study Component: Algebraic equations based problems on signal flow graph**	**Apply**	**8**
Module-3: Time Domain Analysis		
Need for time domain analysis, Standard test signals, 2^{nd} order system and types based on damping factor, time response of second order systems subjected to unit step input, Time domain specifications, steady state error analysis. Illustrative examples **Self Study Component: Elementary signals, static error coefficient for Parabolic input and its steady state error**	**Apply**	**8**
Module-4: Stability analysis using Root locus and Routh Hurwitz techniques		
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 **Self Study Component: Determination of K range for stability in Root locus with R-H criterion**	**Apply**	**8**

Module-5: Stability analysis in the Frequency domain.		
Frequency domain specifications. Co-relation between time and frequency response – 2nd 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, Illustrative examples. Bode plot analysis for Op-amp based circuits **Self Study Component: Derivation of Relation between Mp, wn, wd, Mr, wr**	**Apply**	**8**

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

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

Sl. No.	Experiment
1	Synchro Transmitter- Receiver pair characteristics
2	Design and frequency response characteristics of Lag Network
3	Design and frequency response characteristics of Lead Network
4	Design and frequency response characteristics of Lag-Lead Network
5	Step response of a 2nd order system and effect of variation of damping factor using MATLAB
6	Step response of a 2nd order system and effect of pole location using MATLAB
7	Effect of PID controllers for a system using MATLAB
8	Root locus-based stability analysis for a given system
9	Bode plot-based stability analysis for a given system
10	Speed -Torque Characteristics of DC Servo Motor

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		
COURSE: ARM Processors and Applications (Project Based Laboratory) **Course Code: 24EEE145**		
Teaching Hours/Week (L:T:P:J) : (0:2:1:1)	**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,Background and history, inside typical ARM microcontrollers, Technical Overview: Processor Architecture, features of M3 and M4 processors **Self-study component:** Applications of ARM cortex M3 processor	Understand	**5**
Module-2: Architecture		
Introduction to the architecture, Programmer's model, APSR, Memory system, Exception and interrupts, System control block, Debug, Reset **Self-study component:** IO registers in ARM	Understand	**5**
Module-3: Instruction Set		
Comparison of the instruction set in ARM Cortex- M processors, Instruction set **Self study component:** Thumb instructions	Understand	**5**
Module – 4 : Memory System		
Overview of memory system features,connecting the processor to memory and peripherals, memory requirements **Self study component:** Memory map of ARM Cortex M3 processor	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. **Self study component:** 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 7-segment display and display hexa decimal codes 0-F
11	Write an ALP to count no. of 1's / 0's in a given data

SEMESTER – IV		
Course Name: Database Management System (Professional Core Course) **Course Code:24EEE146**		
Teaching Hours/Week (L:T:P:J) : (1:2:0:0)	**CIA Marks: 50**	
Credits: 2	**SEA Marks: 50**	
Hours: 30	**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 the 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:** Entity types-Entity sets-Attributes and Keys, Relationship types – Relationship Sets – Roles and structural Constraints, Weak Entity Types, **Self-study component: 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, **Self-study component: 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, **Self-study component:** Aggregate functions and GROUP BY clause, Views.	**Apply**	**8**
Module-4: Functional Dependencies and Normalization		
Basics of Functional Dependencies and Normalisation 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, Self-study component: 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**

Self-study component: NoSQL: Why NoSQL? The Emergence of NoSQL		

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
23EEE146.1	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
23EEE146.2	Understand the concepts of database design and enforcing integrity constraints on a database using RDBMS.	**Understand**	PO1, 2, 3,12
23EEE146.3	Apply Structured Query Language (SQL) for database manipulation	**Apply**	PO1, 2, 3, 4, 5, 6, 9,10,12
23EEE146.4	Apply Functional Dependency concepts to normalize relation	**Apply**	PO1, 2, 3, 4, 5,12
23EEE146.5	Understand and the concept of transaction processing and un-structured database	**Understand**	PO1, 2, 3,12

Semester: IV	
Course Name: Internship-1/Innovative Project Lab **Course Code: 24EEE147**	
Teaching Hours/Week (L:T:P:J): (0:0:2:2)	**CIA: 100**
Credits: 1	**SEA: NA**
Hours: 15	**SEA Duration: NA**

Course Objectives:

- To encourage independent learning and innovative attitude of the students
- To inspire teamwork
- 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.

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical and Electronics Engineering

V Semester Syllabus

Semester: V	
Course Name: AI & ML applications in Electrical systems (Professional Core course) **Course Code:24EEE151**	
Teaching Hours/Week (L: T: P: J): (2:2:0:0)	**CIA Marks: 50**
Credits :3	**SEA Marks: 50**
Hours: 40 hours Theory	**Exam Hours: 03**

Course Learning Objectives: This course will enable students to

- To understand the basic theory underlying machine learning, types, and the process.
- To become familiar with data and visualize univariate, bivariate, and multivariate data using statistical techniques and dimensionality reduction.
- To understand various machine learning algorithms such as similarity-based learning, regression, decision trees, and clustering.
- To familiarize with learning theories, probability-based models, and reinforcement learning, developing the skills required for decision-making in dynamic environments.

	Bloom's Level	Hours
Module-1: Introduction to AI and ML		
Introduction to AI: AI problems, Agents and Environments, Structure of Agents, Problem Solving Agents Basic Search Strategies: Problem Spaces, Uninformed Search (Breadth-First Search, Depth-first with Iterative Deepening), Heuristic Search (Hill Climbing, Generic Best-First, A*), **Self-study component:** Depth-First Search **Introduction to Machine Learning**: Need for Machine Learning, Machine Learning Explained, Machine Learning in Relation to Other Fields, Types of Machine Learning, Challenges of Machine Learning, Machine Learning Process, Self-study component: Machine Learning Application. **Sample Program Exercises:** 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 and Depth first Search algorithm	**Apply**	**8**
Module-2: Understanding Data		
Understanding Data: Introduction, Big Data Analytics and Types of Analytics, Descriptive Statistics, Univariate Data Analysis and Visualization, Bivariate Data and Multivariate Data. Multivariate Statistics, Essential Mathematics for Multivariate Data, Overview of Hypothesis, Feature Engineering and Dimensionality Reduction Techniques. **Self-study component:** Big Data Analysis Framework **Sample Program Exercises:** 1. **Exploratory Data Analysis and Visualization:** Perform univariate, bivariate, and multivariate analysis on a real-world dataset t(Iris dataset or Titanic dataset). 2. **Load Profile Analysis and Power Consumption Pattern Recognition:** Analyze residential or industrial electrical load data to understand energy consumption trends and perform statistical analysis. Use the Individual household electric power consumption dataset	**Apply**	**8**

