Vidyavardhaka Sangha ®, Mysuru

VIDYAVARDHAKA COLLEGE OF ENGINEERING

Autonomous Institute, Affillated to Visvesaraya Technological University, Belagavi

(Approved by AICTE, New Delhi & Government of Karnataka)
Accredited by NBA/NAAC with 'A' Grade
website: www.vvce.ac.in

Bachelor of Engineering (B.E)

V & VI Semester Scheme and Syllabus

(Autonomous Scheme: 2020)

2022-23

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vidyavardhaka Sangha®, Mysore
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Autonomous Institute, Affiliated to Visvesvaraya Technological University, Belagavi
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Accredited by NBA | NAAC with 'A' Grade
Department of Electrical & Electronics Engineering
Phone: +91 821-4276240, Email: hodee@vvce.ac.in
Web: http://www.vvce.ac.in
VVCE
@vvceofficial

Scheme of Teaching and Examination for BE (Autonomous Scheme : 2020)												
V SEMESTER - Electrical and Electronics Engineering												
Sl. No.	**Course Area**	**Course Code**	**Course Name**	**Teaching Department**	**Contact Hours / week**			**Examination**				**Credits**
					L	**T**	**P**	**Duration (Hrs.)**	**CIE Marks**	**SEE Marks**	**Total**	
1	PC	20EE51	Power System Analysis 1	EE	4	0	0	3	50	50	100	4
2	PC	20EE52	DC Machines and Synchronous Machines	EE	3	0	0	3	50	50	100	3
3	PC	20EE53	Power Electronics	EE	3	0	0	3	50	50	100	3
4	PC	20EE54	Management and IPR	EE	3	0	0	3	50	50	100	3
5	PE	20EE55X	Professional Elective – I	EE	3	0	0	3	50	50	100	3
6	OE	20EE56X	Open Elective - I	EE	3	0	0	3	50	50	100	3
7	PC	20EE57	DC Machines and Synchronous Machines Laboratory	EE	1	0	2	3	50	50	100	2
8	PC	20EE58	Power Electronics Laboratory	EE	1	0	2	3	50	50	100	2
9	HS	20HS51	Skill Development - III	TAP	0	2	0	2	50	50	100	1
10	PE	20AL51	Career Elective - I	EE	0	0	2	2	50	50	100	1
TOTAL					**21**	**2**	**6**	**-**	**500**	**500**	**1000**	**25**

*** Mandatory Non-Credit Course**

Professional Elective - I		**Open Elective - I**		**Career Elective - I**
20 EE 551	Embedded Systems	20 EE 561	Renewable Energy Sources	Mini / Minor Project
20 EE 552	Non-conventional Energy Sources	20 EE 562	Electronic Instrumentation	Research
20 EE 553	Sensors and Transducers	20 EE 563	Utilization of Electric power	Add on course
20 EE 554	Digital System Design using VHDL	20 EE 564	Basics of Battery Management System	Foreign language.

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Scheme of Teaching and Examination for BE (Autonomous Scheme : 2020)

VI SEMESTER - Electrical and Electronics Engineering

Sl. No.	Course Area	Course Code	Course Name	Teaching Department	Contact Hours / week			Examination				Credits
					L	T	P	Duration (Hrs.)	CIE Marks	SEE Marks	Total	
1	PC	20EE61	Control System	EE	4	0	0	3	50	50	100	4
2	PC	20EE62	High Voltage Engineering	EE	3	0	0	3	50	50	100	3
3	PC	20EE63	Digital Signal Processing	EE	3	0	0	3	50	50	100	3
4	PC	20EE64	Switchgear and Protection	EE	3	0	0	3	50	50	100	3
5	PE	20EE65X	Professional Elective - II	EE	3	0	0	3	50	50	100	3
6	OE	20EE66X	Open Elective - II	EE	3	0	0	3	50	50	100	3
7	PC	20EE67	Control System Laboratory	EE	1	0	2	3	50	50	100	2
8	PC	20EE68	Digital Signal Processing Laboratory	EE	1	0	2	3	50	50	100	2
9	HS	20HS61	Skill Development - IV	TAP	0	2	0	2	50	50	100	1
10	PE	20AL61	Career Elective - II	EE	0	0	2	2	50	50	100	1
TOTAL					**21**	**2**	**6**	**-**	**500**	**500**	**1000**	**25**

Professional Elective - II		Open Elective - II		Career Elective - II
20EE651	VLSI Circuits and Design	20EE661	Electric Vehicle Technologies	Mini / Minor Project
20EE652	Advanced Power Electronics	20EE662	Demand Side Management in Electrical Power	Research
20EE653	Estimation and Costing	20EE663	Fundamentals of Programmable Logic Controller	Add on course
20EE654	PLC & SCADA	20EE664	Electric Traction	Foreign language

SEMESTER –V			
Course Name	**:Power System Analysis-1**	**Course Code :**	**20EE51**
No. of Lecture Hours / Week	**: 04**	**CIE Marks :**	**50**
No. of Tutorial / Practical Hours / Week	**: 00**	**SEE Marks :**	**50**
Total No. of Lecture + Tutorial / Practical Hours	**:40**	**SEE Duration :**	**03 Hrs**
L:T:P	**:04:00:00**	**CREDITS :**	**4**

COURSE OVERVIEW: The course provides an overview of exploring the ways and means to perform power system analysis under fault condition and analyze the power system for stability.

COURSE LEARNING OBJECTIVES (CLO) : The objectives of the course is

1. To acquaint knowledge of per unit scheme and construct per unit impedance diagram.
2. To evaluate the fault current in the power system under different fault conditions.
3. To impart concepts related to power system stability.

MODULES	TEACHING HOURS
MODULE 1 Introduction to power system Representation of Power System Components, Single-phase representation of balanced three phase networks, One-Line diagram, Impedance/Reactance diagram, Per Unit (PU) System, Steady State Model of synchronous machine, power transformer, transmission line of Power system, Representation of Loads. **SSC**: Reactance of the transformer referred to either sides. **Book-1- 4.1-4.7**	**8**
MODULE 2: Symmetrical Fault Analysis: Introduction, Transient on a Transmission Line, Short Circuit of a synchronous machine(On No Load), short circuit of a loaded synchronous machine, Illustrative simple examples on power systems. SSC: Selection of breaker **Book-1- 9.1-9.5**	**8**
MODULE 3 Symmetrical Components: Introduction, Symmetrical Component transformation, Phase Shift in Star-Delta transformers, Sequence Impedances of transmission lines, Sequence Impedances and Sequence Network of power system, Sequence Impedances and Networks of synchronous machine, transmission lines, transformers, Construction of sequence networks of a power system **SSC:** Find current in star delta transformer **Book-1- 10.1-10.9**	**8**
MODULE 4: Unsymmetrical Fault Analysis: Introduction, Symmetrical Component analysis of unsymmetrical faults, Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double Line-To-Ground (LLG) Fault, Open Conductor Faults(one conductor) **SSC:** open conductor fault with two conductor	**8**

Book-1 11.1-11.6	
MODULE 5: Power System Stability: Introduction, Dynamics of a Synchronous Machine, Review of Power Angle Equation, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability, SSC: impact of critical clearing angle **Book-1- 12.1-12.9 and 12.11**	**8**

Text Books:

1. Modern Power System Analysis, D. P. Kothari, McGraw Hill, 3rd Edition, 2011

Reference Books:

1. Elements of Power System, William D. Stevenson Jr, McGraw Hill, 4th Edition, 1982.
2. Power System Analysis and Design, J. Duncan Glover et al, Cengage, 4th Edition, 2008.
3. Power System Analysis, Hadi Sadat, McGraw Hill, 1st Edition, 2002

COURSE OUTCOMES (Cos): At the end of course students will be able to

1	Explain the concepts related to per unit representation of power system, different type of faults, selection of breaker and stability of power system.[L2]
2	Apply the concept of per unit and obtain impedance diagram for given power system, compute fault current in a given power system and evaluate stability parameters of power system [L3]
3	Analyze the power system under different fault condition for its stability [L4]
4	Simulate a circuit to compute the fault current and post fault voltages in a power system[PO4 and PO5]

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	-	-	-		-	
C02	3		-	_	-	-	-	-	-	-	-	-	2	-	
C03	-	2		_	-	-	-	-	-	-	-	-	2	-	
C04	-	-	-	1	1		-	-	-	-	-	-	-	-	
Avg	**2.5**	**2**	**-**	**1**	**1**								**2**		

SEMESTER – V			
Course Name	: DC Machines & Synchronous Machines	Course Code:	20EE52
Number of Lecture Hours / Week	: 03	CIE Marks:	50
Number of Tutorial / Practical Hours / Week	: 00	SEE Marks:	50
Total Number of Lecture + Tutorial/Practical Hours	: 40	SEE Duration:	03 Hours
L:T:P	: 3:0:0	CREDITS:	03

COURSE OVERVIEW:

The subject provides an overview of different types of DC Machines and Synchronous machines that can be used in various applications.

COURSE LEARNING OBJECTIVES (CLO) :

The objectives of this course is :

1. To familiarize the concepts related to DC generators, motors & synchronous machines.
2. To discuss the principle of operation and their performance parameters for a given DC Machine & Synchronous Machine

MODULES	TEACHING HOURS
MODULE 1 **DC Generator**-Review of basics of DC machines,classification of DC generator, types of armature winding, EMF equation, no-load characteristic, armature reaction, load characteristics. Commutation, types of Commutation, interpoles and compensating windings **SSC** : Applications of DC Generators **Text Book 1:** 6.1.1- 6.8.1	**8**
MODULE 2 **DC Motors:** Classification, Back EMF and its significance, Torque equation, Characteristics of shunt and series motors, speed control of shunt and series motors. DC motor starters-3- point and 4- point starter. **SSC :** Application of motors. **Text Book 1:** 8.1 – 8.18, 9.1 – 9.18 and 9.4 – 9.5	**8**
Module-3 **Losses And Efficiency:** Losses in DC machines, power flow diagram, efficiency, condition for maximum efficiency. **Testing Of DC Machines:** Direct & indirect methods of testing of DC machines-Brake test, Swinburn's test, Hopkinson's test, Retardation test, Field's test, **SSC** : merits and demerits of tests. **Text Book 1: 10.1 – 10.13.**	**8**
MODULE 4: **SYNCHRONOUS MACHINES:** Basic principle of operation, construction of salient & non-salient pole synchronous machines, generated EMF. **VOLTAGE REGULATION:** Voltage regulation by EMF, MMF & ZPF method. Short circuit ratio and its importance. **SSC :** Comparison of salient and non salient pole alternator. **Textbook 2: 3.1, 3.2, 3.6, 3.18, 3.25 and 3.26**	**8**

MODULE 5: **PARALLEL OPERATION OF ALTERNATORS:** Synchronizing to infinite bus bars, necessity, conditions, Dark and bright lamp method. parallel operation of alternators. **SYNCHRONOUS MOTOR:** Principle of operation, , Blondal diagram, effect of change in load, effect of change in excitation, V and inverted V curves. Synchronous condenser, hunting and methods of starting synchronous motors. **SSC** : Applications of synchronous motors. **Text Book 2 : 5.13, 5.14, 5.17, 5.20 and 5.25**	**8**

Text Books:

1. **Electrical machinery,** J B Gupta,2009 Edition.
2. **Electrical machines,** DP Kothari, I.J.Nagarath, TMH, 4th edition, 2010.

