Poojya Doddappa Appa College of Engineering, Kalaburagi
B.E.in Electrical and Electronics Engineering
Scheme of Teaching and Examination 2021-22
Outcome Based Education (OBE) and Choice Based Credit System (CBSE)
(Effective from the academic year 2024-25**)**

VII Semester

Sl.No	Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PEC - II	21EE711	Power System Operation And Control	EE	2	2	-	-	3	50	50	100	3
2.	PEC - III	21EE721	Electrical Machine Design	EE	2	2	-	-	3	50	50	100	3
3.	OEC- II	21EEOE73X	Open Elective -II	EE	2	2	-	-	3	50	50	100	3
4.	OEC - III	21EEOE74X	Open Elective -III	EE	3	-	-	-	3	50	50	100	3
5.	Project	21EEP75	Project Work	EE		-	3	-	3	100	100	200	10
6.	AEC	21EE76	Ability Enhancement Course (Online 8 weeks)		-	-	-	-	3	50	50	100	2
			Total		9	3	3		18	300	300	600	24

Professional Electives-II		Professional Electives-III	
Subject Code	**Title**	**Subject Code**	**Title**
21EE711	Power System Operation And Control	21EE721	Electrical Machine Design
21EE712	Operation and maintenance of Solar Electric Systems	21EE722	Electrical Power Quality
21EE713	Digital Signal Processing	21EE723	FACTS
21EE714	Cyber Security in the Electric Sector	21EE724	Uninterruptible Power Supply.

Open Electives -II		Open Electives -III	
Subject Code	Title	Subject Code	Title
21EEOE731	Industrial Applications of Electrical Power	21EEOE741	Electric Vehicles
21EEOE732	Electrical Engg. Materials	21EEOE742	Very Large Scale Integrated Design
21EEOE733	Energy Management	21EEOE743	Illumination Engineering
21EEOE734	Embedded Systems	21EEOE744	EMC in Electrical System

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VIII Semester

Sl.No	Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	Seminar	21EES84	Technical Seminar	EE	-	-	2	-	-	100	-	100	1
2.	Internship	21EEI85	Research / Industry Internship	EE	-	-	-	-	-	100	100	200	15
			Total				2			200	100	300	16

Course Title: **POWER SYSTEM OPERATION AND CONTROL**			
Course Code	21EE711	Credits : 3	CIE: 50
Number of Lecture Hours/Week	**2hrs.(Theory)+2hrsTutorial**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite : Electrical Power Transmission and Distribution System.
Power System Stability and Analysis and control systems.

Course Objectives:

1. To understand optimal dispatch of generation with and without losses
2. To study the optimal scheduling of hydro thermal systems.
3. To study the optimal unit commitment problem.
4. To study the load frequency control for single area system
5. To understand the reactive power control and compensation of transmission lines.

Modules	**Teaching Hours**
Module I **Control Center Operation Of Power Systems:** Power system control and operating states, Introduction to SCADA, control center, digital computer configuration, automatic generation control, area control error, operation without central computers, expression for tie-line flow and frequency deviation, parallel operation of generators, area lumped dynamic model.	08 hrs
Module II **Optimal System Operation And Unit Commitment:** Introduction , Optimal operation of generators on a bus bar, Statement of the Unit Commitment problem, need and importance of unit commitment, Constraint in Unit Commitment, Unit Commitment solution methods-Priority lists method, Forward Dynamic Programming method(excluding problem), Spinning reserve Examples.	08 hrs
Module III **Power System Security:** Introduction, factors affecting power system security, Security analysis, Contingency Selection, Techniques for contingency evaluation-D.C. load flow AC load flow and fast decoupled load flow(with flowcharts excluding problems) detection of network problems, network sensitivity methods.	10 hrs
Module IV **Automatic Generation Control:** Automatic voltage regulator, Automatic Load Frequency Control loops of generators, performance of Voltage Regulator, ALFC of single area system, concept control area, multi area system, POOL operation – two area system, tie-line bias control.	08 hrs
Module V **Control Of Voltage And Reactive Power:** Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, single machine infinite bus systems, methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse. **Power System Reliability:** Introduction, Modes of failures of a system, Reliability index.	08 hrs

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.
Text books/Reference Books: 1. GL Kusic, "Computer aided power system analysis", PHI- 2010. 2. I.J. Nagarath and D.P. Kothri, "//modern power system Analysis", 3rd Edition -2003 3. Allen. J. Wood & Woolenburg "Power Generation , Operation & control", John Wiley & Sons -2nd Edition -2009. 4. Power system operation and control Uma Rao K 1st edition -2016 5. O.I.Elgerd, "Electrical Energy Systems Theory", TMH-2008.
E books and online course materials:

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21EE711	**CO1**	Illustrate the operation power system with SCADA
	CO2	Determine the optimal operation of power system by unit commitment
	CO3	Examine the power system security with different methods
	CO4	Analyze automatic generation control in power system with different control loops
	CO5	Examine voltage and reactive power control in power system
	C06	Recognize the modes of failures in power system for reliability assessments

Course Articulation Matrix for the Academic Year 2024-25

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											1	3		1
2	CO2	3	2										1	3	2	1
3	CO3	3				2							1	3		1
4	CO4	3	2			2							1	3	2	1
5	CO5	3											1	3	2	1
6	CO6	3											**1**	3	2	**1**
		3	**2**			**2**							1	**2**	2	1

Course Title: Operation and Maintenance of Solar Electric Systems		
Course Code	**22EE712**	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50

Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite

Objectives:

To appreciate the importance of solar PV O & M.
To assess the impact of O and M.
To develop safety measures for Operation of solar PV system.
To document the O and M procedures.