(available on UCI Machine Learning Repository) or simulated smart meter data.		
Module-3: Similarity-based Learning and Regression Analysis		
Similarity-based Learning: Introduction to Similarity or Instance-based Learning, Nearest-Neighbor Learning, Weighted K-Nearest-Neighbor Algorithm, Nearest Centroid Classifier, Locally Weighted Regression (LWR). **Regression Analysis:** Introduction to Regression, Introduction to Linearity, Correlation, and Causation, Introduction to Linear Regression, Validation of Regression Methods, Multiple Linear Regression, Polynomial Regression, **Self-component:** Logistic Regression. **Sample Programming Exercises:** 1. Develop a ML Model to predict home prices using Linear Regression method (Source.USA_Housing.csv) 2. Develop a ML model for Electricity-Generation-Analysis-and-Prediction-in-India by Linear regression (Source: energygen.csv)	**Apply**	**8**
Module-4: Decision Trees and Bayesian Learning		
Models Based on Decision Trees: Introduction to Decision Tree, Decision Tree for Classification, Impurity Measures for Decision Tree Construction, Properties of Decision Tree Classifier (DTC), Regression Based on Decision Tress. **Bayesian Learning:** Fundamentals of Bayes Theorem, Classification Using Bayes Model. **Self-study component**: Introduction to Probability-based Learning **Sample Programming Exercises:** 1. Develop a decision tree model to analyze the voltage and current patterns across the three phases of the transmission lines to detect faults 2. Develop a Naive Bayes classification model to predict the probability of a battery fault based on various battery parameters logged from an EV Battery Management System (BMS).	**Apply**	**8**
Module-5: Clustering and Reinforcement learning		
Clustering: Introduction to Clustering, Clustering of Patterns, Divisive Clustering, Agglomerative Clustering, **Reinforcement Learning:** Overview and Scope of Reinforcement Learning, Components of Reinforcement Learning, Q-Learning. **Self-study component**: Partitional Clustering. **Sample Programming Exercises:** 1. Use K-Means clustering to group electricity consumers into distinct categories based on their daily or hourly load profiles. This helps utilities design demand response strategies, pricing models, or infrastructure planning. **2.** Use Q-Learning, a reinforcement learning algorithm, to optimize the charging schedule of an electric vehicle to minimize cost and avoid peak grid load hours.	**Apply**	**8**
Course outcomes: The students will be able to 1. Apply the knowledge of AI to write simple algorithm and to solve problems on search algorithm 2. Demonstrate the need for machine learning, its relationship to other fields, and different types of machine learning 3. Illustrate the fundamental principles of multivariate data and apply dimensionality reduction techniques. 4. Apply similarity-based learning, linear, polynomial regression, decision trees for classification and regression problems, Bayesian models for probabilistic learning , clustering algorithm, Q-learning for decision making tasks 5. Develop solutions for real world problem using similarity-based learning, linear, polynomial regression, decision trees for classification and regression problems, Bayesian models for probabilistic learning, clustering algorithm, Q-learning for decision making tasks		
Text Books /Reference Books:		

1. Kevin Knight, Elaine Rich, B. Nair, “Artificial Intelligence”, Tata McGraw Hill Education Private Limited, 3rd Edition, 2010.
2. S Sridhar and M Vijayalakshmi, “Machine Learning”, Oxford University Press, 2021.
3. M N Murty and Ananthanarayana V S, “Machine Learning: Theory and Practice”, Universities Press (India) Pvt. Limited, 2024.
4. Aurelien Geron, “Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow”, O’Reilly Media, 2nd Edition, 2019
5. Tom Mitchell, Machine Learning, McGraw Hill, 2017.
6. Yuxi (Hayden) Liu, “Python Machine Learning by Example”, Packet Publishing Limited, 2017.

Semester: V			
Course: Digital Signal Processing (Professional Core Course) **Course Code: 24EEE152**			
Teaching Hours/Week (L:T:P:J) : (2:2:0:0)	**CIA**	**:**	**50**
Credits:03	**SEA**	**:**	**50**
Hours: 40 Hours Theory	**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 & Frequency 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, Frequency response of LTI systems. **Self Study component:** Properties of LTI systems: Commutative, associative & distributive properties.	**Apply**	**8**
Prerequisite Knowledge to be covered for Understanding this Module, But not included for Evaluation: Basic Operations on signals (Dependent and Independent variables), Sketch signals.		
Module-2: Discrete Time Fourier Transform (DTFT) and its Spectral Analysis		
Properties of DFT: Periodicity, Linearity, Symmetry, Multiplication of two DFTs, Circular Time Shift, Time Reversal, Circular Frequency Shift with examples, Circular Convolution (Circular Array and DFT-IDFT Methods only) , Linear Filtering of DFT using Overlap ADD and Overlap SAVE methods (only), Spectral Analysis of real signals using DFT **Self Study component:** Circular Convolution using Tabular Array)	**Apply**	**8**
Module-3: Fast Fourier Transforms Algorithms and its Applications		
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, **Applications of FFT** for Linear Filtering **Self Study component:** Inverse DIT and DIF Radix -2 FFT	**Apply**	**8**
Module-4: Design of Digital IIR Filters and Realization		
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. Design of IIR filters using least square method, Realization of Digital IIR filters using Cascade and Parallel structures.	**Apply**	**8**

Self Study component: Realization of Digital IIR filters using Direct form I and II		
Module-5: Design of Digital FIR Filters and Realization: **DSP Architecture & Design of Intelligent Signal Processing Systems**		
Design of Symmetric-Linear Phase FIR Filters using Rectangular, Hamming, Hanning & Blackman Windows, Numerical Examples. Realization of Digital FIR filters using Cascade structures, Multi-rate FIR filter concepts **Self Study component:** Realization of Digital FIR filters using Direct form **Digital Signal Processor TMS320C67x Processor**: Introduction, Features, Internal architecture, Design of Intelligent Signal Processing Systems: Role of DSP in modern intelligent systems, Introduction to Machine Learning for signal processing (Supervised, Unsupervised, DL basics), Signal acquisition and digitization.	**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. "Digital Signal Processing", John G. Proakis, Dimitris. G. Manolakis, Pearson Education India, 4th Edition, 2017.
4. "Digital Signal Processing", A. Nagoorkani, McGraw Hill,3rd Edition, 2021.
5. "Digital Signal Processing", S. Salivahanan, McGraw Hill 4th Edition, 2019.
6. "Digital Signal Processing using MATLAB", Vinay K Ingle. John G. Proakis, CL Engineering, 2nd Edition, 2011
7. "Digital Signal Processing", Jhonny R. Jhonson, Pearson, 1st Edition, 2016.