Reference Books:

1. **Performance & Design of Alternating Current machines**, M. G. Say, CBS publishers,3rd Edition,2002.
2. **The Performance & Design of DC machines** A.E Clayton & N.N.Hancock CBS Publication,3rd Edition,2004.
3. **Electric Motors**, Mantech Publications,New Delhi,K.Gopala Reddy

COURSE OUTCOMES (COs) : **At the end of this Course student will be able to:**	
CO1	**Explain** the construction & operation of DC Machines and Synchronous Machines**.(L2).**
CO2	**Apply** suitable methods to determine the efficiency and losses in DC Machines and Synchronous Machines**(L3)**
CO3	**Analyze** the performance of DC Machines and Synchronous Machines by suitable tests. **(L4)**
CO4	Prepare reports and give effective presentations on generation of electrical energy from any generating station**. (PO10)**

CO – PO PSO Mapping

CO	**PO**												**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2														
CO2	3												2		
CO3		2											2		
CO4										1					
CO	**2.5**	**2**								**1**			**2**		

SEMESTER – V			
Course Name	**: Power Electronics**	**Course Code :**	**20EE53**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial / Practical Hours / Week	**: 00**	**SEE Marks :**	**50**
Total No. of Lecture + Tutorial / Practical Hours	**: 40**	**SEE Duration :**	**03 Hrs**
L:T:P	**:03:00:00**	**CREDITS :**	**3**

COURSE OVERVIEW: The course deals with the principle of operation, characteristics of various power switching devices both classical and emerging and analysis of operation of power conversion systems such as controlled rectifier circuits, inverters and DC choppers

COURSE LEARNING OBJECTIVES (CLO)

The objectives of the course is

To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics.

To acquaint the students with the key concepts of various types of power converters and their applications.

MODULES	TEACHING HOURS
MODULE 1 : Introduction Introduction - Applications of Power Electronics, Power Semiconductor Devices, types of Power Electronic Circuits, peripheral Effects. Power Diodes, Types: Reverse Recovery characteristics, Rectifier: single phase full wave diode rectifier. Power BJTs: Steady state characteristics. Power MOSFETs: device operation, switching characteristics, steady state characteristics IGBTs: device operation, output, and transfer characteristics. Thyristors: Characteristics, and modes of operation, two transistor model of thyristor, thyristor types. di/dt and dv/dt protection of thyristors. **SSC: Applications of Power Electronics** **Textbook 1:** 1.1,1.2,1.5,1.8,2.1,2.4,2.5,3.4,4.2,4.3,4.6,7.1,7.2,7.3,7.6,7.9	**8**
MODULE 2: **Controlled rectifiers** Controlled rectifiers - Introduction, principle of phase-controlled converter operation, Single phase fully controlled converters with R and RL load, Single phase semi-converters, Single phase dual converter, principle of operation of Three phase dual converter. **SSC: Single phase semi-converters** **Textbook 1: 10.1,10.2,10.3,10.4,10.7,10.9.**	**8**
MODULE 3: **AC Voltage Controllers:** Introduction, Principle of phase control and integral cycle control, single phase bidirectional controllers with R load, single phase full wave controllers with R load and single phase full wave controllers with RL load, Three phase full converters. Introduction to cycloconverters. Single phase cycloconverters. SSC: Three phase full controllers. **Textbook 2:** 11.1,11.2,11.3,11.4,11.5,11.6,11.9	**8**

MODULE 4: DC-DC Converters DC-DC Converters - Introduction, principle of step-down operation and it's analysis with R and RL load (only CCM mode of operation), and principle of step-up chopper with R load, performance parameters, Chopper/Converter classification (Quadrant classification). **SSC: performance parameters** **Textbook 1:** 5.1,5.2,5.3,5.4,5.7	**8**
MODULE5: DC-AC Inverters Introduction, principle of operation, performance parameters, Single phase bridge inverters with R and RL load, three phase inverters 180-degree conduction,120-degree conduction. Introduction to multilevel inverters, cascaded multilevel inverter. SSC: Performance parameters **Textbook 1: 6.1,6.2,6.3,6.4,6.5, 9.1-9.6**	**8**

Text Books:

1. Power Electronics – Circuits, Devices and Applications - Muhammad H Rashid, Pearson edition pvt ltd , Third Edition,2004

Reference Books:

1. Power Electronics – Converters, Applications and Design - Ned Mohan, Tore M. Undeland and William P Robbins, John Wiley &sons , 3rd Edition,2002
2. Power Electronics Essentials and Applications-L.Umanand,Wiley India Pvt. Ltd.2009
3. Power Electronics – Principles and Applications - Joseph Vithayathil, TATA McGraw-hillEdition,2010
4. Power Electronics - M.D.Singh, K B Khanchandani, TMH ,Second edition, 2008

COURSE OUTCOMES (COs): At the end of course students will be able to

1	Explain the operation of power semiconductor devices and power converters. **[L2]**
2	Apply relevant equations to determine the parameters for a given power semiconductor device/converter**. [L3]**
3	Analyze the performance of power conversion systems using relevant mathematical expressions. **[L4]**
4	Simulate efficient power conversion systems/subsystems for given specifications and effectively interpret the results to provide valid conclusions. **[PO4 and PO5].**

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	-	2	1	1	-	-	-	-	-	-	-	-	-	
CO Avg	**2.5**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**

SEMESTER – V			
Course Name	**: MANAGEMENT AND IPR**	**Course Code :**	**20EE54**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial / Practical Hours / Week	**: 0**	**SEE Marks :**	**50**
Total No. of Lecture + Tutorial / Practical Hours	**:40**	**SEE Duration :**	**03 Hrs**
L:T:P	**:03:00:00**	**CREDITS :**	**03**

COURSE OVERVIEW : The subject deals with an introduction to management and Entrepreneurship to provide comprehensive knowledge regarding the general principles and concepts related to Intellectual Property Rights and Laws.

COURSE LEARNING OBJECTIVES (CLO) :

1. To familiarize students with the need to understand the levels of management, managerial skills, entrepreneurship, project management, patents, and IPR rules
2. To acquaint the students with key concepts of network construction, arrow diagram, redundancy, CPM, and PERT Networks.

MODULES	TEACHING HOURS
MODULE 1: Introduction to Management: Importance of Management, Management Process, Levels of Management, Role of senior manager, Management and Administration, Management as an art, science profession, Planning types, steps in planning, Limitation in planning, Social Audit, Meaning of social responsibility Organization, Principles of organisation, Delegation, Control techniques, Directing, Motivation, Functions of a Leader SSC: Managerial Skills Text Book 1: 1.1-1.12,3.1-3.5, 4.3-4.6,7.1-7.3,8.6,15.1-15.3,18.6	**08**
MODULE 2: Project Management Introduction, Network construction, Arrow diagram, Redundancy. CPM and PERT Networks, Scheduling computations, PERT time estimates, and Probability of completion of the project. functional areas of management, Operations management, Human resources management, Marketing management, Financial management SSC: Introduction to crashing Text Book 2: 8.1 -8.6	**08**
MODULE 3: Entrepreneurship: Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Entrepreneurial competencies, Women Entrepreneur, Institutions supporting women Entrepreneurs, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship. Definition of Entrepreneur Importance of Entrepreneurship SSC: Characteristics of Successful Entrepreneur Text Book 2: 1.2-1.4,3.1-3.4, Ref.Text Book 1: 5.1-5.6	**08**

MODULE 4:IPR **I**ntroduction to Intellectual Property Rights, Concepts and Theories, Rights of owners of Intellectual Property, ownership and transfer of IPR. Advantages and Disadvantages of IPR. Copyright, Trademark SSC: Kinds of Intellectual Property Rights Text Book 3: 1.1-1.4, 3.1-3.3, 4.1-4.5	**08**
MODULE 5:Introduction to Patents To patent or not to patent an Invention, Rights associated with patents, Need of a patent Attorney, types of a patent application, commonly used terms in patenting SSC: Rights of patentee Text Book 3: 2.1.2.1.20	**08**

Text Books:

1.Principles of Management P.C.Tripathi, P.N.Reddy McGraw Hill, 6 thEdition, 2017

2.Entrepreneurship Development And Small Business Enterprises Poornima M.Charanthimath Pearson 2ndEdition,2014

3.N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow

Reference Books:

1.Management and Entrepreneurship, K.R.PHANESSH, Sudha publication, 7th edition , 2014

2.Intellectual Property A Primer for Academia",Prof. Rupinder Tewari Ms. Mamta Bhardwaj,Publication Bureau, Panjab University Chandigarh-160014, India.

COURSE OUTCOMES (COs):

CO1: Explain the principles of management characteristics, the importance of planning, and Intellectual Property Rights(L2)

CO2: Apply the different network concepts, scheduling computations, and time estimations for project management and Entrepreneurship. (L3)

CO3: Analyze the support system, competencies faced by entrepreneurs to become successful.(L4)

CO4: Conduct the survey on needs and challenges for the write up of patents and obtaining patents.

CO – PO – PSO Matrix

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

SEMESTER – V			
Course Name	**: Embedded Systems**	**Course Code :**	**20EE551**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial Hours / Week	**: 00**	**SEE Marks :**	**50**
Total No. of Lecture Hours	**: 40**	**SEE Duration :**	**3 Hours**
L:T:P	**: 3:0:0**	**Credits :**	**3**

COURSE OVERVIEW: This course gives the knowledge about the concepts of design and development of Embedded systems. The basic knowledge of Microcontrollers is the prerequisite for this course.