Modules	Teaching Hours
Module I **Introduction To Solar PV Operation & Maintenance (O&M):** Necessity of O and M, Expected Outcome, Benefits of O&M. Overview of PV System Components, Types of Rooftop PV Systems, System Components. Maintenance Categorization, Scheduled Maintenance, Unscheduled Maintenance. Common Tools & Equipments Used, Testing Methods and Techniques	08 hrs
Module II **Photovoltaic Modules:** Inspection & Fault Identification, Dust accumulation, Module Shading , Module Mismatch, Physical Integrity. Maintenance & Troubleshooting, Basic Level, Advanced Level, Methods and Techniques for Shading Analysis, Key Points to Remember.	08 hrs
Module III **Inverters:** Inspection and Fault Identification, Classification of Solar Inverters, Routine Inspection. Maintenance and Troubleshooting, Basic Level, Advanced Level, Key Points to Remember.	08 hrs
Module IV **Balance Of Systems:** Inspection and Fault Identification, Cables, Protection Devices, Batteries. Maintenance and Troubleshooting , Basic Level, Advanced Level, Key points to Remember.	08 Hrs
Module V **Jobsite Safety**: General Safety Procedures, General safety, Specific safety, Personal Safety Procedures, Importance of Personal Protective Equipment , Major Safety Hazards, Key points to Remember. **Electricity Bill:** Calculation of consumption of electrical energy, Calculation of energy generated by RTPV system, Before and After Installation of Solar PV system. **Documentation:** Importance of Documentation and its significance, System Documentation, Maintenance Documentation, Component Documentation.	10 hrs
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Text books/Reference Books: 01. Best Practices in OPERATION AND MAINTENANCE of Rooftop Solar PV Systems in India, JAYA VASITA, AKHILESH MAGAL, Gujarat Energy Research & Management Institute Hand book, 2018	

02. ***Solar Photovoltaic Technology and Systems: A Manual for Technicians***, ***Trainers and Engineers,*** Chetan Singh Solanki, PHI, 2018.
03. PV System Operations and Maintenance Fundamentals, Josh Haney Adam Burstein Next Phase Solar. Inc. August 2013
04. Operation & Maintenance Best Practices Guidelines, Solar Power Europe, June 2018.
05. http://mnre.gov.in/file-manager/UserFiles/Best-Practices-Guide-on-State-Level-Solar-Rooftop-Photovoltaic-Programs.pdf
06. Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems, National Renewable Energy Laboratory, Sandia National Laboratory, SunSpec Alliance, and the SunShot National Laboratory Multiyear Partnership (SuNLaMP) PV O&M Best Practices Working Group, 3rd Edition, December 2018.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)	Blooms Level
22EE712	CO1	Discuss O& M procedures for solar PV systems.	L1
	CO2	Theorise the O & M procedures for PV Modules	L2
	CO3	Establish the O&M procedures for inverters.	L4
	CO4	Determine the O&M procedures for balance of systems	L4
	CO5	Compile safety measures and summarise O&M data.	L5

Course Title: **DIGITAL SIGNAL PROCESSING**			
Course Code	21EE713	Credits:3	CIE: 50
Number of Lecture Hours/Week	3hrs (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: 1. Knowledge of signals and systems is needed
2.Knowledge of Digital Electronics is needed.

Course Objectives:

1. To study Discrete Fourier Transforms.
2. To understand Fast Fourier Transforms Algorithms.
3. To know Realization of Digital Systems
4. To Design IIR and FIR Digital Filters.

Modules	Teaching Hours
Module I **Discrete Fourier Transforms:** Introduction**,** properties-linearity, shift symmetry periodic convolution, circular convolution, linear convolution.	**08 hrs**
Module II **Fast Fourier Transforms Algorithms:** Introduction decimation in time algorithm, decimation in frequency algorithm, decomposition for N a composite numbers, calculation of numbers of computations, and	**07 hrs**

computational efficiency.	
Module – III **Realization of Digital Systems:** Introduction, block diagrams and signal Flow graphs, matrix representation, realization of IIR systems-direct form, cascade form, parallel form realization of FIR systems-direct form, cascade form and linear phase realization.	**08 hrs**
Module IV **Design of IIR Digital Filters:** Introduction, Impulse Invariant, bilinear transformation and approximation of derivative, all pole analog filters Butterworth, chebyshev and Elliptic filters, frequency transformations.	**10 hrs**
Module V **Design of FIR Digital Filters:** Introduction, symmetric /Asymmetric FIR filters and linear phase property windowing, rectangular hamming, hamming windows, frequency sampling technique.	**08 hrs**
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Reference Books: 1. Digital signal processing: Principle, algorithms and application By Proakis, Pearson Education/ PHI. 2. Digital signal processing by Oppenheim's Pearson Education/PHI 3. Digital signal processing by feachor Emmauel, Pearson Education. 4. Digital signal processing by J.S. Chitthode. Technical publishers, Pune	
Course outcomes: **On completion of the course, the student will have the ability to:**	

Course Code	CO	Course Outcome (CO)	Blooms Level
18EE633	CO1	**Illustrate discrete Fourier transformation and FFT**	**L2**
	CO2	**Interpret the different types of realization of digital systems**	**L2**
	CO3	**Illustrate different types of IIR and FIR filters**	**L2**
	CO4	**Analyze the IIR and FIR filters**	**L4**
	CO5	**Design of FIR and IIR filters**	**L5**

CYBERSECURITY IN THE ELECTRICITY SECTOR			
Course Code	21EE714	CIE Marks	50
Teaching Hours/Week (L:P:T)	2:0:2	SEE Marks	50
Credits	03	Exam Hours	03
Module-1			
Introduction: Transformation, Dependence on the ICT, 8Cybersecurity, Priority Critical Infrastructure. **State of Cybersecurity in the Electricity Sector:** Introduction, Vulnerabilities, Threats, Challenges, Initiatives,Future Directions. **(09 HRS)**			
Module-2			
Cybersecurity Standards Applicable to the Electricity Sector: Introduction, Literature Search, Literature Analysis, Standards' Selection and Evaluation Criteria, Results, Most Relevant Standards, Standards' Limitations,Standards' Implementation and Awareness. **(08 HRS)**			

Module-3
A Systematic Approach to Cybersecurity Management: Introduction, Cybersecurity Management Approachesin Standards, The Systematic Approach to Cybersecurity Management in the Electricity Sector. **(08 HRS)**
Module-4
Cost of Cybersecurity Management: Introduction, Economic Studies, Organisation Management Studies, Cost-Benefit Analysis, Cost Calculators, Costing Metrics, CAsPeA. **Cybersecurity Assessment:** Introduction, Security Assessment Methods for the Electricity Sector, Cybersecurity Test beds for Power Systems, JRC Cybersecurity Assessment Method, Laboratory Infrastructure, MAlSim. **(09 HRS)**
Module-5
Cybersecurity Controls: Introduction, Standard Technical Solutions, Information Sharing Platform on Cybersecurity Incidents for the Energy Sector, Situation Awareness Network. **(08 HRS)**
Course outcomes: At the end of the course the student will be able to: • Discuss the current cybersecurity situation in the electricity sector and the relevant standards that can beemployed for cybersecurity. • Explain cybersecurity management approach and the methods for the electricity sector. • Explain available solutions that support the cost-benefit analyses involved in cybersecurity managementand cybersecurity assessment approach. • Discuss cybersecurity controls, for reducing cyber risks.
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.
Textbook
1. Cybersecurity in the Electricity Sector, Rafal Leszczyna, Springer, 2019

Course Title: **ELECTRICAL MACHINE DESIGN**			
Course Code	21EE721	Credits: 3	CIE: 50
Number of Lecture Hours/Week	2hrs (Theory) +2(Tutorial)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03
Prerequisite: Study of Electrical machines – I and Electrical machines – II. Study of Electrical Circuit Analysis.			