Semester: V	
Course Name: REAL TIME OPERATING SYSTEM [Professional Core Integrated] **Course Code: 24EEE153**	
Teaching Hours/Week (L:T:P:J): (2:0:4:0)	**CIA Marks: 50**
Credits: 4	**SEA Marks: 50**
Hours: 30 Hours Theory +20 lab Sessions	**SEA Duration: 03 Hours**

Course Learning Objectives:

- ❖ Understand the Architecture of QNX Neutrino RTOS and Develop Real-Time Applications
- ❖ Understand the working of QNX Development Tools (Momentics IDE)
- ❖ Able to Implement Process and Thread Management
- ❖ Understand the Master Inter-Process Communication (IPC)
- ❖ Debug and Optimize Embedded Systems

Pre-Requisites: Operating Systems basics and C programming and Linux commands.

QNX Momentics Development Basics: Eclipse Basics, Targets, Projects and Source, Compiling, Exercise, Running and Debugging, Exercise and Versions.

QNX Neutrino RTOS Environment Setup

Objective: Install and configure QNX SDP, Momentics IDE, and target system (real or virtual).

Outcome: Understand development workflow in QNX.

Course outcomes:

The students will be able to

- Understand the Architecture of QNX Neutrino RTOS and implement Real-Time Applications
- Apply the working of QNX Development Tools (Momentics IDE) on Processes, Threads & Synchronization.
- Implement the QNX Inter-Process Communication and compare QNX IPC Methods
- Apply the QNX Inter-Process Communication with Hardware Programming and Interrupt handling
- Understand the timing architecture, High-Resolution Timers, Images & Buildfiles and Resource Manager

Module-1:	RBT	Hrs
Introduction to QNX Real Time Operating System: Architecture – Executive, Microkernel, Inter process Communication, Processes and Threads model, Timing, Interrupt Handling, Scheduling, Boot Sequence, Security.	**Apply (CO1)**	**4**
Laboratory Component: Process Creation and Management **Running and Debugging: Exercise** Objective: Create and run hello world example on VM Ware virtual machine or Rasp-pi board. Outcome: Print hello world on panel of QNX Momentics IDE Objective: Write a program to create and manage multiple processes. Outcome: Demonstrate use of fork(), exec(), and wait() in QNX. **Self-Study Component:** Demonstrate how to Detect the termination of a child processes.	**Apply (CO1, CO2)**	**6**
Module–2:	**RBT**	**Hrs**
Security Policies: Introduction to the use of security policies in securing a QNX system, Process Managers: System Library, Shared Objects, OS Services, Boot Sequence and Security. **Processes, Threads & Synchronization:** Introduction, Processes: Creation and Detecting termination, Threads, Process Termination and Cleanup.	**Apply (CO2)**	**4**
Laboratory Component: Thread Creation and Synchronization Processes - Detecting Termination: Exercise Synchronization - Mutexes: Solution to synchronization problems using Mutex Synchronization - Conditional Variables: Program in synchronization using Conditional Variables. **Self-Study Component:**	**Apply (CO2)**	**6**

Synchronization - Atomic Operations: Simple program solutions on atomic operations		
Module–3:	**RBT**	**Hrs**
Introduction to QNX Inter-Process Communication: Message Passing, Designing a Message Passing System (1): Pulses, Client Information Structure, How a Client Finds a Server, Multi-Part Messages. **Comparing QNX IPC Methods:** The Methods, How to Choose.	**Understand (CO3)**	**4**
Laboratory Component: **Inter-Process Communication using Message Passing:** Implement server-client IPC using MsgSend(), MsgReceive(), and MsgReply(). Programs to demonstrate IPC with pulses Programs to demonstrate IPC with multipart messages **Self-Study Component:** Assignment on Inter-Process Communication (IPC)	**Apply (CO3,CO4)**	**6**
Module–4:	**RBT**	**Hrs**
QNX Inter-Process Communication: Issues Related to Priorities, Designing a Message Passing System (2): Event Delivery Shared Memory **Introduction to Hardware Programming:** Hardware I/O, Programming PCI bus devices, Handling Interrupts.	**Apply (CO4)**	**4**
Laboratory Component: Event Delivery: Program to demonstrate IPC – event delivery Shared Memory: Implement IPC using shared memory **Self-Study Component:** Handling Interrupts : Program on Interrupt handling	**Apply (CO4)**	**6**
Module–5:	**RBT**	**Hrs**
Timers, Clocks and Timeouts: Introduction, Timing Architecure, Getting and Setting the System Clock, Introduction to Timers, High-Resolution Timers, Design Considerations, Kernel Timeouts. **Build a QNX Neutrino Boot/OS Image:** Introduction, Images & Buildfiles, Images & Buildfiles: Exercise option **Resource Managers:** Introduction, A Simple Resource Manager: Initialization and Handling read() and write().	**Apply (CO5)**	**4**
Laboratory Component: Timers: Program on timers Program to initialize Resource managers. Handling read() and write() - read() ***Self-Study Component:*** Implementation of Image building	**Apply (CO5)**	**6**

Reference Books:

1. Operating Systems: Design and Implementation - Andreq S Tanenbaum
2. The Linux Programming Interface- Michael Kerrisk

Marks Distribution for Assessment

CIA (50)	Components	Description	Marks
	Written test	• Total Number of Test:03 • Each Theory test will be conducted for 30 marks • Average of 3 tests= 30 Marks	**30**
	Practical	• Total number of Test: 02 [Part-A (Modue-1 and 2) and Part-B (Module 3,4 and 5)] Each Lab test will be conducted for 50 marks and reduce to 10 Average of 2 tests= 10 Marks	**10**

		• Laboratory conduction is to be evaluated every week. conducted & Viva = 5 Marks Lab Record = 5 Marks	**10**
		Total CIA	**50**
SEA (50)	Theory Part	5 Questions to answer each of 6 M (6M * 5= 30M) 2 Questions from each module with internal choice. Student should answer one full question from each module.	30
	Execution Part	Conduction – 60 Marks Viva Voce – 10 Marks (one experiment from Part-A and one experiment from PART-B)	70
		Scaled down to 50 marks	**50**
		Total Marks for the Course	**100**

Semester: V	
Course Name: Power Electronic Devices and Circuits [PCI] **Course Code: 24EEE154**	
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 and snubber circuits **Applications of Power Electronics:** Types of Power Electronic Converter Circuits and their applications, Peripheral Effects of Power Electronic Converters **self-study:** Applications of power electronics converters with block diagram.	**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, Principle of 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 of working, Switching times. **self-study:** 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 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. **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. **self-study:** Thyristor classification according to Switching times and Thyristor selection according to Converter types, Unijunction Transistor characteristics and firing circuit.	**Understand**	**8**
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. **self-study:** single phase uncontrolled rectifiers [excluding mathematical analysis]	**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, peak ripple 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 **self-study:** Basic classification and working of DC-DC Converters [based on quadrant operation], inverter 120° mode of operation.	**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
11	Demonstration: Firing pulse generation using Arduino

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	4thEdition, 2017
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	Dr. P S Bimbhra	Khanna Publications	7th Edition, 2022