COURSE LEARNING OBJECTIVES (CLO):

The objective of this course is to

1. Describe the components and applications of Embedded system.
2. Describe the concepts of design and development of Embedded system.

MODULES	Teaching hours
Module-1: **Introduction to Embedded Systems**: What is an Embedded System? Embedded Systems VS. General Computing Systems, History of Embedded Systems, Classification of Embedded Systems, Major Application Areas of Embedded Systems, Purpose of Embedded Systems, Communication Interface. **SSC**: Wearable Devices—The Innovative Bonding of Lifestyle with Embedded Technologies. Textbook: 1.1-1.7,2.4	**8**
Module-2: **Embedded Systems—Application- and Domain-Specific**: Washing Machine—Application-Specific Embedded System, Automotive–Domain Specific Examples of Embedded System. **Hardware Software Co-Design and Program Modeling**: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design. **SSC**: Hardware Software Trade-offs. Textbook: 4.1,4.2, 7.1,7.2,7.4	**8**
Module-3: Embedded product Design and Development approach. **Embedded Firmware Design and Development**: Embedded Firmware Design Approaches, Embedded Firmware Development Languages. **Integration and Testing of Embedded Hardware and Firmware**: Integration of Hardware and Firmware. **SSC**: Board Bring up. Textbook: 8 (introduction only), 9.1,9.2, 12.1,12.2	**8**
Module-4: **The Embedded System Development Environment**: The Integrated Development Environment (IDE), Types of Files Generated on Cross-Compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging. **SSC**: Boundary Scan. Textbook: 13.1-13.6	**8**
Module-5: **The Embedded Product Development Life Cycle (EDLC)**: What is EDLC? Objectives of EDLC, Different Phases of EDLC – Need, Conceptualization, Analysis, Design, Development and Testing, Deployment, Support, Upgrades, Retirement. EDLC Approaches (Modeling the EDLC)- Linear, incremental, prototyping and spiral.	**8**

SSC: Why EDLC? Textbook: 15.1-15.5	

Textbooks

1. "Introduction to Embedded Systems" by Shibu K V - Second Edition – McGraw Hill Education India Private Limited, 2017

Reference books

1. Introduction to Embedded Systems, Raj Kamal, Tata McGraw Hill
2. Steve Heath, "Embedded System Design", 2nd Edition, Newnes, Burlington, 2003
3. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
4. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.

COURSE OUTCOMES (COs)

At the end of course students will be able to

CO1	Explain the basics of Embedded system and Embedded product development life cycle. [L2]
CO2	Apply the knowledge of design and development concepts of embedded systems for a given application. [L3]
CO3	Analyze the design and development process of embedded systems for a given application. [L4]
CO4	Design and implement simulation/hardware-based projects. [ABA]

CO – PO – PSO Mapping

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2													
CO4			2		2									2	2
Avg.	**2.5**	**2**	**2**		**2**									**2**	**2**

SEMESTER – V			
Course Name	: Non-conventional Energy Sources	Course Code:	20EE552
Number of Lecture Hours / Week	: 03	**CIE Marks:**	50
Number of Practical Hours / Week	: 00	**SEE Marks:**	50
Total Number of Lecture Hours	: 40	**SEE Duration:**	03
L:T:P	: 3:0:0	**Credits:**	03

COURSE OVERVIEW: This course gives an insight about the principle, working, utilization and availability of renewable energy sources and its applications.

COURSE LEARNING OBJECTIVES (CLO):

1. To familiarize students with available renewable energy resources to harness energy considering local energy needs.
2. To acquaint students with key concepts of energy generation using renewable energy resources for citing the requirements and propose appropriate methods to generate energy.

MODULES	TEACHING HOURS
Module-1: Introduction to Energy Sources World population and Energy consumption pattern, Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability. Energy Storage. SSC: Renewable Energy in India. Text Book 1: 1.2, 1.5, 1.7, 1.9, 1.12.1, 1.12.2, 1.14	**08**
Module-2: Solar Energy and Applications Measurement of Solar radiation, Solar radiation geometry, Solar day length. Solar Thermal Systems: Solar collectors, solar water heater, solar cooker, Solar Furnaces, Solar distillation. Solar Photovoltaic systems: Solar cell, module panel and array construction, solar PV systems. SSC: Solar dryer & Solar PV applications Text Book 2: 4.7, 4.10, 4.11, 5.1, 5.2, 5.6, 5.7, 5.9, 5.10,6.4, 6.8, 6.9	**08**
Module-3: Wind Energy & Geothermal Energy Wind Energy: Origin of wind, Nature of wind, wind turbine siting, wind turbine types and their construction, wind energy conversion systems. Environmental aspects, wind energy programme in India. Geothermal Energy: Origin & distribution of geothermal energy, Types of geothermal resources, environmental consideration, geothermal energy in India. SSC: Applications of wind energy & geothermal energy Text Book 2: 7.1, 7.2, 7.3, 7.7, 7.8, 7.12, 7.13, 9.2, 9.3, 9.6, 9.7	**08**
Module-4: Tidal, Wave Energy & Ocean Thermal Energy Tidal Energy: Introduction, origin and nature of tidal energy, limitations of tidal energy, tidal energy technology, tidal power range, ocean tidal energy conversion schemes, environmental impacts. Sea Wave Energy: Introduction, Wave Energy Technology, Devices for Harnessing Wave Energy, environmental impacts.	**08**

Ocean Thermal Energy: Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Closed Cycle, Open Cycle and Hybrid Cycle, Application of OTEC in Addition to Produce Electricity, Benefits of OTEC. SSC: Advantages & disadvantages of tidal, wave & ocean thermal energy. Text Book 2: 10.1, 10.2; Text book 1: 13.1, 13.2, 13.3, 13.5, 13.7, 13.8	
Module-5: Biomass Energy, Hydrogen Energy & Fuel Cells Energy Biomass Energy: Biomass production, biomass gasification, Updraft, downdraft & cross-draft gasifiers. Fluidized bed gasification, gasifier biomass feed characteristics. Hydrogen Energy: Properties of Hydrogen, Production, Storage, conversion safety issues. Fuel cells – Introduction, potential applications, classification of fuel cells, fuels for fuel cells, fuel cell power plant, environmental effects. SSC: Applications of Biomass, Hydrogen energy & fuel cell. Text Book 1: 9.1, 9.3, 9.7,9.8,9.9, 9.10, 9.12; Text Book 2:12.1.1- 12.1.7, 12.1.9, 12.1.12, 12.1.14, 12.2.1 to 12.2.3,12.2.5 to 12.2.7	**08**

Text Books:

1. Nonconventional Energy Resources Shobh Nath Singh Pearson 1st Edition, 2015
2. Nonconventional Energy Resources B.H. Khan McGraw Hill 3rd Edition

References

1. G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 2004.

COURSE OUTCOMES (COs):

CO1	Discuss the need for generating power using Renewable energy resources with environmental considerations. [L2]
CO2	Apply the concepts of power generation and economics to identify the need and kind of power to be generated and propose appropriate methods to generate power. [L3]
CO3	Analyze the type of location in which the power plant must be installed and suggest suitable methods to harness energy from locally available resources. [L4]
CO4	Study the renewable energy resource availability across the globe and its environmental impact with effective presentation. [ABA]

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-
CO	**2.5**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**

SEMESTER – V			
Course Name : Sensors and Transducers		**Course Code** :	20EE553
Number of Lecture Hours / Week	: 03	**CIE Marks :**	50
Number of Practical Hours / Week	: 00	**SEE Marks :**	50
Total Number of Lecture Hours	: 40	**SEE Duration :**	03
L:T:P	: 3:0:0	**Credits :** 03	

COURSE OVERVIEW:

This course is designed to illustrate the use of sensors and transducers associated with electronic circuits. It emphasizes on different principles of sensing to carry out electrical and non electrical measurements and highlights on the basics of signal conditioning and data acquisition systems.

COURSE LEARNING OBJECTIVES (CLO) :

1. To familiarize students about the need of transducers, their classification, advantages and disadvantages.
2. To enlighten the students regarding different types of transducers and sensors and discuss the recent trends in sensor technology and their selection.
3. To elucidate the basics of signal conditioning, data acquisition, data conversion and data transmission

MODULES	TEACHING HOURS
Module 1 **Introduction to Transducers:** Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Thermoelectric Transducers, Photoelectric Transducers. **SSC:** Hall Effect Transducers **Text Book:** 7.1 to 7.12	**08**
Module 2 **Introduction to sensors:** Strain Gauges, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Induction Potentiometers, Micro Electromechanical Systems **SSC:** Synchros and Resolvers **Text Book:** 7.12 to 7.20	**08**
Module-3 **Signal Conditioning and Data acquisition systems and conversion:** Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Electrical and Electronic Amplifiers. Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion	**08**

SSC: Optical Amplifiers **Text Book:** 8.1 to 8.6, 9.1 to 9.4	
Module 4 **Data transmission and Telemetry: Types of** Data/Signal Transmission- Mechanical transmission, Pneumatic transmission, Magnetic transmission and Electric transmission Telemetry- Voltage Telemetering system, Current Telemetering system, Position Telemetering system ad RF Telemetering system **SSC:** Frequency modulation Telemetry system **Text Book:** 10.1 to 10.2	**08**
Module 5: **Measurement of Non – Electrical Quantities:** Pressure Measurement, Temperature Measurement, Flow Measurement – Introduction, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Metes, Wire Anemometers. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Liquid Level. **SSC:** Measurement of Torque and Shaft Power **Text Book:** 12.1 to 12.10	**08**

Text Books:

1. Electronic Measurements and instrumentation, R.K Rajput, S. Chand, 3rd Edition, 2013.

References

1. A Course in Electronics and Electrical Measurements and Instruments, J.B. Gupta, Katson Books, 13th Edition, 2008.
2. A Course in Electrical and Electronic Measurements and Instrumentation, A. K. Sawheny, Dhanpat Rai, 2015

COURSE OUTCOMES (COs):At the end of this Course student will be able to:	
CO1	Explain the operating principle of various transducers and sensors (L2)
CO2	Apply the knowledge of type of sensor best suited for different electronic applications (L3)
CO3	Analyze the performance of various sensors, Signal conditioning methods and Data Acquisition Systems (L4)
CO4	Prepare reports and give effective presentation on Different types of sensors and transducers used in Industrial Applications

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3													2	
CO3		2													
CO4										1					
Avg.	2.5	**2**								**1**				**2**	

SEMESTER – V			
Course Name	Digital System Design using VHDL	**Course Code**	20EE554
Number of Lecture Hours / Week	03	**CIE Marks**	50
Number of Practical Hours / Week	00	**SEE Marks**	50
Total Number of Lecture Hours	40	**SEE Duration**	03 Hours
L:T:P	3:0:0	**Credits**	03

COURSE OVERVIEW :

The course focus on the modeling of digital system from gate level using VHDL. And design of combinational and sequential building blocks, for the implementation in large scale digital systems.