Course Objectives:

1. To Study the Principles and design of DC machines.
2. To understand the design concept and design of AC machines.
3. To design of Induction motors and synchronous Machines.

Modules	Teaching Hours
Module - I **Introduction :** Needs of design of electrical machines and limitations. **Design of Armature of DC Machine :** Output equation, choice of specific loadings and choice of number of poles, main dimensions of the armature, design of armature winding, design of armature core, performance of the designed armature.	**07 hrs**
Module - II **Design of Magnetic circuit of DC Machine** : Design of Field system, dimensions of pole, dimensions of the yoke, length of air gap, design of the field winding, performance of the field system. Design of the commutator and brushes, performance of the commutator. Design of inter poles: Flux density in the air gap under the inter pole, dimensions of the inter pole, design of inter pole winding.	**08 hrs**
Module III **Design of Single phase and Three phase Transformers** : Output equation for single phase and three phase transformer, expression for volts/ turn, choice of specific loadings, determination of main dimensions of the core, design of windings and estimation of number of turns and conductor cross sectional area of primary and secondary windings, design of tank and cooling tubes.	**09 hrs**
Module IV **Design of Three Phase Induction Motors:** Output equation, choice of specific loadings, main dimensions of three phase induction motor, stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of rotor bars and end rings, design of slip ring induction motor.	**09 hrs**
Module V **Design of Synchronous Machine:** Output equation, choice of specific loadings, short circuit ratio, design of main dimensions, armature slots and windings, slot details for the stator of salient and non-salient pole synchronous machines, magnetic circuit, dimension of the pole body, design of the field winding, and design of rotor of non-salient pole machine.	**09 hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text books / Reference Books:

1. A.K.Sawhney, Dhanpat Rai & Co., "A course in Electrical Machine Design". 6th Edition, 2006.
2. V.N.Mittle, Arvind Mittal "Design of Electrical Machine". 5h edition-2009.
3. M.G. Say, "Performance And Design of AC machines", CBS publishers and distributors Pvt. Ltd. Edition 1983.
4. A.Shanmugsundarm, G.Gangadharan, R.Palani, "Design Data Hand book", Wiley Eastern Ltd.
5. H.M.Rai (Dhanpat Rai) "Principles of Electrical Machines Design", Satyaprakasham, 1992.

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)
21EE721	CO1	Design of a dc machine armature core and armature winding and provide the information required for the fabrication of the same along with an estimate of various performance indices. Design of a dc machine field system and inter pole and provide the information required for the fabrication of the same along with an estimate of various performance indices.
	CO2	Design of a transformer and provide the information required for the fabrication of the same along with an estimate of various performance indices.
	CO3	Design of a Induction motors and provide the information required for the fabrication of the same along with an estimate of various performance indices.
	CO4	Design of a Synchronous Machines and provide the information required for the fabrication of the same along with an estimate of various performance indices.
	CO5	Design of a dc machine armature core and armature winding and provide the information required for the fabrication of the same along with an estimate of various performance indices. Design of a dc machine field system and inter pole and provide the information required for the fabrication of the same along with an estimate of various performance indices.

Course Articulation Matrix for the Academic Year 2024-25

S.No.	PO/ CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2	3	2								1	3		1
2	CO2	3	2										1	3		2
3	CO3	3	2	3	2								1	3	2	2
4	CO4	3	1										1	3		1
5	CO5	3	3	2	2								1	3		2
		3	2	2.67	2								1	3	2	1.6

Course Title: **ELECTRICAL POWER QUALITY**			
Course Code	21EE722	Credits:3	CIE: 50
Number of Lecture Hours/Week	**2hrs.(Theory) +2hrs (Tutorial)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03
Prerequisite:			
Course Objectives:			

Modules	**Teaching Hours**
Module I **1.Basics of Electrical Power quality:** Introduction, Power Quality Issues, Remedial measures, power quality V/S Equipment immunity, Power Quality concerns, power quality standards and power quality monitoring 2. **Power Frequency Distribution:** Introduction, common power frequency disturbances, Sources of steady state disturbances , Disturbances recognition system, effect of steady state system disturbances on loads. Technique to reduce disturbances, Uninterruptable power supplies (UPS), Isolation transformers, voltage regulation, Indicators of quality power in a plant.	**05 hrs** **08 hrs**
Module II **3. Electrical Transients:** Introduction, Types and causes of transients over voltage mitigation techniques, Transient over voltage in communication circuits, Standards of transient over voltages, Transient measurements, Surge generators, Surge suppressors, Interruption of fault circuits, Power factor correction using capacitors, motor start transient.	**08 hrs**
Module III **4. Harmonics:** Introduction, Harmonic analysis, Effect of harmonics on power system devices, Harmonic current mitigation, Individual harmonic distortion, Total Harmonic Distortion (THD), causes of voltage & current harmonics, Guide lines for harmonic voltage & current limitation.	07 hrs

Module IV **5. Measuring and Solving Power Quality problems:** Introduction, power quality measurements, types of equipment for monitoring of power quality, Analyzing power quality measurement Data, PQA features, CBEMA & ITIC curves.	06 hrs
Module V **6.Custom powerdevices:** Introduction, Dynamic Voltage Restorer (DVR), D-Statcom, Unifed power quality conditioner (UPQC), Unifed power quality converter topology, principles and configuration of UPS.	07 hrs

Question paper pattern:

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1. J.D. Dixit & Amit Yadav "Electrical Power Quality" University Science Press" First edition 2010.
2. Math H J Bollen, "Understanding power Quality Problems; voltage Sags and Interruptions", Wiley India.
3. Roger C, Dugan, et.el, "Electrical power System Quality", 2nd Edition, TMH, 2011.
4. G T Heydt, "Electric power Quality", Stars in Circle publications, 1991.
5. Ewald F Fuchs, et.el, "Power Quality in power System and Electrical Machines", Academic press, Elsevier, 2009

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)	Bloom s Level
21EE722	**CO1**	Describe basics of power quality and power frequency distribution.	C1
	CO2	Discuss electrical transients.	C2
	CO3	Explain about harmonics.	C5
	CO4	Measure and solve power quality problems.	C6
	CO5	Identify custom power devices.	C1