Semester: V

COURSE: Design of digital controllers using Programmable Logic Controller
(Project Based laboratory)
Course Code: 24EEE155

Teaching Hours/Week (L:T:P:J) : (0:2:1:1)	**CIA Marks: 50**
Credits: 2	**SEA Marks: 50**
Hours: 30	**SEA Duration: 03 Hours**

Course Learning Objectives: The students will 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:

- Digital Logic Circuits
- Microcontrollers

	Bloom's Level	Hours
Module-1: Programmable logic controllers (PLCs): An Overview		
Programmable logic controller, Parts of a PLC, principles of operation, Modifying the operations, PLC verses computers, PLC size and applications ***Self-Study Component:*** *PLC verses computers, PLC size*	Understand	**5**
Module-2: PLC Hardware Components		
The I/O Section, Discrete I/O Modules, Analog I/O Modules, The Central Processing Unit (CPU), Memory Types, Programming Terminal Devices, Human Machine Interfaces (General structure only) ***Self-Study Component:*** *Memory Types*	Understand	**5**
Module-3: Fundamentals of Logic		
Basic Concept, AND, OR, XOR and NOT Functions, Boolean Algebra, Developing Logic gate circuits from Boolean expressions, Boolean equation for a given logic gate circuit, Programming Word Level Logic Instructions ***Self-Study Component:*** *Basic Concept, AND, OR, XOR and NOT Functions, Boolean Algebra*	Analyze	**5**
Module – 4 : Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs		
Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors (proximity sensor, ultrasonic sensor), output control devices, Seal-In Circuits, Electrical Interlocking Circuits, Writing a Ladder Logic Program Directly from a Narrative Description(Ex 6.1,6.3) ***Self-Study Component:*** *Manually Operated Switches, Mechanically Operated Switches*	Apply	**5**
Module – 5: Timers and Counters		
Mechanical Timing Relays, Timer Instructions, On-delay Timer Instruction, Off-Delay Timer Instruction, Counter Instructions, Up-counter (One shot Instruction only), Down Counter, Up-down counter, Introduction to SCADA systems and architectures. ***Self-Study Component:*** *Mechanical Timing Relays, SCADA Systems*	Apply	**5**

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

1. Understand the technical overview and Instruction set of Programmable logic controller.

2. Understand the architecture of hardware components interfacing with PLC.
3. Construct the logical circuits from Boolean expressions and also derive Boolean equations for given logic circuits
4. Developing PLC Wiring Diagrams and Ladder Logic Programs Interfacing with Switch, contactor, Motor, and relays.
5. Build projects using Programmable logic controller for a real-life problem.

Reference Books

1. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, Mc Graw Hill
2. John W Webb, Ronald A Reis, "Programmable Logic Controllers : Principles and Application", PHI Learning, New Delhi, 5 th Edition

Sl.No	Experiments
1	Introduction to PLC trainer & its Installation with PC
2	Write and implement a simple ladder logic program to study and verify gates using digital inputs and outputs for PLC (AND, OR, NOT, XOR)
3	Write a ladder program to switch ON/OFF the light
4	Write a ladder program to Forward – Reverse- Stop with Mutual Interlock
5	Write a ladder program for an Alarm system
6	To study the On Delay Timer operation
7	To study the OFF Delay Timer operation
8	Implementation of simple ladder logic program using Up counter
9	Implementation of simple ladder logic program using down counter
10	Write a ladder program to implement DOL starter for a motor

Department of Electrical and Electronics Engineering

Semester: V		
COURSE: Energy Audit and Energy Management System (Open Elective) **Course Code:24EEE1561**		
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,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. **Self study component:** Energy scenario in India	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 Medium Industries, Energy conservation in Small scale industries. **Self study component**: Energy conservation in Large 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. Electrical system, HVAC, Compressed air system, and Buildings, Certifying agencies in India. **Self study component:** Energy audit for illumination system	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, Availability based tariff **Self study component:** Energy efficient motors	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, **Self study component:** 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

Department of Electrical and Electronics Engineering

Semester: V		
Course Name: Non-Conventional Energy Resources (Open Elective) **Course Code: 24EEE1562**		
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 resources 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, and site selection for wind turbines ❖ To discuss geothermal systems, their classification and geothermal-based electric power generation ❖ To discuss biomass production, types of biomass gasifiers, and and properties of producer gas. ❖ To discuss tidal energy resources, energy availability, and power generation. ❖ To explain the principles of ocean thermal energy conversion and the production of electricity		
Prerequisites: 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, and biomass energy. **Self-study component:** Case studies on conventional and non-conventional power plants	**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, Illustrative Problems. **Emerging PV applications:** Solar thermal applications—solar water heating system and active solar space heating and cooling, Building Integrated PV (BIPV), Agri-voltaics, floating solar PV **Self-study component:** Solar forecasting for grid integration.	**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.	**Understand**	**08**

Self-study component: Parts of a Wind Turbine		
Module 4: Biomass energy & Tidal energy		
Biomass energy - Biomass production, Biomass gasification, Theory of gasification, Gasifiers 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). **Self-study component:** Applications of biomass gasifiers, Problems faced in exploiting tidal energy	**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, and 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 **Self-study component:** Environmental Effects of Geothermal Power Plants, Application of OTEC in addition to energy production	**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

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical and Electronics Engineering

Semester: V		
Course Name: Fundamentals of Hybrid and Electric Vehicles (Open Elective) **Course Code: 24EEE1563**		
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, **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) **Self Study component:** Electric Vehicle Market	**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,. Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains (Excluding classification) **Self Study component:** Energy consumption of Electric Vehicle	**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. **Self Study component:** Supercapacitors	**Understand**	**08**
Module-4: Electric Propulsion		
Introduction, DC motor Drives, the principle of operation, Special Electric Motors: Permanent Magnet BLDC Motor Drives, Basic principles of BLDC Motor Drives, BLDC Machine Construction, and Classification, introduction to SRM Motor Drives. **Self Study component:** Speed control using armature voltage, and field control method.	**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, **Self Study component:** 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. 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

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of Electrical and Electronics Engineering

Semester: V		
Course Name: Sensors and Transducers (Open Elective) **Course Code: 24EEE1564**		
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, **Self-Study component:** 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 **Self-Study component:** 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, **Self-study component:** Quartz crystal microbalance.	**Understand**	**8**
Module-4: Signal conditioning and DAQ systems		
Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types	**Understand**	**8**

of Amplifiers, Mechanical Amplifiers, Fluid Amplifiers, Optical Amplifiers, Electrical and Electronic Amplifiers. **Data Acquisition Systems and Conversion:** Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, **Self-study component:** 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. Self-study component: 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,2008.
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

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Department of EEE

Semester: V	
Course Name: Internship -2 **Course Code: 24EEE158**	
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