COURSE LEARNING OBJECTIVES (CLO) :

The objective of the course is to

1. Impart the industry-standard hardware description language for the design of digital system design for large scale hardware models.
2. To discuss the VHDL models ranging in complexity from a simple adder to more complex circuits.
3. To synthesize the information related to testing of models using PLD's and SM Charts.

MODULES	TEACHING HOURS
Module 1 **INTRODUCTION**: VHDL description of combinational networks, Modeling flip-flops using VHDL, VHDL models for a multiplexer, Compilation and simulation of VHDL code, Modeling a sequential machine, Variables, Signals and constants, Arrays, VHDL operators, VHDL functions, VHDL procedures, Packages and libraries, VHDL model for a counter. SSC: Gate level model of combinational circuits Text Book 1: 2.1 – 2.12 Text Book 2: Chapter 1 - 3	**8**
Module 2 **DESIGNING WITH PROGRAMMABLE LOGIC DEVICES**: Read-only memories, Programmable logic arrays (PLAs), Programmable array logic (PALs), Other sequential programmable logic devices (PLDs), Design of a keypad scanner. SSC: Characteristics of ROM, RAM and PLD's Text Book 1: 3.1 – 3.5	**8**
Module 3 **DESIGN OF NETWORKS FOR ARITHMETIC OPERATIONS:** Design of a serial adder with accumulator, State graphs for control networks, Design of a binary multiplier, Multiplication of signed binary numbers, Design of a binary divider **FLOATING-POINT ARITHMETIC:** Representation of floating-point numbers, Floating-point multiplication, Other floating-point operations. SSC: Design of latches and Flip Flop Text Book 1: 4.1 – 4.5, 7.1 – 7.3	**8**
Module 4	**8**

DIGITAL DESIGN WITH SM CHARTS: State machine charts, Derivation of SM charts, Realization of SM charts. Implementation of the dice game, Alternative realization for SM charts using microprogramming, Linked state machines. SSC: SM Chart for Arithmetic operations Text Book 1: 5.1 – 5.6	
Module 5 **DESIGNING WITH PROGRAMMABLE GATE ARRAYS AND COMPLEX PROGRAMMABLE LOGIC DEVICES:** Xilinx 3000 series FPGAs, Designing with FPGAs, Xilinx 4000 series FPGAs, using a one-hot state assignment, Altera complex programmable logic devices (CPLDs), Altera FELX 10K series COLDs. SSC: Characteristics of FPGA and PLD's. Text Book 1: 6.1 - 6.6	**8**

Text Books

1. Digital Systems Design Using VHDL,Charles H. Roth. Jr, Cengage, 2010.
2. VHDL Primer, J. Bhaskar , PHI, 2009.

Reference Books

1. Digital Electronics And Design With VHDL, A. Pedroni, Volnet, Elsevier, 1st edition, 2008

COURSE OUTCOMES (COs)

CO1	Explain the concepts related to combinational and sequential circuit programming. [L2]
CO2	Apply behavioral and structural methods of programming for arithmetic networks. [L3]
CO3	Analysis of arithmetic operators using SM chart and micro programming. [L4]
CO4	Simulation of FPGA and CPLD's using Xilinx and prepare report. [ABA]

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2												2	
CO4					1					1					1
CO Avg.	2.5	2			1					1				2	1

SEMESTER – V			
Course Name : Renewable Energy Sources		Course Code:	20EE561
Number of Lecture Hours / Week	: 03	**CIE Marks:**	50
Number of Practical Hours / Week	: 00	**SEE Marks:**	50
Total Number of Lecture Hours	: 40	**SEE Duration:**	03
L:T:P	: 3:0:0	**Credits:**	03

COURSE OVERVIEW: This course gives an insight about the principle, working, utilization and availability of renewable energy sources and its applications.

COURSE LEARNING OBJECTIVES (CLO):

1. To familiarize students with available renewable energy resources to harness energy considering local energy needs.
2. To acquaint students with key concepts of energy generation using renewable energy resources for citing the requirements and propose appropriate methods to generate energy.

MODULES	TEACHING HOURS
Module-1: Introduction to Energy Sources World population and Energy consumption pattern, Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability. Energy Storage: pumped storage, compressed air storage, battery storage, sensible heat storage. SSC: Renewable Energy in India. Text Book 1: 1.2, 1.5, 1.7, 1.9, 1.12.1, 1.12.2 Text Book 2: 3.2.1(a) & (b), 3.2.2 (a), 3.2.5 (a)	**08 Hours**
Module-2: Solar Energy and Applications Measurement of Solar radiation, Solar radiation geometry, solar time, Solar day length. Solar Thermal Systems: Solar collectors, solar water heater, solar cooker, Solar Furnaces, Solar distillation. Solar Photovoltaic systems: Solar cell, module panel and array construction, solar PV systems. SSC: Solar dryer & Solar PV applications Text Book 2: 4.7, 4.9,4.10, 4.11, 5.1, 5.2, 5.6, 5.7, 5.9, 5.10,6.4, 6.8, 6.9	**08 Hours**
Module-3: Wind Energy & Geothermal Energy Wind Energy: Origin of wind, Nature of wind, site selection, wind turbine types and their construction, wind energy conversion systems. Environmental aspects, wind energy programme in India. Geothermal Energy: Origin & distribution of geothermal energy, Types of geothermal resources, environmental consideration, geothermal energy in India. SSC: Applications of wind energy & geothermal energy Text Book 2: 7.1, 7.2, 7.3, 7.7, 7.8, 7.12, 7.13, 9.2, 9.3, 9.6, 9.7	**08 Hours**
Module-4: Tidal, Wave Energy & Ocean Thermal Energy	**08 Hours**

Tidal Energy: Introduction, origin and nature of tidal energy, limitations of tidal energy, tidal energy technology, tidal power range, ocean tidal energy conversion schemes, environmental impacts. Sea Wave Energy: Introduction, Wave Energy Technology, Devices for Harnessing Wave Energy, environmental impacts. Ocean Thermal Energy: Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Closed Cycle, Open Cycle and Hybrid Cycle, Application of OTEC in Addition to Produce Electricity, Benefits of OTEC. SSC: Advantages & disadvantages of tidal, wave & ocean thermal energy. Text Book 2: 10.1, 10.2; Text book 1: 13.1, 13.2, 13.3, 13.5, 13.7, 13.8	
Module-5: Biomass Energy, Hydrogen Energy & Fuel Cells Energy Biomass Energy: Biomass production, biomass gasification, Updraft, downdraft & cross-draft gasifiers. Fluidized bed gasification, gasifier biomass feed characteristics. Hydrogen Energy: Properties of Hydrogen, Production, Storage, conversion safety issues. Fuel cells – Introduction, potential applications, phosphoric acid fuel cell, fuels for fuel cells, fuel cell power plant, environmental effects. SSC: Applications of Biomass, Hydrogen energy & fuel cell. Text Book 1: 9.1, 9.3, 9.7,9.8,9.9, 9.10, 9.12; Text Book 2:12.1,12.1.1, 12.1.3, 12.1.9, 12.1.12, 12.1.14, 12.2.1 to 12.2.3,12.2.5 to 12.2.7	**08 Hours`**

Text Books:

1. Nonconventional Energy Resources Shobh Nath Singh Pearson 1st Edition, 2015
2. Nonconventional Energy Resources B.H. Khan McGraw Hill 3rd Edition

References

1. G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 2004.

COURSE OUTCOMES (COs):

CO1	Discuss the need for generating power using Renewable energy resources with environmental considerations. [L2]
CO2	Apply the concepts of power generation and economics to identify the need and kind of power to be generated and propose appropriate methods to generate power. [L2]
CO3	Analyze the type of location in which the power plant must be installed and suggest suitable methods to harness energy from locally available resources. [L3]
CO4	Study the renewable energy resource availability across the globe and its environmental impact with effective presentation. [ABA]

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-
CO	**2.5**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**

SEMESTER – V			
Course Name : Electronic Instrumentation		**Course Code :**	20EE562
Number of Lecture Hours / Week	: 03	**CIE Marks :**	50
Number of Practical Hours / Week	: 00	**SEE Marks :**	50
Total Number of Lecture Hours	: 40	**SEE Duration :**	03
L:T:P	: 3:0:0	**Credits :**	03

COURSE OVERVIEW:

This course is designed to illustrate the use of sensors and transducers associated with electronic circuits. It emphasizes on different principles of sensing such as strain, pressure, temperature, light radiation and environmental factors-based methods.

COURSE LEARNING OBJECTIVES (CLO) :

1. Explain the use of gauges and transducers to measure pressure, direction, distance and electromagnetic radiations.
2. Explain the transducers used for temperature sensing, and for the measurement of sound.
3. Explain the sensors and transducers used for the measurement of mass, volume and environmental quantities.