Course Title: **FACTS** **(As per Choice Based Credit System (CBSE) Scheme)** **(From the academic year 2024-25)**		
Course Code	21EE723	CIE: 50
Credits	**03**	SEE: 50

Course Type	Theory	Total Marks : 100
Lecture Hours/Week (L-T-P)	3-0-0-0	
Total Hours	42 Hours	SEE: 3 Hrs

Prerequisites: Power Electronics and Power Systems

Course Objectives:

Modules	Teaching Hours
Module I **BASICS OF TRANSMISSION SYSTEM AND FACTS CONTROLLERS** Reactive power flow control in Power Systems – Control of dynamic power un-balances in Power System. Power flow control - Constraints of maximum transmission line loading – Benefits of FACTS Transmission line compensation.- Uncompensated line -Shunt compensation - Series compensation –Phase angle control. Reactive power compensation.- Shunt and Series compensation principles – Reactive compensation at transmission and distribution level .	**09 hrs**
Module II **SVC AND STATCOM** Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM -Compensator control. Comparison between SVC and STATCOM.	**08 hrs**
Module III **STATIC SERIES COMPENSATION** TSSC, SSSC -Static Voltage and phase angle regulators – TCVR and TCPAR Operation and Control –Applications, Static series compensation – GCSC, TSSC, TCSC and their Control.	**08 hrs**
Module IV **UNIFIED POWER FLOW CONTROLLER** SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC. Basic Principle of P and Q control- Independent real and reactive power flow control- Applications.	**08 hrs**
Module V **INTERLINE POWER FLOW CONTROLLER:** Introduction to interline power flow controller. Modeling and analysis of FACTS Controllers – Simulation of FACTS controllers Power quality problems in distribution systems, harmonics. Loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering– shunt, series and hybrid and their control. **POWER QUALITY ISSUES:** Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners- IEEE standards on power quality.	**09 hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

TEXT BOOKS:

1. K R Padiyar, *FACTS Controllers in Power Transmission and Distribution*, New Age International Publishers, 2007**.** (Unit-I, II&V)
2. N.G. Hingorani, L. Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001. (Unit-II,III,IV)

REFERENCES:

1. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems-ModellingandControl", Springer Verlag, Berlin, 2006.
2. K.S.Suresh Kumar, S.Ashok, "FACTS Controllers & Applications", E-book edition,Nalanda Digital Library, NIT Calicut, 2003.
3. G. THeydt, "Power Quality", McGraw-Hill Professional, 2007.
4. T. J. E. Miller, "Static Reactive Power Compensation", John Wiley and Sons, Newyork,1982.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108107114/
2. https://new.siemens.com/global/en/products/energy/high-voltage/facts.html
3. https://new.abb.com/facts

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

Course Code	CO #	Course Outcome (CO)
	CO1	Distinguish the performance of Transmission line with and without FACTS Devices
	CO2	Compare the SVC and STATCOM
	CO3	Understand the operation and control of various Static Series Compensators
	CO4	Understand the operation and control of Unified Power Flow Controller
	CO5	Distinguish various power quality issues and how are they mitigated by various FACTSDevices

UNINTERRUPTIBLE POWER SUPPLY			
Course Code	21EE724	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Credits	03	Exam Hours	03
Module-1			
Uninterruptible Power Supplies: Classification, Batteries for UPS Applications, Flywheels for UPS Applications, Comparative Analysis of Flywheels and Electrochemical Batteries, Applications of UPS Systems, Parallel Operation, Performance Evaluation of UPS Systems, Power Factor Correction in UPS Systems, Control of UPS Systems, Converters for UPS Systems, Battery Charger/Discharger. **(09 HRS)**			
Module-2			
Active Filters: Harmonic Definition, Harmonic Sources in Electrical Systems, Effects of Harmonics, Harmonic Mitigation Methods, Classification of Active Filters, Active Filters for DC/DC Converters, Modelling and Analysis, Control Strategies, Stability Assessment. **(08 HRS)**			
Module-3			
Unified Power Quality Conditioners: Series–Parallel Configuration, Current Control, Voltage Control, PowerFlow and Characteristic Power. **Reduced-Parts Uninterruptible Power Supplies:** Concept of Reduced-Parts Converters Applied to Single-PhaseOn-Line UPS Systems, New On-Line UPS Systems Based on Half-Bridge Converters. **(08 HRS)**			
Module-4			

New On-Line UPS Systems Based on a Novel AC/DC Rectifier: New Three-Phase On-Line UPS System with Reduced Number of Switches, New Single-Phase to Three-Phase Hybrid Line-Interactive/On-Line UPS System. **(08 HRS)**

Module-5

Reduced-Parts Active Filters: Reduced-Parts Single-Phase and Three-Phase Active Filters, Reduced-Parts Single-Phase Unified Power Quality Conditioners, Reduced-Parts Single-Phase Series–Parallel Configurations, Reduced-Parts Three-Phase Series–Parallel Configurations.

Modelling, Analysis, and Digital Control: Systems Modelling Using the Generalized State Space Averaging Method, Digital Control. **(09 HRS)**

Course outcomes:

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

- Explain classification of UPS, batteries for UPS, parallel operation and performance evaluation and control of UPS systems.
- Describe sources of harmonics and their mitigation using active filters.
- Describe topologies of active filters, their applications, control methods, modeling analysis, and stabilityissues.
- Explain steady-state operation and control of unified power quality conditioners.
- Explain an on-line ups system based on novel AC/DC rectifier.
- Explain the concept of reduced parts active filters, their modeling and control.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text/Reference Books

1. Uninterruptible Power Supplies and Active Filters, Ali Emadi et al, CRC Press, 2005.

2. Uninterruptible Power Supplies and Standby Power Systems, Alexander C King, William Knight, McGraw-ill, 2003.

Course Title: **INDUSTRIAL APPLICATIONS OF ELECTRICAL POWER**			
Course Code	21EEOE731	Credit:3	CIE: 50
Number of Lecture Hours/Week	**2hrs.(Theory) +2hrs (Tutorial)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

1. Knowledge of Electrical Machines
2. Applications of Electrical energy

Course Objectives:

1. To study Heating and Welding
2. To understand Illumination.
3. To know Electrolytic Process.
4. To understand Power Factor Considerations
5. To Get an Exposure about Electric traction and hybrid Vehicles.