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: Object Oriented Programming using Java (Professional Core course) **Course Code: 24EEE161**		
Teaching Hours/Week (L:T:P:J): (2:2:0:0)	**CIA Marks:** 50	
Credits: 4	**SEA Marks:** 50	
Hours: 40 Theory	**SEA Duration:** 03 Hours	
Course Objectives: ❖ To learn primitive constructs in JAVA programming language. ❖ To understand Object Oriented Programming Features of JAVA. ❖ To gain knowledge on packages, multithreaded programming and exceptions.		
Pre-Requisites: Basic Programming Concepts		
	Bloom's Level	**Hours**
Module-1:		
Data Types, Variables, and Arrays: The Primitive Types (Integers, Floating-Point Types, Characters, Booleans), Variables, Type Conversion and Casting, Arrays. **Operators:** Arithmetic Operators, Relational Operators, Boolean Logical Operators, The Assignment Operator, The ? Operator, Operator Precedence. **Control Statements:** Java's Selection Statements (if, the Traditional switch), Iteration Statements (while, do while, for, Nested Loops), **Self-study Component:** Jump Statements (Using break, Using continue, return).	**Understand**	**8**
Module-2:		
Introducing Classes: Class Fundamentals, Declaring Objects, Assigning Object Reference Variables, Introducing Methods, Constructors, The this Keyword. **Methods and Classes:** Overloading Methods, Objects as Parameters, Argument Passing, **Self study component**: Returning Objects.	**Understand**	**8**
Module-3:		
Inheritance: Inheritance Basics, using super, creating a Multilevel Hierarchy, When Constructors Are Executed, Method Overriding, **Interfaces:** Interfaces, Default Interface Methods, Use static Methods in an Interface, Private Interface Methods. **Self-study component:** Using Abstract Classes.	**Apply**	**8**
Module-4:		
Packages: Packages, Packages and Member Access, Importing Packages. **Exceptions:** Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Nested try Statements, throw, throws, finally, Java's Built-in Exceptions.	**Apply**	**8**
Module-5:		
Multithreaded Programming: The Java Thread Model, The Main Thread, Creating a Thread, Creating Multiple Threads, Using isAlive() and join(). Enumerations, Type Wrappers and Autoboxing: Enumerations (The values() and valueOf() Methods), Type Wrappers (Character, Boolean, The Numeric Type Wrappers), **Self-study component:** Autoboxing (Autoboxing and Methods).	**Apply**	**8**
Course Outcomes: After the completion of the course the students will be able to: CO 1: Demonstrate proficiency in writing simple programs involving branching and looping structures. CO 2: Design a class involving data members and methods for the given scenario. CO 3: Apply the concepts of inheritance and interfaces in solving real world problems.		

CO 4: Use the concept of packages and exception handling in solving complex problem. CO 5: Apply concepts of multithreading, autoboxing and enumerations in program development.		

Reference Books

1. Java: The Complete Reference, Twelfth Edition, by Herbert Schildt, November 2021, McGraw-Hill, ISBN: 9781260463422.
2. Programming with Java, 6th Edition, by E Balagurusamy, Mar-2019, McGraw Hill Education, ISBN: 9789353162337.
3. Thinking in Java, Fourth Edition, by Bruce (https://sd.blackball.lv/library/thinking_in_java_4th_edition.pdf)

B.N.M. Institute of Technology

An Autonomous Institution under VTU, Approved by AICTE

Department of Electrical and Electronics Engineering

Semester: VI		
Course Name: Power System Analysis and Stability (Professional Core Integrated) **Course Code: 24EEE162**		
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 understand the representation of power systems for further analysis. ❖ Develop network matrices and models for solving load flow problems. ❖ Compute Z-bus matrix using Z bus building algorithm ❖ 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 and apply the tool symmetrical components for unsymmetrical fault analysis. ❖ To analyse the unsymmetrical faults on an alternator and on power systems and designing the protection schemes. ❖ To understand the stability aspects of a synchronous machine under fault conditions. ❖ Solve steady state power flow of power system networks using Gauss-Seidel, Newton-Raphson and Fast decoupled iterative methods. ❖ Solve the swing equation by point-by-point method.		
Pre-Requisites: Equivalent circuits of Synchronous Machines and Transformers, complex number calculations		
	Bloom's Level	**Hrs**
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. Advantages of per-unit computations. Illustrative examples. Properties and Formation of Y Bus using Inspection Method. **Self study component**: Per-unit equivalent impedance of three winding transformers.	**Apply**	**08**
Module-2: Network Topology		
Introduction, Graphs, terminologies of Graph Theory, Introduction to Incidence Matrices, Bus Incidence Matrix, Primitive Networks – Impedance and Admittance forms, and Singular Transformation Method, Problems (Restricted to 3-bus systems and without mutual coupling). Z-Bus Building Algorithm and problems (Without mutual coupling). **Self study components**: Tie-set and Cut-set matrices.	**Apply**	**08**
Module-3: Symmetrical three-phase faults on Synchronous Machines and on power systems.		
Introduction. Types and Classification of faults. Transients in R-L series circuits. Short-circuit currents and the reactances of Synchronous Machines. Need for fault study. Selection of circuit breakers. 3-phase fault MVA calculations on simple power systems, Illustrative examples. **Symmetrical components**. Symmetrical components of unsymmetrical phasors.	**Apply**	**08**
Module-4: Unsymmetrical Faults Analysis using Symmetrical Components		

Introduction. Sequence impedances. Positive, negative and zero sequence networks of generators, transformers, transmission lines and power systems. Illustrative examples. 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 with simple two-bus systems. **Self study components:** Power in terms of symmetrical components.	**Apply**	**08**
Module-5: Load Flow Analysis		
Introduction, Power flow Equations, Types of Buses, operating constraints, Data for Load Flow Studies, Solution technique, Gauss- Seidel (G-S) Method – Algorithm and Flowchart for Load flow solution using G-S Method, Acceleration Factor, Illustrative examples. Newton Raphson (N-R) Method for Load flow solution (Only Polar coordinates), Illustrative examples, Comparison of Load Flow Methods. **Self study components:** Fast Decoupled Load flow (FDLF) studies – Assumptions,	**Apply**	**08**
CO1-Compute per unit reactance diagram with the understanding of the concept of one line diagram & its implementation in power system networks.		
CO2- Analyze short circuit on synchronous machine under no load and loaded conditions and the effect of transients on a Transmission Line.		
CO3-Evaluate the sequence impedance & sequence networks of power system components, power system and parameters in unbalanced three phase circuits.		
CO4- Analyze three phase synchronous machine and simple power systems for single line to ground fault, line to line fault, double line to ground fault and open conductor faults using symmetrical components.		
CO5- Evaluate the stability of a simple power system under fault conditions by equal area criterion with the knowledge of dynamics of synchronous machine, stability and types of stability.		
CO6- Measurement of sequence impedances of an alternator.		