MODULES	TEACHING HOURS
Module 1 **Strain and Pressure:** Mechanical strain, Interferometry, Fiber optic methods, pressure gauges, low gas pressures, Ionization gauges, Transducer use. Position, direction, distance, and motion: Position, Direction, Distance measurement, Distance traveled, Accelerometer systems,Linear Encoders. **SSC:** Rotary Encoders	**08 Hours**
Module 2 **Light and associated radiation:** Nature of light, Colour temperature, Light flux, Photosensors, Photoresistors and photoconductors, Photodiodes, Phototransistors, Photovoltaic devices, Fiber – optic applications, Light transducers, Solid-state transducers, Liquid crystal displays (LCD), Light valves, Image transducers. **SSC:** Radio waves	**08 Hours**
Module-3 **Temperature sensors and thermal transducers:** Heat and temperature, The bimetallic strip, Liquid and gas expansion, Thermocouples, Metal – resistance sensors, Thermistors, Radiant heat energy sensing, Pyroelectric detectors, Thermal transducers, Thermal to electrical transducers. **SSC:** Different classes of Thermocouple	**08 Hours**
Module 4 **Sound, infrasound and ultrasound:** Principles of detection, Audio electrical sensors- moving iron, moving coil, capacitive and ribbon type	**08 Hours**

microphone.Electrical to audio transducers - moving iron, moving coil, capacitive and ribbon type. **SSC:** Microphone Problems	
Module 5: Solids, liquids and gases: Mass and volume, Electronic sensors, Proximity detectors, Liquid levels, Liquid flow sensors, Timing, Gases, Viscosity. Environmental Sensors: Environmental quantities, Time, Moisture, Acidity/alkalinity, Wind chill, Radioactive count rate, Surveying and security, Animal fat thickness, Water purity, Air purity, Smoke and fire detectors **SSC:** Building acoustics.	**08 Hours`**

Text Books:

1. Sensors and Transducers, Ian Sinclar, 3rd Edition,2013

References

1. Electronic Measurements and instrumentation, R.K Rajput, S. Chand, 3rd Edition, 2013.

COURSE OUTCOMES (COs):At the end of this Course student will be able to:	
CO1	Explain the operating principle of various transducers and sensors (L2)
CO2	Apply the knowledge of type of sensor best suited for different electronic applications
CO3	Analyze the performance of various sensors and transducers (L4)
CO4	Prepare reports and give effective presentation on Different types of sensors and transducers used in Industrial Applications

CO-PO-PSO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2														
CO2	3													2	
CO3		2													
CO4										1					
Avg.	2.5	**2**								**1**				**2**	

SEMESTER – V			
Course Name	**: Utilization of Electric Power**	**Course Code:**	**20EE563**
No. of Lecture Hours / Week	**: 03**	**CIE Marks:**	**50**
No. of Tutorial Hours / Week	**: 00**	**SEE Marks:**	**50**
Total No. of Lecture Hours	**: 40**	**SEE Duration:**	**3 Hours**
L:T:P	**: 3:0:0**	**Credits:**	**3**

COURSE OVERVIEW: This course gives the knowledge about how electrical power can be utilized in domestic, Industrial and traction applications.

COURSE LEARNING OBJECTIVES (CLO)

1. To familiarize students about the need for utilization of electrical power in Domestic, Industrial and Traction applications.
2. To acquaint the students with key concepts of electric power utilization required for proposing appropriate methods to complete the assigned work using electrical power.

MODULES	Teaching hours
Module-1: ELECTRIC HEATING AND WELDING Definition of Heating, Advantages of Electric heating over other systems of heating, Modes of Heat transfer, Classification of electric heating methods, Resistance heating: Direct, Indirect, Resistance ovens, Properties of material used as heating element, Causes of Failure of heating Elements. Arc Furnace: Direct, Indirect and Submerged, Induction Heating: Direct Core type, Vertical Core type Induction Furnace, High Frequency eddy current heating, Dielectric heating, and Applications. Definition of Welding, Importance, Advantages and Disadvantages, Resistance welding: Butt welding, Spot Welding, Projection Welding, Electric Arc Welding: Carbon arc welding, Metal arc welding, Laser Beam welding, Requirements of a good Weld SSC: Coreless induction furnace, Electric Welding equipment. **Textbook 1:** 5.1 to 5.3, 5.4.1,5.4.6,5.5.1,5.6.1, 5.7,5.9, 6.1.1,6.1.2,6.2.1 to 6.2.3, 6.3.1,6.3.2,6.6,6.7	**8**
Module-2: ILLUMINATION Definition of Light, Nature of Light, Colour of light, Relative Sensitivity, Laws of illumination (Numerical included), Photometry: Bunsen grease spot Photometer, Sources of light, Carbon arc lamp, Incandescent lamp, Gaseous discharge Lamps: Sodium vapour lamp, Mercury vapour lamp, fluorescent lamp, CFL, LED lamp, Types of Lighting schemes, Design of Lighting schemes, Factory lighting, Lighting calculations (Numerical included), street lighting, Flood lighting, SSC: Terms used in Illumination, Neon Lamps **Textbook 1:** 7.1, 7.3, 7.5,7.8, 7.9.1,7.10,7.11.1,7.11.2,7.11.6,7.11.7,7.14,7.15 to 7.17, 7.18, 7.19	**8**
Module-3: ELECTROLYSIS Electrolysis, Faraday's Laws of electrolysis, Calculation of current required for depositing given amount of Metal, Application of Electrolysis: Extraction of Metals (Zinc & Aluminum), Refining of Metals (Copper, Zinc & Lead), Production of Chemicals (Caustic Soda, oxygen & Hydrogen), Electrodeposition, Factors affecting the quality of electrodeposition, Electroplating, Electroforming. SSC: Power supply for Electrolytic processes.	**8**

Textbook 1: 8.1 to 8.3, 8.8 to 8.14	
Module-4: ELECTRIC TRACTION Definition of Traction, Basic requirements of Traction, Systems of Traction : Steam Engine, ICE engine, Electric traction, Systems of Track Electrification: DC, Single phase and Three Phase AC, Composite, Comparison between DC and AC Track Electrification, Typical Speed – Time curves, Types of speed, Factors affecting scheduled speed, Simplified Speed – Time curves , Trapezoidal and Quadrilateral (Including derivation and Numerical), Mechanics of Train movement, Tractive effort for propulsion of Train, Power output from Driving axles, Energy output from Driving axles, Factors affecting Energy Consumption. Power supply for electric Traction, Current collection systems: Conductor rail system, Overhead system: trolley collector, Bow collector, Pantograph collector. SSC: DC and AC track Electrification **Textbook 1:** 10.1, 10.2, 10.4, 11.1 to 11.9, 11.10.1, 15.1 to 15.3	**8**
Module-5: ELECTRIC TRACTION MOTORS General Features of Traction Motors, Speed Control of DC traction motors: Rheostatic control, Series Parallel Control, Field Control, Derivation to show that the Series parallel starting is more efficient compared to plain rheostatic control, Series – Parallel Transition methods: Open circuit Transition, Bridge transition, Speed Control and Starting of AC motors: Single phase AC Series motor and Three phase Induction motor, Braking, Requirements of Braking System, Types of braking, Electric Braking : Plugging, Rheostatic / Dynamic braking, Regenerative braking, Mechanical Braking : Compressed Air brakes, Vacuum brakes, Auxiliary equipment installed on the electric locomotives. SSC: Multiple unit Control **Textbook 1:** 12.1, 13.2 to 13.5, 13.11, 13.12, 14.1, 14.3, 14.11	**8**
Textbooks 1. Utilization of Electric Power and Electric Traction, J.B Gupta, Kataria & Sons Publication, 10th Edition, 2014	
Reference books 1. Utilization of Electric Power and Electric Traction, G.C. Garg, Khanna Publishers, 9th Edition, 2014.	

COURSE OUTCOMES (COs)

At the end of course students will be able to

CO1	Discuss the need for utilization of electrical power in domestic, Industrial and Traction applications. [L2]
CO2	Apply the concepts of Electrical power utilization to identify the requirements and suggest appropriate methods to complete the work using electrical power. [L3]
CO3	Analyze the requirements of vehicles used in transportation and suggest an appropriate scheme of traction. [L4]
CO4	Study the environmental impact of conventional methods of heating, welding and traction over Electrical Heating, Welding and Traction with effective presentation [ABA]

CO – PO – PSO Matrix

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

CO Avg.	**2.5**	**2**				**1**				**1**			**2**		

SEMESTER – V			
Course Name	: Basics of Battery Management System	**Course Code :**	20EE564
Number of Lecture Hours / Week	: 03	**CIE Marks :**	50
Number of Practical Hours / Week	: 00	**SEE Marks :**	50
Total Number of Lecture Hours	: 40	**SEE Duration :**	03
L:T:P	: 3:0:0	**Credits :**	03

COURSE OVERVIEW:

This course is designed to illustrate the construction and functioning of a lithium-ion battery and introduce the concept of battery management systems as applied to electric vehicles. Measurement, control and communication technologies associated with BMS are also explained. The course emphasizes on modelling of batteries, estimation of battery states, charge balancing and fault detection. Finally, hardware and software integration and safety aspects of BMS are described.

COURSE LEARNING OBJECTIVES (CLO):

1. To illustrate the working of electric and hybrid electric vehicles, lithium-ion batteries, sensing, control and communication in battery management systems
2. To model lithium batteries and estimate state of charge and state of health
3. To describe the ideas of cell balancing and fault detection in lithium batteries
4. To depict the hardware, software and safety aspects of battery management systems

MODULES	**TEACHING HOURS**
Module – 1: Introduction to Electric Vehicles and Battery Technologies General configuration and architectures of electric and hybrid electric vehicles. Battery parameters. Construction, operation, chemistry, safety, performance and integration of Lithium-ion batteries. Balance of plant. System description and architectures of battery management system. **SSC:** Load interface **Text Book 2:** 4.1, 5.2; **Text Book 1:** 2.1 to 2.7, 3.2, 4.1 to 4.3, 5.1 to 5.3	**08**
Module – 2: Measurement, Control and Communication in BMS Measurement: Measurement of cell voltage, current and temperature. Synchronization of current and voltage. Interlock status Control: Contractor control. Soft-start circuits. Contractor topologies Communication: I^2C/ SPI, RS-232 and RS-484, LIN, CAN bus, Modbus and Flexray **SSC:** Ethernet and TCP/IP **Text Book 1:** 6.1 to 6.4, 6.6, 7.1 to 7.2, 7.7, 10.2	**08**
Module – 3: Estimation of SoC and SoH Thevenin equivalent circuit of a battery. Definitions of SoC and SoH, Challenges in estimation of SoC. OCV measurement. Coulomb counting for SoC estimation. Predictive SoH models **SSC:** Self discharge detection **Text Book 1:** 11.2, 11.7 to 11.8, 15.3 to 15.8, 16.3	**08**
Module – 4: Charge Balancing and Fault Detection	**08**