Modules	**Teaching Hours**
Module I **Heating and Electrolytic process:** Different methods of Electric heating and their advantages, Resistance heating, Resistance ovens, Induction heating, Arc furnace. Fundamental principles of Electrolysis process, Extraction, refining of metals, Electroplating, Factors effecting electro deposition process.	**09 hrs**
Module II **Illumination:** Introduction, Radiant energy, Definitions, Laws of illumination, Polar curves, Photometry, Energy radiation and luminous efficiency, lighting calculations, Factory lighting, Flood lighting, street lighting. **Lamps:** Construction and working of Incandescent, Fluorescent, Mercury vapor, sodium vapor lamps and CFL.	**08 hrs**
Module III **Power Tariffs:** Electric Tariff, Types, Domestic and Non –Domestic prevailing tariffs and their structures. Introduction to Availability-Based Tariff (ABT). **Power Factor and its Improvement:** Causes, disadvantages and improvement of Low Power Factor (LPF), Economic aspects.	**08 hrs**
Module IV **Electric Traction:** Introduction to traction system, requirement of an ideal traction system, supply system for electrical traction, Motors for Electric traction, Speed- Time curves for train movement. **Electrical Braking:** Introduction, and types of braking, Regenerative braking with three phase induction motors, Braking with single phase series motors, Magnetic track brake, and Electro-Mechanical Drum brakes.	**09 hrs**

Module V	
Electric Vehicle: Introduction to Electric vehicle, components of electric vehicle**.** Overview of charging, motors, and Storage of Electric Vehicle. **Hybrid Electric Vehicles :** Introduction, Concept and working of Hybrid Electric Drive trains. **Electric Drive-trains:** Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.	**08 hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1. Soni Gupta and Bhatnagar, "A Course in Electrical Power", Dhanpatrai and Sons Edition 2002
2. G.C Garg, "Utilization of Electrical Power and Electric Traction", Khanna Publishers 6th Edition 1999.
3. Open Shaw Taylor, "Utilization of Electrical Energy", 12th Impression Universities Press-2009
4. Dr. S.L.Uppal, "Electrical Power", Khanna Publishers Eighth Reprint -1999.
5. Mehrbad Ehsani, Yimin Gao, Sabastian E. Gay Ali Emadi, "Modern Electric Hybrid Electric and Fuel cell vehicles", CRC Press, 2010.
6. Utilization of Electrical Power, 2nd Edition, R.K.Rajput, Laxmi publications, New Delhi
7. Mehrda Ehsani et al, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamental theory and Design", Ist Edition 2005, CRC Press.

Course outcomes: On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)
21EE731	CO1	Describe the specified heating & welding methods and electrolysis process
	CO2	Define the laws of illumination and compute the illumination for specified applications,
	CO3	Discuss the causes, disadvantages and methods of improving, low power factor.
	CO4	Classify the power tariffs.
	CO5	Discuss about of hybrid vehicles and analyze electric traction

Course Articulation Matrix for the Academic Year 2024-25

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3		1									1	3	2	1
2	CO2	3	3										1	3	2	1
3	CO3	3	2										1	3	1	1
4	CO4	3											1	3	1	1
5	CO5	3											1	3	1	1
		3	2.5	1									1	3	1	1

Course Title: **Electrical Engineering Materials**			
Course Code	21EEOE732	Credits:3	CIE: 50

Number of Lecture Hours/Week	2hrs (Theory) +2(Tutorial)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite: Basics of Electrical Engineering

Course Objectives:

- To impart the knowledge of conducting, dielectric, insulating and magnetic materials and their applications.
- To impart the knowledge of superconducting materials and their applications
1. To impart the knowledge of plastics and materials for Opto - Electronic devices.

Modules	Teaching Hours
Module I **Introduction to Electrical Materials:** Importance, Classification, Scope of electrical materials. Requirement of Engineering materials, Operational requirements of electrical materials, Classification of solid materials on the basis of energy gap, Types of engineering materials, Levels of material structure. Ferromagnetic semiconductors. **Conductors**: Conductor materials, Factors affecting conductivity, Thermal conductivity, Heating effect of current, Thermoelectric effect, Seebeck effect, Thomson effect.	08 hrs
Module II **Magnetic Materials**: Origin of permanent magnetic dipole, Magnetic terminology, Relation between relative permeability and magnetic susceptibility. Classification of magnetic materials, Diamagnetic, Paramagnetism, Ferromagnetism, Antiferromagnetism and the corresponding materials. Ferrimagnetism and ferrites – properties and applications, Soft and hard ferrites. Curie temperature, Laws of magnetic materials. Magnetization curve, Initial and maximum permeability. Hysteresis loop and loss, Eddy current loss. Types of magnetic materials, Soft and hard magnetic materials, High energy magnetic materials, Commercial grade soft and hard magnetic materials.	**08 hrs**
Module III **Conductive Materials and Applications**: Mechanically processed forms of electrical materials, Types of conducting materials, Low resistivity materials, High resistivity materials, Contact materials, Fusible materials, Filament materials, Carbon as filamentary and brush material, Material for conductors, cables, wires, solder, sheathing and sealing.	**08 hrs**
Module IV **Dielectrics**: Introduction to dielectric materials, classification of dielectric materials, Dielectric constant, Dielectric strength and Dielectric loss. **Insulating Materials**: Insulating materials and applications – Ceramic, Mica,	**09 hrs**

Porcelain, Glass, Micanite and Glass bonded mica. Polymeric materials – Bakelite, Polyethylene. Natural and synthetic rubber. Paper. Choice of solid insulating material for different applications, Liquid insulating materials – Requirements, Transformer oil, Bubble theory, Aging of mineral insulating oils. Gaseous insulating Materials – Air, Nitrogen, Vacuum**.**	
Module V **Superconductive Materials:** Concept of superconductors, Meaning of phenomenon of superconductivity, Properties of superconductors, Types of superconductors, Critical magnetic field and critical temperature, Effects of Isotopic mass on critical temperature, Silsbee rule, Depth of penetration and coherence length. Ideal and Hard superconductors, Mechanism of super conduction, London's theory for Type I super conductors, GLAG theory for Type I superconductors, BCS theory, Applications and limitations. Applications of high temperature superconductors, Superconducting solenoids and magnets, MRI for medical diagnostics. **Plastics:** Introduction, Thermoplastics, Rubbers, Thermosets, DC and AC properties, Mechanical properties and processing of plastic.	**09 hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text books/Reference Books:

1. Advanced Electrical and Electronics Materials; Processes and Applications K.M. Gupta Nishu Gupta Wiley First Edition, 2015
2. Electronic Engineering Materials R.K. Shukla Archana Singh McGraw Hill 2012
3. Electrical Properties of Materials L Solymar et al Oxford 9 th Edition, 2014
4. Electrical Engineering Materials A.J. Dekker Pearson 2016
5. Principle of Electronic Materials and Devices S.O. Kasap McGraw Hill 3 rd Edition