Reference Books:

1. Electrical Power Systems. Ashfaq Hussain. CBS Publishers. 5th Ed.
2. "Computer Methods in Power System Analysis", Glenn W. Stagg, Ahmed H El-Abiad, MEDTECH, Scientific International Pvt. Ltd., 1st Edition, 2019
3. Elements of Power System Analysis. William D Stevenson, McGraw-Hill Pub. 2nd. Ed.
4. "Modern Power System Analysis", D P Kothari, I J Nagrath, Tata McGraw Hill, 5th Edition, 2022.
5. Electrical Power Systems. C.L.Wadhwa. New Age International Publishers. 7th Ed,2006
6. Power System Analysis and Design with WebAssign, 7th Edition Paperback – 1 April 2024 by Thomas Overbye Adam Birchfield, J. Duncan Glover, Mulukutla S. Sarma

and Web links and Video Lectures:

List Of Experiments

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

Experiments 1 to 5 are conducted using MATLAB

B.N.M. Institute of Technology

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Department of Electrical and Electronics Engineering

Semester: VI	
Course Name: High Voltage & Power System Protection **Course Code: 24EEE163**	
Teaching Hours/Week (L:T:P:J): (3:0:2:0)	**CIA Marks: 50**
Credits: 3	**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 construction, operating principles and performance of various Overcurrent, distance and differential relays protection schemes.
- To explain the principle of circuit interruption and operation of circuit breakers.
- 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. ***Self study:*** 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. Simulation and Safety Analysis of High Voltage ***Self study:*** Generation Circuits Using MATLAB/Simulink or LTspice.	**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**

Self study: Effect of Ambient Temperature on Flash and Fire Point of Transformer Oil.		
Module-4: Relays in Modern Power System		
Introduction to Power System Protection: Need for protective schemes, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Static Relays, Numerical Relays Merits and Demerits of Static Relays & Numerical Relays **Overcurrent Protection:** Overcurrent Protective Schemes (with numerical on plug setting and time multiplier settings), Directional Overcurrent Relay, Block diagram of Static and Numerical Overcurrent Relays. **Distance Protection:** Impedance Relay - Operating Principle, Characteristics, Microprocessor-based Impedance Relay ***Self study:*** Differential Protection-Percentage Differential Relay for protection Generator and Transformer	**Understand**	**8**
Module-5: 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, ***Self study:*** Rating of Circuit Breakers, Testing of Circuit Breakers.	**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. Explain the working principle of Overcurrent, Distance and Differential protection schemes
5. Explain the principle of circuit interruption & construction of air, oil, vacuum and SF6 circuit breakers
6. Explain the impact of high voltage systems on society

Reference Books:

1. High Voltage Engineering, M.S. Naidu and Kamaraju, McGraw Hill, 6th Edition, 2020.
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, 4th Edition, 2020
4. High-Voltage Test and Measuring Techniques, Wolfgang Hauschild, Eberhard Lemke, Springer, 2nd Edition, 2019
5. Power system protection & Switchgear, Bhuvanesh Oza Nirmal Kumar Nair Rashesh Mehta Vijay Makwana, McGraw-Hill Education, 2nd edition, 2017.
6. Fundamentals of Power System Protection, Y.G.Paithankar, S.R. Bhide, PHI, 2nd Edition, 2010
7. Power system protection & Switchgear, J Badariram& D.N Vishwa Kharma, McGraw Hill, 3rd Edition 2022.

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
3. NPTEL Course on "Power system protection and switchgear", https://onlinecourses.nptel.ac.in/noc21_ee110/preview, coordinated by IIT Roorkee.

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 and 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: 24EEE164		
L:T:P:J: 0:0:2:2	**CIA Marks: 50**	
Credits: 2	**SEA Marks: 50**	
Hours: 30	**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, Introduction to multilevel inverters. **Self study:** 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. **Self study:** Summary of existing electric and hybrid vehicles	**Analyze**	**05**
Module-3: Energy storage systems - Batteries and fuel cells		
Battery: Current Status of Rechargeable Batteries -general definitions, battery design, Constant current, constant voltage and constant current and voltage charging methods. Introduction to BMS. Fuel cells: Introduction, Classifications of fuel cells - Aqueous Fuel Cell Using Specific Electrolyte, Fuel Cells Using Semi Solid Electrolyte, Fuel Cells Using Molten Electrolyte. Classifications of Fuel Cells Based on Electrolytes.Fuel Cells for Aircraft Applications. **Self study:** Applications of batteries and fuel cells to Electric vehicles.	**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. Designing Grid-connected PV systems. **Self study:** Article on grid connected PV System	**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. **Self study:** Article on wind turbine power generation.	**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:

1. **Eklas Hossain - MATLAB and Simulink Crash Course for Engineers (2022)**
2. **Wireless Power Transfer Technologies for Electric Vehicles, Xi Zhang, Chong Zhu, Haitao ,Song, Year:2022, Publisher:Springer**
3. **Electric and Hybrid Vehicles Design Fundamentals by Iqbal Husain. 2021**
4. **Next-Generation Batteries and Fuel Cells for Commercial, Military, and Space Applications,A.R. JHA, CRC Press, Taylor & Francis Group, 2012.**

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.**CO5**
5	Design and develop a Simulink model for boost converter.**CO5**
6	Design and develop a Simulink model for buck boost converter.**CO5**
7	Develop a vehicle dynamic simulation model. **CO2**
8	Design and develop a charging circuit for li ion batteries. **CO3, CO5**
9	Develop a circuit to estimate SoC of Battery using coulomb counting method.**CO3, CO5**
10	Develop a Simulink mathematical model of the solar PV cell and compare it with the inbuilt model. **CO4**
11	Develop a wind turbine -based generator in Simulink. **CO4**

Semester: VI		
Renewable Energy Sources (Professional Elective Course) **Course Code: 24EEE1651**		
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 **Self-study component:** Case studies on conventional and non-conventional power plants	**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). **Emerging PV applications:** Solar thermal applications—solar water heating system and active solar space heating and cooling, Building Integrated PV (BIPV), Agri-voltaics, floating solar PV, **Self-study component:** Solar forecasting for grid integration.	**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	**Understand**	**8**

Hydrogen Energy: Introduction, Hydrogen Production (thermochemical & electrolysis process only), Hydrogen Storage, Utilization of Hydrogen Gas, Safety, Environmental, and Economic Aspects of Hydrogen Fuel. **Self-study component:** Parts of wind turbine, Environmental Effects of Geothermal Power Plants		
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 **Self-study component**: Applications of biomass gasifiers	**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 **Self-study component:** Problems faced in exploiting tidal energy, Application of OTEC in addition to energy production	**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.