Balancing strategies. Charge transfer balancing. Dissipative balancing and balancing faults. Over-charge, over-current and over-temperature conditions. Excessive self-discharging. Detection of internal short and venting **SSC:** Detection of lithium plating **Text Book 1:** 14.1, 14.3 to 14.5, 17.2	
Module – 5: Hardware, Software and Safety Aspects of BMS Packaging and product development. IC and component selection for BMS. Power supply architectures and EMC. Safety critical software and their analysis. Functional safety - ISO 26262 and IEC 61508 protocols. Reference design for safety **SSC:** Circuit design and layout **Text Book 1:** 18.1 to 18.3, 18.6 to 18.7, 19.1, 19.3, 20.1, 20.5	**08**

Text Books:

1. A Systems Approach to Lithium Battery Management, Phillip Weicker, Artech House, 2014
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition, Mehrdad Ehsani, Yimin Gao, Sebastien E Gay, Ali Emadi, CRC Press, 2009

References:

1. Battery Management System: Design by Modelling, H. J. Bergveld, W. S. Kruijt, P. H. L. Notten, Kluwer Academic Publishers, 2005
2. Battery Management Systems: Equivalent Circuit Methods, Gregory L. Plett, Artech House, 2016

COURSE OUTCOMES (COs): At the end of this course, students will be able to

CO1	Describe the working of electric and hybrid electric vehicles, lithium batteries and its management, measurement, control and communication in BMS and charge balancing and fault detection in lithium batteries (L2)
CO2	Apply the knowledge of electric circuits and mathematics to model lithium batteries and to estimate the state of charge and state of health of lithium batteries (L3)
CO3	Analyze safety critical software and reference design for safety in BMS (L4)
CO4	Effectively present and prepare technical reports on hardware implementation and functional safety aspects of BMS

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					1							2	1	
CO2	3	2												2	
CO3	2	1											2	1	
CO4										1					
Avg.	**2.6**	**1.5**				**1**				**1**			**2**	**1.3**	

SEMESTER – V

Course Name : DC Machines & Synchronous Machines Laboratory	Course Code: 20EE57
Number of Lecture Hours / Week : 01	CIE Marks: 50
Number of Practical Hours / Week : 02	SEE Marks: 50
Total Number of Practical Hours : 20	SEE Duration: 03 Hours
L:T:P : 1:0:2	CREDITS: 02

COURSE OVERVIEW:

The subject gives practical knowledge about various electrical machines like DC Machines & Synchronous Machines.

COURSE LEARNING OBJECTIVES (CLO)

The objectives of this course is,

1. To discuss the performance of DC generators, motors by conducting suitable experiments.
2. To conduct experiments on a synchronous machine to determine voltage regulation.

Experiments	
Exercise	
1	Swinburne's Test.
2	Hopkinson's Test.
3	Field's test on series motors.
4	Retardation test- electrical braking method.
5	Ward Leonard method of speed control of D.C. motor.
	Structured Enquiry
6	Voltage regulation of an alternator by EMF and MMF method.
7	**V**oltage regulation of an alternator by ZPF method.
8	Performance of synchronous generator connected to infinite bus, under constant power and variable excitation.
Demonstration	
9	Load characteristics of a D.C. shunt generator
10	Load test on a DC motor- determination of speed-torque and HP-efficiency characteristics.
	Open Ended Experiment
1	V and Inverted V curves of a synchronous motor.

COURSE OUTCOMES (COs)

At the end of course students will be able to

CO1	Discuss the role of DC and synchronous machines in power generation.
CO2	Conduct suitable test to determine the parameters for a given AC and DC machine.[PO1]
CO3	Analyze the performance by conducting suitable experiment for a given machine [PO2]

CO – PO PSO Mapping

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1														
CO2	3												2		
CO3		2											2		
CO	**2**	**2**											**2**		

SEMESTER – V			
Course Name	**: Power Electronics Laboratory**	**Course Code :**	**20EE58**
No. of Lecture Hours / Week	**: 01**	**CIE Marks :**	**50**
No. of Practical Hours / Week	**: 02**	**SEE Marks :**	**50**
Total No. of Lecture/Practical Hours	**: 30**	**SEE Duration :**	**3 Hours**
L:T:P	**: 1:0:2**	**Credits :**	**2**

COURSE OVERVIEW: The course gives an overview of experiments related to operation, characteristics of various power switching devices and power conversion systems.

COURSE LEARNING OBJECTIVES (CLO)

The objective of this course is to

1. Conduct experiments on power semiconductor devices and power converters to demonstrate the principle of operation.
2. Discuss the characteristics of power converters with different types of loads.

Experiments	
Exercise	
1	Experimental determination of Static V-I Characteristics of SCR
2	Experimental determination of Static V-I Characteristics of MOSFET
3	Experimental determination of Static V-I Characteristics of IGBT
4	Experiment on Digital Triggering of SCR
5	Experiment of Speed control of Universal motor using single phase AC voltage controller.
6	Speed control of DC motor using single semi converter.
7	Speed control of DC motor using MOSFET/IGBT chopper.
8	Single Phase fully controlled Bridge rectifier with R load, R-L load with and without freewheeling diode
	Structured Enquiry
9	Simulation and realization of Controlled rectifier circuits with R load.
10	Simulation and realization of Step up DC-DC converter with R-Load.

	Demonstration
1	Speed control of stepper motor
2	AC voltage controller using TRIAC and DIAC combination connected R and RL loads.
	Open Ended Experiment
1	Simulation of Power Electronic Circuits using Modern Software tools
COURSE OUTCOMES (COs) At the end of course students will be able to	
CO1	Explain the role of power electronics in power and energy applications
CO2	Apply suitable methods to obtain the characteristics of semiconductor devices.
CO3	Analyze the characteristics and performance of power conversion systems by conducting experiments
CO4	Conduct experiments on power converters/power semiconductor devices and interpret to provide valid conclusions

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2													
CO4				2	2										2
Avg	**2.5**	**2**		**2**	**2**										**2**

SEMESTER – V			
Course Name	**: Skills Development 3**	**Course Code :**	**20HS51**
Number of Lecture Hours / Week	**: 00**	**CIE Marks :**	**50**
Number of Tutorial / Practical Hours / Week	**: 02**	**SEE Marks :**	**50**
Total Number of Lecture + Tutorial/Practical Hours	**: 2**	**SEE Duration :**	**02 Hours**
L:T:P	**: 0:2:0**	**CREDITS :**	**01**
COURSE PREREQUISITES: Skill Development 1 and 2			

MODULES	TEACHING HOURS
MODULE 1: **General Aptitude 3.1:** **Quantitative Aptitude:** Permutation and Combination **Logical Reasoning:** Syllogisms Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	**6**
MODULE 2: **Soft Skills** **Time Management –** Principles of Time Management, Need for Time Management, Urgent vs Important Matrix **Business Etiquette –** Business Introductions, The art of Small Talk, Dressing Etiquette, Corporate Grooming, Telephone, Cubicle and Dining Etiquette **Verbal Ability –** Change of Speech and Voice Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	**6**
MODULE 3: **General Aptitude 3.2:** **Quantitative Aptitude:** Problems on Ages, Simple and Compound Interest **Verbal Ability –** Ordering of Sentences Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	**6**

MODULE 4: **Soft Skills** **Stress Management –** Understanding Stress, Identifying Sressors, Effects of Stress, Coping with Stress, Stress Management Techniques. **Email Etiquette –** Email Etiquettes – Do's and Don'ts, Scenario based emails **Verbal Ability –** Closet Test Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	**6**
MODULE 5: **General Aptitude – 3.3** **Logical Reasoning:** Direction Sense Test, Clocks, Calendars Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	**6**

Textbooks:

1. Notes and Textbooks are part of learning methodology

Reference Books:

1. Bizotic Course Material, Text Bank and Hand outs
2. Quantitative Aptitude for Competitive Examinations by R.S Aggarwal
3. A Modern Approach to Verbal & Non-Verbal Reasoning by R.S. Aggarwal
4. AMCAT Preparation Guide

COURSE OUTCOMES (COs):

CO1	Understand the importance of continuous learning and implement it successfully Understand the basic concepts of the topics covered. Understand what conflict is and how it escalates within the workplace
CO2	Apply concepts of goal setting , interpersonal behaviors in life Appreciate team skills and dynamics. Identify Critical Thinking
CO3	Self-Analyze and develop self-confidence and a positive attitude Analyze common conflict resolution styles and use them effectively in teamwork
CO4	Compete in various competitive exams with positive mind set Practice Positive thinking and Attitude in walks of life

SEMESTER – VI			
Course Name	: Control Systems	Course Code :	20EE61
Number of Lecture Hours / Week	: 04	CIE Marks :	50
Number of Practical Hours / Week	: 00	SEE Marks :	50
Total Number of Lecture Hours	: 50	SEE Duration :	03 hrs
L:T:P	: 4:0:0	Credits : 04	

COURSE OVERVIEW:

The course gives an overview about the behavior of Linear Time Invariant control systems. And illustrates the time and frequency domain analysis as per the required design criteria.

COURSE LEARNING OBJECTIVES (CLO) :

The objectives of the course is

1. To acquaint the students with mathematical models of various electrical and mechanical systems.
2. To discuss the methods of determining transient and steady state response parameters of a system.
3. To examine the stability of a system using various methods.