Course outcomes: On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	
21EE732	CO1	**Describe electrical and electronics materials, their importance, classification and operational requirement**	
	CO2	**Distinguish conducting materials used in engineering, their properties and classification.**	
	CO3	**Distinguish dielectric materials, insulating materials and magnetic materials used in engineering, their properties and classification.**	
	CO4	**Appraise the phenomenon of superconductivity, super conducting materials and their application in engineering.**	
	CO5	**Identify the plastic and its properties and applications and materials used for Opto electronic devices.**	

Course Articulation Matrix for the Academic Year 2024-25

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	1	2									2		1	
2	CO2	3	1	2									2		1	
3	CO3	3	1	2									2		1	
4	CO4	3	1	2									2		1	
5	CO5	3	1	2									2		1	
		3	1	2									2		1	

Course Title: **ENERGY MANAGEMENT**			
Course Code	21EEOE733	Credits:3	CIE: 50
Number of Lecture Hours/Week	**2hrs.(Theory) +2hrs (Tutorial)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03
Prerequisite			
Course Objectives			

Modules	**Teaching Hours**
Module I Energy resources, Energy conversion processes and devices – Energy conversion plants – Conventional - Thermal, Hydro, Nuclear fission , and Non – conventional – Solar, Wind Biomass, Fuel cells, Magneto Hydrodynamics and Nuclear fusion. Energy from waste, Energy plantation.	**08 hrs**

Module II Energy storage and Distribution – Electrical energy route – Load curves – Energy conversion plants for Base load , Intermediate load, Peak load and Energy displacement – Energy storage plants. Energy Scenario – Global and Indian –Impact of Energy on economy, development and environment, Energy policies, Energy strategy for future.	**08 hrs**
Module III Energy Management – Definitions and significance – objectives –Characterising of energy usage – Energy Management program – Energy strategies and energy planning Energy Audit – Types and Procedure – Optimum performance of existing facilities – Energy management control systems – Computer applications in Energy management.	08 hrs
Module IV Energy conservation – Principles – Energy economics – Energy conservation technologies – cogeneration – Waste heat recovery – Combined cycle power generation – Heat Recuperators – Heat regenerators – Heat pipes – Heat pumps – Pinch Technology Energy Conservation Opportunities – Electrical ECOs – Thermodynamic ECOs in chemical process industry – ECOs in residential and commercial buildings – Energy Conservation Measures.	09 hrs
Module V Energy Conservation Opportunities – Electrical ECOs – Thermodynamic ECOs in chemical process industry – ECOs in residential and commercial buildings – Energy Conservation measures.	09 hrs
Question paper pattern: Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Reference Books: References: 1. Amlan Chakrabarti, Energy Engineering and Management, Prentice Hall India, 2011. 2. Eastop T. D. and D. R. Croft, Energy Efficiency for Engineers & Technologists, Longman, 1990. 3. Albert Thumann P. E. and W. J. Younger, Handbook of Energy Audits, Fairmont Press, 2008. 4. Doty S. and W. C. Turner, Energy Management Hand book, 7/e, Fairmont Press, 2009. 5. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 2005. 6. Rai G. D., Non-conventional Energy Sources, Khanna Publishers, 2011.	
E books and online course materials:	

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)	Bloom s Level
21EE733	**CO1**	Gain an understanding of the impact of energy on society ,	C1
	CO2	Appraise the need for sustainable energy, global and Indian energy policies.	C2
	CO3	Gain knowledge on various techniques of energy management and conservation.	C5
	CO4	Gain the basic ideas of conducting an energy audit.	C6
	CO5		C1

Course Title: Embedded Systems			
Course Code	21EEOE734	Credits:3	CIE: 50
Number of Lecture Hours/Week	**3Hrs (Theory)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Pre-requisites:

Programming languages C, C++, OOPs Java, Microcontroller, Microprocessor, ARM processor, sensors and networking.

Course Objectives:

To impart knowledge on the following Topics

- Building Blocks of Embeded System
- Various Embeded Development Strategies
- Bus Communication in processors, Input/output interfacing.
- Basics of Real time operating system and example

Modules	Teaching Hours

Module – I **Introduction to Embedded Systems:** Embedded Systems, Processor Embedded into a system, Embedded Hardware Units and Devices in a System, Embedded Software, Complex System Design. Design process in Embedded Systems. Formalization of System Design. Classification of Embedded Systems.	**08 Hrs**
Module – II **8051 Microcontroller:** Architecture, Input/Output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/output, Interrupts, Real World Interfacing, Processor and Memory organization. **Devices and Communication Buses for Devices Network:** Serial and Parallel Devices and Ports, Wireless Devices, Timer and counting devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Internet Enabled Systems, Wireless and Mobile System protocols.	**09 Hrs**
Module – III **Device Drivers and Interrupts service Mechanism:** Programming – I/O, Busy Wait Approach without interrupt service mechanism, ISR concept, Interrupt sources, Interrupt service Handling, Multiple Interrupts, Direct Memory Access. **Real Time Operating Systems:** OS services, Process and Memory Management, Real – Time Operating Systems, Basic Design Using an RTOS, Task Scheduling Models, Interrupt Latency.	**09 Hrs**
Module – IV **Embedded Programming Concepts**: Software Programming in Assembly language and High level Language, Data types, Structures, Modifiers, Loops and Pointers, Macros and functions.	**08 Hrs**
Module – V **Embedded Software Development Process and Tools:** Introduction to Embedded Software Development Process and Tools, Host and Target Machines, Linking and Locating Software, Getting Embedded Software into the Target System, Issues in Hardware-Software Design and Co-Design. **Testing, Simulating and Debugging Techniques and Tools:** Testing on Host Machine, Simulators, Laboratory Tools.	**08 Hrs**
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Reference Books: **Text Books:** **Embedded Systems, Raj Kamal, Second Edition TMI.**	
Reference Books: **1. Embedded/Real – Time Systems, Dr.K.V.K.K.Prasad, DreamTech press.** **2. The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Pearson** **3. An Embedded Software Primer, David E Simon, Pearson Education.** **4. Microcontrollers, Raj Kamal, Pearson Education.** **5. Introduction to Embedded Systems, Shibu K.V.TMH.**	
Course outcomes: **On completion of the course, the student will have the ability to:**	