B.N.M. Institute of Technology

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Department of Electrical and Electronics Engineering

Semester: VI		
COURSE: Energy Audit and Energy Management System (Open Elective) **Course Code:24EEE1652**		
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, 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. **Self study component:** Energy scenario in India	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. **Self study component:** Energy conservation in Large 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. Electrical system, HVAC, Compressed air system, and Buildings, Certifying agencies in India. **Self study component:** Energy Audit for illumination system,	**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,Availability based tariff **Self study component:** Energy efficient motors	**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,. **Self study component:** 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: VI		
Course Name: Fundamentals of Electric and Hybrid Electric Vehicles (Professional Elective Course) **Course Code: 24EEE1653**		
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). Compare thermal, mechanical and electric specifications of recently launched electric and hybrid electric vehicles in the market	**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. Compare recently launched Lithium ion phosphate (LiFe-Po4) and sodium air cells in the market.	**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. Design and simulation steps involved in the analysis of Buck converters using Simulink software tool.	**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: 24EEE1654**			
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. **Self study component**: 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, **Self-study component:** 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, **Self-study component:** hardware-software trade-offs		**Understand**	**8**
Module-4: COMMUNICATION INTERFACE			
Onboard communication interfaces-I2C, SPI, CAN, parallel interface; External communication interfaces-RS232 and RS485, USB, infrared, Bluetooth, Wi-Fi, ZigBee, GPRS, GSM		**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, **Self study component**: 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: 24EEE1655**			
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 **Self-study component:** 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. **Self-study component:**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: **Self-study component:** 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		**Apply**	**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. **Self-study component:** 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. **Self-study component:** 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: Fuzzy Logic and its applications (Professional Elective Course)
Course Code: 24EEE1656

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 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, ***Self study component***: 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 membership function. ***Self study component:*** MATLAB program code for implementing 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**

Self study component: Fuzzy Tolerance and Equivalence Relations		
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, ***Self study component:*** 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, ***Self study component:*** 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., "Fuzzy logic with engineering applications," John Wiley & Sons, 3rd Edition, 2011.
2. Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Pearson Education India, 2015

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: 24EEE1657**		
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; Key Performance Indicators and Key Result Areas. **Self-study component**: Industry Key Success Factors,	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, **Self-study component**: 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, **Self-study component:** 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, **Self-study component**: 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). Self-study component: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: 24EEE1671**		
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. **Self study Component:** Manufacturing and Assembly processes, PLC advantages and disadvantages, overall PLC system	**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 **Self study Component:**PLC operation faults, A look at fail-safe circuits,Large Process Ladder diagram construction	**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. **Self study Component:**PLC trigonometric and Log functions, 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 **Self study Component:** Digital Logic gates	**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 **Self study Component:**SCADA systems in operation and control of interconnected power system, Power System Automation	**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/

Department of Electrical and Electronics Engineering

Semester: VI		
Course Name: Fuel Cell Technology (Open Elective) **Course Code: 24EEE1672**		
Teaching Hours/Week (L:T:P:J): (3:0:0:0)	**CIA Marks: 50**	
Credits: 3	**SEA Marks: 50**	
Hours: 4	**SEA Duration: 3 Hours**	
Course Learning Objectives:		
❖ To understand the fundamentals and 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 applications of Fuel Cell.		
Pre-Requisites: --		
	Bloom's Level	**Hours**
Module-1: Fuel Cell Fundamentals		
Fuel cell introduction, A Simple Fuel Cell, Fuel Cell Advantages ,Fuel Cell Disadvantages Fuel Cell Types, Basic Fuel Cell Operation Fuel Cell Performance, Characterization and Modeling, **Self study:** Fuel Cells and the Environment	**Understand**	**08 Hrs**
Module-2:Fuel Cell Systems: Principles, Technologies, and Modeling		
Electrode Potential and current- voltage curve, Fuel and oxidant consumption, Fuel cell system characteristics, Fuel Cell Technologies, Fuel Supply, Non-Hydrogen Fuel Cells, Fuel Cell Modeling. **Self study**: Non-Hydrogen Fuel Cells	**Understand**	**08 Hrs**
Module-3: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 Configuration, Control Strategy, Parametric Design, Design Example **Self study:** Parametric Design, Design Example	**Understand**	**08Hrs**
Module-4: Fuel Cells HEV Energy Storage System		
Hybrid Fuel Cell Energy Storage systems, 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 **Self study** :Detailed Electrical Modeling of Renewable Fuel Cell Power Sources	**Understand**	**08Hrs**
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 **Self study** : Fuel cells for Electric Power Plant Applications.	**Understand**	**08Hrs**
Course Outcomes: After the completion of the course the students will be able to: 1. Understand the fundamentals and principle of operation of fuel cells. 2. Learn the types, technologies and modelling of Fuel cells,		

3. Understand the control strategy and parametric design of Fuel cell Hybrid Electric Vehicle.
4. Understand Fuel Cells HEV Energy Storage System and modelling
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: 24EEE1673**		
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: 24EEE1674**		
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 **Self study:** World Production of Solar PV modules and cost	**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 **Self study: Design of Solar Cells**: Upper limits of Cell Parameters – Short Circuit current, Open circuit voltage, Fill Factor, Efficiency	**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. **Self study:** Simulation of PV Module I-V and P-V Characteristics Using PVsyst or MATLAB/Simulink under Real-World Conditions.	**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 **Self study:** three phase DC to AC Converter.	**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. **Self study:** Design and Simulation of a Smart Hybrid Solar PV System for a Residential	**Understand**	**08**

Building Using HOMER or MATLAB.		

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/

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: 24EEE171**		
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: 24EEE1721**		
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: 24EEE1722

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: 24EEE1723			
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

B.N.M. Institute of Technology

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Department of Electrical and Electronics Engineering

Semester : VII	
Course Name: Digital Design Through Verilog **Course Code:24EEE1724**	
Teaching Hours/Week: **L:T:P:J (3:0:0:0)**	**CIA: 50**
Credits: 3	**SEA: 50**
Hours: 30 hrs.	**SEA Duration: 03 Hours**

Course Objectives:

- Understand the basics of Hardware Description Languages, Program structure and basic language elements of Verilog.
- Understand various types of modelling of digital circuits using Verilog
- Design, Simulate and synthesize various Verilog descriptions for Combinational circuits.
- Design, Simulate and synthesize various Verilog descriptions for Sequential circuits
- Understand the architecture of Field Programmable Logic Arrays (FPGAs) and its use in designing Digital Electronics Circuits.

Pre-requisites: Digital Circuits

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

1. Write Verilog programs in gate, dataflow (RTL), behavioural and switch modeling levels of Abstraction.
2. Design a digital circuit for complex systems using Verilog HDL.
3. Identify the suitable Abstraction level for a particular digital design.
4. Analyze the circuit behavior by writing test benches using Verilog.
5. Understand the design methodology of digital circuits using Various implementation technology.