MODULES	TEACHING HOURS
Module 1 **Introduction to Control Systems:** Control system, open and closed loop control systems with examples. **Mathematical modelling of linear time invariant systems:** Obtaining Transfer function of electrical networks, Mathematical modelling of mechanical systems and Analogous systems. **SSC:** Classification of different types of control systems **Text Book 1:** 1.1 to 1.5, 2.1 to 2.2, 5.1 to 5.18	**08 Hours**
Module 2 **Time response analysis for 1st and 2nd order system:** Standard test signals, step response of first and second order linear-time-invariant systems, time domain specifications, transient response of second order linear-time-invariant systems, steady state error analysis. **SSC:** Ramp and Impulse response of second order system **Text Book 1:** 6.1 to 6.3, 6.8 to 6.18	**08 Hours**
Module-3 **Stability Analysis and Root locus:** Routh Hurwitz criteria and relative stability analysis. Introduction to root locus, steps to plot root locus, construction of root locus, effect of addition of poles and zeros on stability. **SSC:** Applications of addition of poles and zeros to LTI systems. **Text Book 1:** 7.1 to 7.8, 9.1 to 9.18	**08 Hours**
Module 4 **Frequency response analysis:** Frequency domain specifications, Correlation between time and frequency response, Polar plots, Bode plots, Steps to construct bode plot, computation of gain margin and phase margin, derivation of transfer function from bode plot	**08 Hours**

SSC: Real time Application of compensators **Text Book 1:** 10.1 to 10.8, 8.1 to 8.12, 8.17	
Module 5 **Design of controllers:** Introduction to P, PI and PID controllers. Design of controllers to improve transient and steady state response. **Design of compensators:** Design of lag compensators, lead compensators and lag-lead compensators. **SSC:** Advantages and disadvantages of P, PI and PID Controllers **Text Book 2:** 10.1 to 10.6	**08 Hours`**

References:

1. Modern control Engineering-Ogata, Prentice Hall
2. Engineering control systems - Norman S. Nise, John WILEY & sons , fifth Edition

COURSE OUTCOMES (COs):	
CO1	**Discuss** the types of control systems and methods of determining stability (L2)
CO2	**Apply** the knowledge of mathematics, science and control systems to model the given system and determine the desired parameters. (L3)
CO3	**Analyse** the stability of LTI systems in time and frequency domain using different techniques (L4)
CO4	Carry out stability analysis of given transfer function using time domain and frequency domain approach using MATLAB simulation tool.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2											2		
CO4					1										
Avg.	2.5	2			1								2		

SEMESTER – VI			
Course Name	**: High Voltage Engineering**	**Course Code:**	**20EE62**
No. of Lecture Hours / Week	**: 03**	**CIE Marks:**	**50**
No. of Tutorial / Week	**: 00**	**SEE Marks:**	**50**
Total No. of Lecture + Tutorial Hours	**: 40**	**SEE Duration:**	**03 Hrs.**
L:T:P	**: 03:00:00**	**Credits:**	**3**

COURSE OVERVIEW: The subject deals with introduction to conduction and breakdown phenomenon in gases, liquid dielectrics and breakdown phenomenon in solid dielectrics, generation of high voltages and currents, measurement techniques for high voltages and currents.

COURSE LEARNING OBJECTIVES (CLO):

1.To familiarize students about the need for generation of High voltage and Impulse voltages in Electrical Engineering.

2.To acquaint the students with key concepts of High Voltage Engineering necessary for citing the causes of breakdown in an insulator and suggesting appropriate methods for generation and Measurement of High Voltage and Currents.

MODULES	TEACHING HOURS
MODULE 1: INTRODUCTION TO HIGH VOLTAGE ENGINEERING AND GENERATION OF HIGH VOLTAGES AND CURRENTS Introduction to High Voltage Engineering, Generation of High Voltages and Currents: Generation of High DC voltage: Voltage Doubler Circuits, Voltage Multiplier Circuits, Deltatron Unit, Van de Graaff Generator, Electrostatic Generator. Generation of High AC voltage: Cascade Transformers, Impulse voltage, Standard Impulse Waveshape, Generation of Impulse voltage using Marx Circuit, Impulse Currents: Generation of High Impulse Currents using cascaded LC network, , Tripping of an impulse generator with: Three electrode gap, Trigatron gap. ***SSC:*** Need for tripping in impulse generators **Textbook 1: 6.1 - 6.5**	**8**
Module 2: CONDUCTION AND BREAKDOWN IN GASEOUS DIELECTRICS Gas as an Insulating Media, Ionization processes: Ionization by Collision, Photo Ionization, Secondary Ionization processes. Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown, Breakdown in Electronegative Gases, Streamer Theory of Breakdown in Gases, , Corona Discharges, Post-Breakdown Phenomena and Applications, Properties of a gaseous dielectric for high voltage applications ***SSC:*** Paschen's Law and its significance **Textbook 1: 2.1 -2.10**	**8**
MODULE 3 : CONDUCTION AND BREAKDOWN IN VACUUM AND LIQUID DIELECTRICS Introduction to Vacuum and its types, Vacuum Breakdown due to: Particle exchange, Field Emission, clump formation. Liquid as Insulator, Breakdown in pure and impure liquid dielectrics: Suspended particle theory, electronic breakdown, cavity breakdown (bubble's theory) and electroconvection breakdown. ***SSC:*** Electrical Properties of liquid dielectric **Textbook 1:** 3.1 -3.4	**8**
Module 4 : CONDUCTION AND BREAKDOWN IN SOLID AND COMPOSITE DIELECTRICS Solid Dielectrics used in practice, Intrinsic breakdown: Electronic Breakdown, Streamer Breakdown, Electromechanical Breakdown, Thermal breakdown, Breakdown due to: Chemical	**8**

and Electrochemical Deterioration, Composite Dielectrics: Properties of Composite Dielectric materials, Breakdown mechanism in Composite Dielectrics. ***SSC:*** Treeing and Tracking **Textbook 1:4.1 - 4.7**	
Module 5: Over voltage phenomenon and applications of insulating material Natural Causes for Over voltage—Lightning Phenomenon, , System Faults and other Abnormal Conditions, Principles of Insulation Coordination on High-Voltage and Extra High-Voltage Power Systems, Applications in Power Transformers Applications in Rotating Machines, Applications in Circuit Breakers Applications in Cables Applications in Power Capacitors, Applications in High-Voltage Bushings, Applications in Fractional Horsepower Motors ***SSC:*** Overvoltage due to Switching Surges **Textbook 1: 5.1-5.8, 8.1-8.3**	**8**
Textbook: 1. High Voltage Engineering, M.S.Naidu and Kamaraju- 4th Edition, THM, 2008.	
Reference Books: 1. High Voltage Engineering Fundamentals, E.Kuffel and W.S. Zaengl, 2nd Edition, Elsevier Press, 2005. 2. High Voltage Engineering ,C.L.Wadhwa, New Age International Private limited, 1995	

CO1	Discuss the need of High voltage, Impulse voltage generation with respect to insulation and different dielectrics material.
CO2	Apply the concept of over voltage, insulating material properties and cite the factors that can affect the rate of breakdown in the insulators.
CO3	Analyze the different process, theories, phenomenon, nature of high voltage / current , method for generation and Measurement of the same.
CO4	Conduct survey on applications of High voltage and need of insulating materials in power systems.

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2													
CO4										2					
	2.5	**2**								**2**					

SEMESTER – VI			
Course Name	**: DIGITAL SIGNAL PROCESSING**	**Course Code :**	**20EE63**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial / Practical Hours / Week	**: 0**	**SEE Marks :**	**50**
Total No. of Lecture + Tutorial / Practical Hours	**:40**	**SEE Duration :**	**03 Hrs**
L:T:P	**:03:00:00**	**CREDITS :**	**03**

COURSE OVERVIEW : Digital Signal Processing briefs about the analysis and representation of discrete-time signal systems. The course emphasis on digital network, finite impulse response filters design and computation of the discrete fourier transform.

COURSE LEARNING OBJECTIVES (CLO) :
The objectives of the course is

1) To discuss the N-point DFT & Solve the problems based on Properties.
2) To compute DFT and IDFT using FFT algorithms.
3) To acquaint the student with FIR and IIR filters to meet specific magnitude and phase requirements using various methods
4) To realize digital filters in a various form.

MODULES	TEACHING HOURS
MODULE 1: **Discrete Fourier Transforms:** Definitions, properties-Circular time shift, Circular frequency shift, symmetry. circular convolution – use of tabular arrays, Matrix method, Stock ham's method, Filtering of Long Sequence: overlap add and save methods**.** SSC: Properties- Periodicity & Linearity Text Book 1: 7.1-7.3	**08**
MODULE 2: **Fast Fourier Transforms Algorithms:** Introduction, decimation in time algorithm, first decomposition, number of computations, continuation of decomposition, number of multiplications, computational efficiency, decimation in frequency algorithms, Inverse radix – 2 algorithms. SSC: Comparison of number of computations b/w direct form and FFT Text Book 2: 7.1 -7.6	**08**
MODULE 3: **Design of IIR Analog Filters:** Introduction, all pole Analog filters- Butterworth & Chebyshev filters, design of Analog low pass and high pass - Butterworth filter & Chebyshev filter 1 with Frequency transformations. SSC: Types of filters. Text Book 2: 8.1-8.3 & 8.6-8.8	**08**

MODULE 4: **Design of IIR Digital Filters** Design of digital low pass and high pass Butterworth and Chebyshev –type 1 filter by impulse invariant transformation and bilinear transformation, Frequency transformations. **Realization of IIR digital systems:** Direct form II, Cascade form and parallel form. SSC: Direct form I Text Book 2: 4.3.2, 4.3.4 & 4.3.5, 8.4-8.5	**08**
MODULE 5: **Design of FIR Digital Filters:** Introduction, windowing, rectangular, Hamming, Hanning, Blackman window, design of FIR digital filters by use of windows. **Realization of FIR systems:** cascade form, linear phase form. SSC: Lattice Structure Text Book 2: 9.1-9.6, 4.4.3 & 4.4.5	**08**

Text Books:

1. **Digital Signal Processing – Principles, Algorithms, and Applications Jhon G. Proakis Dimitris G. Manolakis** Pearson 4th Edition, 2007.
2. **Digital Signal Processing- A Anand Kumar** PHI publication 2nd Edition January 2015.

Reference Books:

1. Digital Signal Processing, A.NagoorKani, McGraw Hill, 2nd Edition, 2012.
2. Introduction to Digital Signal Processing, Jhonny R. Jhonson, Pearson, 1st Edition, 2016.

COURSE OUTCOMES (COs):

CO1. **Explain** concepts related to discrete time signals and systems. [L2]
CO2. **Apply** the knowledge of transformation techniques to obtain the time and frequency domain representation of linear discrete time signals and systems.[L3]
CO3. **Analyze** discrete LTI systems to meet given specifications. [L4]
CO4. **Ability** to engage in independent study on Modern tool usage (MATLAB).

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2													
CO4										2					
	2.5	**2**								**2**					

SEMESTER –VI			
Course Name	: Switchgear and Protection	Course Code:	20EE64
No. of Lecture Hours / Week	: 03	CIE Marks:	50
No. of Tutorial / Week	: 00	SEE Marks:	50
Total No. of Lecture + Tutorial Hours	: 40	SEE Duration:	03 Hrs.
L:T:P	: 03:00:00	Credits:	3

COURSE OVERVIEW: The subject deals with switchgear arrangement to monitor, control and protect the power system under faulty conditions.