Course Code	CO	Course Outcome (CO)	Blooms Level
	CO1	Explain and analyze Embedded systems.	**L2**
	CO2	Describe various processors architecture and suggest	**L4**

		an embedded system for a given application.	
	CO3	Operate various Embedded Development Strategies	**L4**
	CO4	Study about the bus Communication in processors and programming concepts in Embedded systems	**L2**
	CO5	Explain the basics of Real time operating system and software development process and testing tools in embedded systems.	**L4**

Course Title: ELECTRIC VEHICLES			
Course Code	21EEOE741	Credits:3	CIE: 50
Number of Lecture Hours/Week	**3Hrs (Theory)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03
Pre-requisites:			

Course Objectives:

- To develop basic schemes of electric vehicles and hybrid electric vehicles.
- To understand requirement of electric vehicle motors & their control
- To Choose a suitable drive scheme for developing an electric vehicle depending on resources
- To Choose proper energy storage and charging systems for vehicle applications

Modules	**Teaching Hours**
Module I **Introduction to Electrical Vehicle (EV):** Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **Hybrid Electric Vehicle (HEV):** Configuration of HEV (Series, Parallel, Series-parallel &Complex), Examples of HEV system performance, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine.	**09 Hrs**
Module II **Electric Drive-trains:** Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.	**08 Hrs**

Module III **EV Motors:** Requirement of EV motors, Comparison of EV motors, Types of EV motors: **DC Motor (**Basics of DC Motor, Torque speed characteristics), **Induction Motor (**Rotating Magnetic Field, Basics of Induction motor, Speed-Torque Curve) and construction & working of **Switched reluctance Motors**(SRM).	**08 Hrs**
Module IV **EV Storages:** **Battery parameters:** Cell and battery voltages, Charge capacity, Energy stored, Energy density, Specific power, charge efficiency, Energy efficiency, Self-discharge rates, Battery geometry, Battery temperature, heating and cooling needs, Battery life and number of deep cycles. **EV Batteries:** Lead Acid, Nickel-based, Sodium-based, Lithium and Metal Air Batteries, Ultra-Capacitors.	**09 Hrs**
Module V **EV Charging:** **Battery Chargers**: Charge equalization, Conductive (Basic charger circuits, Arrangement of an off-board conductive charger, Standard power levels of conductive chargers), Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods. **Charging Infrastructure**: Domestic and Public Charging Infrastructures, Normal, Occasional and Fast Charging Stations, Battery Swapping Station, Move-and-charge zone.	**08 Hrs**
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Reference Books: **Text books / Reference Books:** 1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003 2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003. 3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004. 4. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001 5.K Wang Hee Nam: AC Motor Control & Electrical Vehicle Application, CR Press, Taylor & Francis Group, 2019	

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)
21EE741	CO1	Analyze suitable drive scheme for Electric Vehicles depending on resources.
	CO2	Relate the electric drive trains for EV
	CO3	Identify appropriate motor and converter for EV applications
	CO4	Distinguish battery, battery indication system for EV applications
	CO5	Appraise battery charger for an EV

Course Articulation Matrix for the Academic Year 2024-25

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2	1			3	2					2	3	2	
2	CO2	3	2	1			3	2					2	3	2	

3	CO3	3	2	1			3	2					2	3	2	
4	CO4	3	2	1			3	2					2	3	2	
5	CO5	3	2	1			3	2					2	3	2	

Course Title: **Very Large Scale Integrated Circuits and Design**			
Course Code	21EEOE742	Credits:3	CIE: 50
Number of Lecture Hours/Week	3 hrs.(Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: Electronic Circuits, Power Electronics, Linear integrated circuits.

Objectives:

1. To study Microelectronics & an introduction MOS technology
2. To understand about Basic Electrical properties of MOS and BIMOS circuit.
3. To know MOS and CMOS circuit design processes.
4. To study Basic circuit concepts.
5. To study Scaling of MOS circuits.
6. To understand Subsystem design & layout .

Modules	**Teaching Hours**
Module-I **Introduction to MOS Technology:** Introduction to IC technology, IC era, Basic MOS transistor, enhancement & depletion mode transistor action, NMOS fabrication, CMOS, Fabrication, thermal aspects of processing BICMOS technology, production of E-beam masks.	**08 Hours**
Module-II **MOS and BiCMOS Circuits**: Drain-to-Source current I_{ds} Versus voltage $\mathbf{V}_{ds}$ relationship, aspects of MOS transistor threshold voltage V_t, MOS transistor trans-conductance G_m and output conductance, MOS transistor figure of merit W_o, The pass transistor, The nMOS inverter, determination of pull-up to pull-down ratio (Zpu/Zpd) for an nMOS inverter driven by another nMOS inverter. MOS layers, stick diagram design rules and layout, observation on design rules layout diagrams.	**10 Hours**
Module-III **Basic Circuit Concepts:** Sheet resistance R_s, sheet resistance concept applied to MOS transistors and inverters, area capacitance of layers, standard unit of capacitance, area capacitance calculations, delay unit τ, inverter delays, driving large capacitance loads, prorogation delays, wiring capacitance.	**08 Hours**
Module-IV	

Scaling of MOS Circuits: Scaling models and scaling factors, scaling factors for device parameters, some discussions on & limitations of scaling, limitations due to sub-threshold current , limits on logic levels and supply voltage due to noise.	**08 Hours**
Module-V **Subsystem Design & Layout:** Architectural issues, switch logic, gate logic, examples of structured design (Combinational logic), clocked sequential circuits, power dissipation for CMOS circuits, current limitation for V_{DD} & V_{SS} rails.	**08 Hours**
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Reference Books: 1. Douglas, Puknell, & Eshragian, "Basic VLSI Design", PHI, 3rd Edition -2009 2.John P. Uyemura, "Introduction to VLSI Circuits and Systems" John Wiley, 3.Wayne Wolf, "Modern VLSI design", Pearson Education 3rd Edition -2003. 4.Yuan Taur, Tak H.Ning "Fundamentals of Modern VLSI device" Cambridge press, South Asia Edition., 2015. 5.VLSI design by Debaprasad Das, Oxford University Press, Published 2010,3rd Edition.	

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)
21EE742	CO1	Explain the basic circuits concepts.
	CO2	Explain the MOS and BiCMOS Circuits parameters and stick diagram design rules.
	CO3	Explain Scaling of MOS circuits
	CO4	Design of MOS & CMOS circuits.
	CO5	Design of Layout & Subsystem design.