	Blooms Level	Hours
Module-1: Introduction to Verilog		
Introduction to Verilog HDL: Verilog as HDL, Levels of design description, Concurrency, Simulation and Synthesis, Function Verification, System Tasks, Programming Language Interface, Module, **Language Constructs and Conventions:** Introduction, Keywords, Identifiers, White Space, Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, **Self-study component:** Parameters, Operators	Apply	8
Module–2: Gate level modeling		
Gate Level Modelling: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Array of Instances of Primitives, Design of Flip-Flops with Gate Primitives, Delay, Strengths and Construction Resolution, Net Types **Self-study component: Tristate Gates**	Apply	8
Module–3: Switch level and Dataflow level modeling		
Switch Level Modelling: Switch Level Modeling: Basic Transistor Switches, CMOS Switches, Bidirectional Gates, Time Delays with Switch Primitives, instantiation with strengths and delays, Switch level modeling for NAND, NOR. **Self study component: Switch level modeling of XOR**	Apply	8

Modelling at Dataflow Level: Introduction, Continuous Assignment Structure, Delays and Continuous Assignments, Assignment to Vector, Operators		
Module–4: Behavioral Level Modelling		
Behavioural Modeling: Introduction, Operations and Assignments, Functional Bifurcation, Initial Construct, Always Construct, Assignments with Delays, Wait construct, Multiple Always Blocks, Designs at Behavioural Level, Blocking and Non-Blocking Assignments, The case statement, Simulation Flow i*f* and i*f*-else constructs, Assign-De-Assign construct, Repeat construct, for loop, the Disable construct, While loop, Parallel Blocks, Force-Release construct, Event. **Self-study: Forever loop**.	Apply	8
Module 5: Implementation Technology		
Implementation Technology: Introduction Programmable Logic Array (PLA), Programmable Array Logic (PAL), Field-Programmable Gate Arrays(FPGAs), The role of FPGAs in the ASIC market, FPGA technologies, Implementation Details and comparison for SPLDs, CPLDs, and FPGAs. **Self-study component:** Complex Programmable Logic Devices (CPLDs)	Understand	8

Reference Books				
Sl. No.	Title	Author	Publication	Edition
1	Design through Verilog HDL	T. R. Padmanabhan and B. Bala Tripura Sundari	WSE, IEEE Press,	1st Edition,2008
2	Advanced Digital Design with Verilog HDL	Michael D. Ciletti,	PHI	2010, 2nd Edition
3	Digital Systems Design Using Verilog	Charles H. Roth, Jr., Lizy Kurian John, and Byeong Kil Lee	Cengage Learning	1st Edition, 2016
4	Fundamentals Of Digital Logic with Verilog Design	Stephen Brown and Zvonko Vranesic	McGraw-Hill	3rd Edition,2013
Web links and Video Lectures:				
https://archive.nptel.ac.in/courses/108/103/108103179/ https://archive.nptel.ac.in/courses/106/105/106105165/				

Course Code	**Description**	**Bloom's Cognitive level**	**POs/PSOs**
21EEE1734.1	Write Verilog programs in gate, dataflow (RTL), behavioural and switch modelling levels of Abstraction.	Apply	1,2,3/ 2
22EEE1734.2	Design a digital circuit for complex systems using Verilog HDL.	Apply	1,2,3/ 2
22EEE1734.3	Identify the suitable Abstraction level for a particular digital design.	Apply	1,2,3/ 2
22EEE1734.4	Write test benches for a digital circuit and model sequential circuits using Verilog	Apply	1,2,3 2
22EEE1734.5	The design methodology of digital circuits using PAL, PLA, and Field Programmable Arrays (FPGAs).	Understand	1/2

Department of Electrical & Electronics Engineering

Semester: VII			
Course: DATA VISUALIZATION **Course Code: 24EEE1725**			
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	
1	To understand the categories of data quality principles.
2	To describe data through visual representation.
3	To provide basic knowledge about how large datasets are represented into visual graphics and easily understand the complex relationships within the data.
4	To provide basic knowledge about how large datasets are represented into visual graphics and easily understand the complex relationships within the data.
5	To design effective visualization techniques for any different problems

Module-1:	**No. of hours**	**Blooms cognitive Levels**
INTRODUCTION Visualization – visualization process – role of cognition – Pseudocode conventions – Scatter plot – Data foundation : Types of data – Structure within and between records – Data preprocessing – Human perceptions and information processing	**8**	**Understand**
Module-2:		
VISUALIZATION FOUNDATIONS Semiology of graphical Symbols – Eight Visual Variables – Historical Perspective- Visualization Techniques for spatial data – One-dimensional data- two dimensional data – Three dimensional data- dynamic data – combining techniques- Visualization of Geospatial data – Visualization of Point, line, area data	**8**	**Apply**
Module-3:		
DESIGNING EFFECTIVE VISUALIZATION Steps in Designing Visualization – problems in Designing Effective Visualization – Comparing and evaluating visualization techniques – Visualization Systems	**8**	**Apply**
Module-4:		
INFORMATION DASHBOARD DESIGN Characteristics of dashboards – Key goals in visual design process – Dashboard display media – Designing dashboards for usability – Meaningful organization – Maintaining consistency – Aesthetics of dashboards – Testing for usability – Case Studies: Sales dashboard, Marketing analysis dashboard	**8**	**Apply**
Module-5:		

VISUALIZATION SYSTEMS Systems based on Data type-systems based on Analysis type – Text analysis and visualization – Modern integrated visualization systems – toolkit-Research directions in visualization – issues of cognition, perception and reasoning –issues of evaluation – issues of Hardware.	**8**	**Apply**

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

CO1: Describe principles of visual perception

CO2: Apply visualization techniques for various data analysis tasks – numerical data

CO3: Apply visualization techniques for various data analysis tasks – Non numerical data

CO4: Design effective visualization techniques for different problems

CO5 :Design information dashboard.

Reference Books:

1. Matthew O. Ward , Georges Grinstein , Daniel Keim "Interactive Data Visualization: Foundations, Techniques, and Applications", CRC Press; 2nd edition, 2015
2. Stephen Few, *Now You See It: An Introduction to Visual Data Sensemaking*, 2nd Edition, Analytics Press, 2021.
3. Stephen Few, *Information Dashboard Design: Displaying Data for At-a-Glance Monitoring*, 2nd Edition, Analytics Press, 2013.
4. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", 1st Edition, O'Reilly, 2013.
5. Andy Kirk, "Data Visualization: A Handbook for Data Driven Design", 2nd Edition, Sage Publications, India, 2019.
6. Claus O.Wilke, "Fundamentals of Data Visualization", 1st Edition, O'Reilly Media, USA, 2019

SEMESTER – VII

Course Name: ANN and its Applications to Electrical systems (Professional Elective)

Course Code:24EEE1726

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), **Self-study component:** Radial Basis Function Network (RBFN)	**Understand**	**8**

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: 24EEE1727**	
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: 24EEE174	
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: 24EEE1811	
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: 24EEE182**	
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: 24EEE183**
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.