Course Articulation Matrix for the Academic Year 2024-25

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3												1	1	
2	CO2	2	2	1									1	1	1	
3	CO3	2	1											1	1	
4	CO4	3	3	3									2	2	2	1
5	CO5	3	3	3								1	1	2	2	1
		3														

Course Title: **Illumination Engineering**

Course Code	21EEOE743	CIE: 50
Number of Lecture Hours/Week	**3hrs.(Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite: Basic Terminologies of Electrical Engineering

Course Objectives:

1. To provide an introduction to the fundamentals of illumination engineering and architectural lighting designs.
2. To impart lighting fundamentals and measurements.
3. To gain knowledge on illumination technology and their application in lighting systems.
4. To design indoor and outdoor lighting systems.

Modules	**Teaching Hours**
Module I **Introduction of Light** : Types of illumination, Day lighting, Supplementary artificial lighting and total lighting, Quality of good lighting, Factors affecting the lighting-shadow, glare, reflection, Colour rendering and stroboscopic effect, Methods of artificial lighting, Lighting systems-direct, indirect, semi direct, semi indirect, Lighting scheme, General and localised	07 hrs
Module II **Measurement of Light** : Definition of luminous flux, Luminous intensity, Lumen, Candle power, Illumination, M.H.C.P, M.S.C.P, M.H.S.C.P, Lamp efficiency, Brightness or luminance, Laws of illumination, Inverse square law and Lambert's Cosine law, Illumination at horizontal and vertical plane from point source, Concept of polar curve, Calculation of luminance and illumination in case of linear source, round source and flat source	07 hrs
Module III **Design of Interior Lighting** : Definitions of maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilization and factors affecting it, Illumination required for various work planes, Space to mounting height ratio, Types of fixtures and relative terms used for interior illumination such as DLOR and ULOR, Selection of lamp and luminance, Selection of utilization factor, reflection factor and maintenance factor. Determination of Lamp Lumen output taking into account voltage and temperature variations, Calculation of wattage of each lamp and no of lamps needed, Layout of lamp luminaire, Calculation of space to mounting height ratio, Indian standard recommendation and standard practices for illumination levels in various areas, Special feature for entrance, staircase, Corridor lighting and industrial building	10 hrs
Module IV **Design of Outdoor Lighting** : Street Lighting : Types of street and their level of illumination required, Terms related to street and street lighting, Types of fixtures used and their suitable application, Various arrangements in street lighting, Requirements of good street lighting, Selection of lamp and luminaire, Calculation of their wattage, Number and arrangement, Calculation of space to mounting height ratio, Calculation of illumination level available on road.	10 hrs

Design of Outdoor Lighting : Flood Lighting : Terms related to flood lighting, Types of fixtures and their suitable applications, Selection of lamp and projector, Calculation of their wattage and number and their arrangement, Calculation of space to mounting height ratio, Recommended method for aiming of lamp	
Module V **Special Features of Aesthetic Lighting** : Monument and statue lighting, Sports lighting, Hospital lighting, Auditorium lighting Case Study: On Domestic, Commercial, Industrial and community service buildings.	08 hrs
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Text books/Reference Books: 1. D.C. Pritchard Lighting, Routledge, 2016 2. Jack L. Lindsey, Applied Illumination Engineering , PHI, 1991 3. John Matthews Introduction to the Design and Analysis of Building Electrical Systems, Springer, 1993 4. M.A. Cayless, Lamps and Lighting , Routledge, 1996	
Course outcomes: **On completion of the course, the student will have the ability to:**	

Course Code	CO #	Course Outcome (CO)
21EE743	**CO1**	**Outline the fundamentals of illumination engineering and architectural lighting designs.**
	CO2	**Describe lighting fundamentals and measurements.**
	CO3	**Design of indoor lighting**
	CO4	**Design of outdoor lighting**
	CO5	**Examine illumination technology and their application in lighting systems**

Course Articulation Matrix for the Academic Year 2024-25

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	2				1	1	1			1		1		
2	CO2	3	2													
3	CO3	3		2		1										1
4	CO4	3	2	2		1										1
5	CO5	3	2					1				1	1			
		3	2	2		1	1	1	1			1	1	1		1

EMC IN ELECTRICAL SYSTEMS			
Course Code	22EEOE744	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Credits	03	Exam Hours	03
Module-1			

Electromagnetic Disturbances: Introduction, Classification of disturbances by frequency content, by character and transmission mode.

Conducted EMI Measurement: Introduction, EMI measuring instruments, Basic terms and conducted EMI references, Measuring the interference voltage and current, Spectrum analysers, EMI measurements for consumerapplications, Measuring impulse like EMI.

EMI in Power Electronic Equipment: EMI from power semiconductors, controlled rectifier circuits, EMI calculation for semiconductor equipment. **(09 HRS)**

Module-2

EMI Filter Elements: Measuring High Frequency Characteristics OF EMI Filter Elements, Capacitors, Choke Coils, Resistors. **(08 HRS)**

Module-3

Noise Suppression: Noise Suppression in Relay Systems, Application of AC Switching Relays, Application of RC – Snubbers to Power Semiconductors, Shielded Transformers, Capacitor Filters, EMI Generation and Reduction at its Source, Influence of Layout and Control of Parasitics.

EMI Filter Circuit selection and measurement: Definition of EMI Filter Parameters, ENI Filter Circuits, Insertion Loss Test Methods. **(09 HRS)**

Module-4

EMI Filter Design: EMI Filter Design for Insertion Loss, Calculation of Worst – case Insertion Loss, Design Method for Mismatched Impedance Condition, Design Method for EMI Filters with Common – Mode Choke Coils, Damped EMI Filters and Lossy Filter Elements, HF Characteristics of Noise Filter Circuit Elements, EMI Filter Layout. **(08 HRS)**

Module-5

Testing for Susceptibility to Power Line Disturbances: Surge Voltages in AC Power Mains, EMC Tests per IEC Specifications, Other EMS Test Methods.

Reduction Techniques for internal EMI: Conductive Noise Coupling, Electromagnetic Coupling, Electromagnetic Coupling Reduction Methods, Wiring Layout Methods to Reduce EMI Coupling, PCB Design Considerations. **(08 HRS)**

Course outcomes:

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

- Describe Electromagnetic interference and its classification and measurement of conducted highfrequency disturbance.
- Survey electromagnetic interference specific to power electronic equipment.
- Explain the characteristics of circuit elements used for noise suppression.
- Explain EMI suppression methods used in semiconductor and electromechanical devices.
- Explain design of EMI filter circuits and filtering methods.
- Explain susceptibility and noise withstand capability test.
- Explain EMS reduction techniques for power electronic equipment.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1. Electromagnetic Compatibility in Power Electronics, Laszlo Tihanyi, Newnes, 1st Edition, 1995.