COURSE LEARNING OBJECTIVES (CLO):

1. To familiarize students about the need for protection in an electrical power system and the different protective devices available.
2. To acquaint the students with key concepts of power system protection necessary for citing the causes of fault and providing suggestions to prevent the occurrence of fault.

MODULES	TEACHING HOURS
MODULE 1: INTRODUCTION TO POWER SYSTEM PROTECTION AND PROTECTIVE DEVICES General characteristics of Electrical Equipment, Faults in power system, Main Kinds of Fault, Short circuit current, Harmful effects of Short Circuit Faults in Power System, Necessity for Protection system, Basic Requirements of Protection systems, Zones of Protection, Types of Protection, Instrument Transformers (CT & PT), Relay and Circuit breaker and Fuse, Fault Clearing process. ***SSC:*** *Sources of Fault power, Errors in Instrument transformers (CT & PT).* **Textbook 1:** 1.1 to 1.11	**8**
Module 2: PROTECTIVE RELAYS Introduction to relaying, Basic terminologies of a relay, Basic operating principle of a Relay, Basic elements of a relay, Thermal relays, Buchholz relay, Types of Over current Relays based on operation time and their characteristics. Electromagnetic Induction type over current Relays: Non-Directional and Directional type, Distance Protection: Distance relays, Types, Applications and Choice, Electromagnetic type Impedance relay, Reactance type relay. Differential Protection: Differential relays, Biased or Percentage differential Relay, Balanced Voltage differential relay, Determination of Relay operating time. ***SSC:*** *Mho type relay, Difficulties associated with Differential protection.* **Textbook 1:** 9.1 to 9.4 , 9.8 to 9.11, 9.14 to 9.15.1, 9.16, 9.19.1 to 9.19.3, 9.10.2	**8**
MODULE 3 : CIRCUIT BREAKERS Introduction to switchgear and its purpose, Circuit breaker: Basic Construction and Working, Arc Phenomena: Initiation and Maintenance, Arc voltage, Arc Extinction: High resistance Method, Current Zero interruption, Cassie Theory, Slepian's Theory. Concept of Restriking Voltage and Recovery Voltage. Circuit Breaker ratings (including numerical), Tests on a circuit breaker. Oil circuit breakers (Low oil and Bulk oil), Plain break OCB, Air break Circuit breaker: Arc chute Air break CB, Air blast CB: Cross blast Air CB, SF_6 Circuit breaker, Vacuum Circuit breaker. ***SSC:*** *Test plant, Direct testing of CB, Simplified Synthetic testing test of CB.* **Textbook 1:** 7.1 to 7.5, 7.9 to 7.10, 8.3 to 8.3.1, 8.4.3,8.5.2, 8.6, 8.7.9 to 8.7.12	**8**
Module 4 : PROTECTION FOR BUSBARS, FEEDERS AND LIGHTNING. Bus zone faults, Backup protection, Frame leakage protection, Requirements of line protection, Overload protection, over current and earth fault protection, Time graded protection for: Radial feeders, Parallel feeders, Ring main system, Current graded protection, Translay protection for feeders. Internal and External overvoltage, Internal Causes of overvoltage, Lightning phenomena, Wave Shape of Voltage due to Lightning, Protection of Stations, and Sub – Stations from Direct Strokes, Protection of Transmission Lines against Direct Lightning Strokes using overhead grounding wire, Protection of electrical equipment against Travelling Waves. Lightning Arrester: Rod Gap arrester, Sphere Gap arrester, Horn Gap Arrester	**8**

SSC: *Phase comparison Carrier protection, Over Voltage due to Lightning* **Textbook 1:** 13.3 to 13.5, 14.1 to 14.4.3, 14.9, 15.1 to 15.4, 15.9 to 15.10.1, 15.11 to 15.14	
Module 5: PROTECTION FOR GENERATORS, MOTORS, AND TRANSFORMERS Generator Faults: Stator Faults, Rotor Faults, Abnormal operating conditions, all schemes of Merz price protection and percentage differential relay protection for generators, Self-balance protection scheme, Balanced Earth Fault protection, Types of Stator Inter turn protection, Stator over heating protection, Rotor earth Fault Protection, Field failure protection, Rotor overheating protection, Negative phase sequence protection. Faults in transformer, Choice of Protective gear for distribution and Power Transformers, Buchholz protection, core balance leakage protection, combined leakage and overload protection, Differential protection for power transformers and problems associated, Biased differential protection for power transformers, Harmonic restraint relay. ***SSC:*** *Protection for Direct Connected Generator, Generator-Transformer unit Protection*. **Textbook 1:** 11.1 to 11.3.7, 11.8 to 11.8.3, 11.9, 12.1 to 12.6, 12.7	**8**
Textbook: **1.** Switchgear and Protection, J B Gupta, KATSON publications Hill 3rd Edition, 2013.	
Reference Books: 1. Protection and Switchgear Bhavesh et al Oxford 1st Edition, 2011. 2. Power System Switchgear and Protection N. Veerappan, S.R. Krishnamurthy S. Chand 1st Edition, 2009	

COURSE OUTCOMES:

At the end of course students will be able to

CO1	Discuss the need for various types of switchgear devices used in power system protection. [L2]
CO2	Apply the concepts of switchgear & protection to identify the faults in the circuit and suggest appropriate protective devices with proper ratings. [L3]
CO3	Analyze the nature of fault in the electrical machine and suggest an appropriate scheme of protection. [L4]
CO4	Study the BIS for protective devices and their environmental impacts on disposal with effective presentation. [ABA]

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3												2		
CO3		2											2		
CO4						1	1								
CO Avg.	**2.5**	**2**				**1**	**1**						**2**		

SEMESTER – VI			
Course Name	VLSI Circuits and Design	**Course Code**	20EE651
Number of Lecture Hours / Week	03	**CIE Marks**	50
Number of Practical Hours / Week	00	**SEE Marks**	50
Total Number of Lecture Hours	40	**SEE Duration**	03 Hours
L:T:P	3:0:0	**Credits**	03

COURSE OVERVIEW :

The course provides an overview of integrated circuit (IC) by combining millions of MOS(Metal Oxide Silicon transistor)transistors over a single chip including complex semiconductor fabrication and design of memory technology.

COURSE LEARNING OBJECTIVES (CLO) :

The objective of the course is

1. To impart knowledge of MOS transistor theory and CMOS technologies
2. To discuss architectural choices and performance involved in designing the circuits in CMOS technology
3. To provide an overview of SoC issues and PLD architectures with advanced features.

MODULES	TEACHING HOURS
Module 1 **INTRODUCTION TO MOS TECHNOLOGY:** Introduction to integrated circuit technology. Introduction, VLSI technologies, MOS transistors, fabrication, thermal aspects, production of E-beam masks. SSC: Properties of MOS Text Book 1: 1.1 – 1.10	**8**
Module 2 **ELECTRICAL PROPERTIES OF MOS AND BICMOS CIRCUIT:** Drain to source current Ids versus Vds relationships-BICMOS latch up susceptibility. MOS transistor characteristics, NMOS and COMS inverters, circuit model, latch up in CMOS circuits. SSC: MOS transistor threshold voltage ratings Text Book 1: 2.1 – 2.6, 2.10 – 2.14	**8**
Module 3 **MOS AND BICMOS CIRCUIT DESIGN PROCESSES:** MOS layers, stick diagrams, design, symbolic diagrams. **BASIC CIRCUIT CONCEPTS:** Sheet resistance, capacitance layer inverter delays, wiring capacitance, choice of layers SSC: MOS design layouts and rules Text Book 1: 3.1 – 3.8, 4.1 – 4.7, 4.11	**8**
Module 4 **SCALING OF MOS CIRCUITS:** Scaling model and scaling factors- Limitations due to current density. **SUBSYSTEM DESIGN AND LAYOUT:** Architectural issues, systems considerations, clocked sequential circuits. SSC: Subsystem device parameters	**8**

Text Book 1: 5.1 – 5.6, 6.1 – 6.5	
Module 5 SUBSYSTEM DESIGN PROCESSES: General considerations, illustration of design process, observations. Self-Study: arrangement of arithmetic processor Text Book 1: 7.1 -7.3.	**8**

Text Books

1. Basic VLSI Design, Douglas Pucknell &Eshragian, PHI, 3 rd Edition, 2009.

Reference Books

Fundamentals of Modern VLSI Devices,Yuan Taun Tak H Ning Cambridge Press, South Asia Edition 2003,

COURSE OUTCOMES (COs)	
CO1	Explain the fundamentals of MOS transistor, fabrication process, circuit design concepts and issues related to subsystem design. [L2]
CO2	Apply the concepts of MOS transistors to model digital circuits. [L3]
CO3	Analyze the design issues related to different MOS technologies. [L4]
CO4	Simulation of transistor modeling using open source tools and preparing reports. [ABA]

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2												2	
CO4					1					1					1
CO Avg.	2.5	2			1					1				2	1

SEMESTER – VI			
Course Name : Advanced Power Electronics		Course Code :	20EE652
Number of Lecture Hours / Week	: 03	CIE Marks :	50
Number of Practical Hours / Week	: 00	SEE Marks :	50
Total Number of Lecture Hours	: 40	SEE Duration :	03
L:T:P	: 3:0:0	Credits : 03	

COURSE OVERVIEW:

The course deals with the various topologies of power converters and analysis of its operations. The application of power electronics in residential, industrial and electrical utility are also discussed.

COURSE LEARNING OBJECTIVES (CLO) :

The objectives of the course is

1. To familiarize students with the need of advanced power electronics devices and its applications.
2. To acquaint students with key concepts of switched mode power converters, power supplies and its operation.

MODULES	TEACHING HOURS
Module-1 **DC-DC SWITCHED MODE CONVERTERS:** Topologies, Buck, boost, buck-boost, and Cuk converters, Full Bridge DC-DC converter-detailed theory, working principles, modes of operation, with detailed circuits and waveforms. SSC: Applications, merits & demerits Text Book 1: 6.1 to 6.7; Text book 2: 7.7	**08**
Module-2 **DC-AC SWITCHED MODE INVERTERS:** Single-phase inverters, three phase inverters. SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis. **Multilevel Inverters:** Introduction, Multilevel Concept, Types of Multilevel Inverters, Diode – Clamped Multilevel Inverter, Flying - Capacitors Multilevel Inverter. Features of Multilevel Inverters. SSC: Applications & comparison of multilevel inverters Text book 2: 8.1 to 8.5; Text book 3: Chapter-9	**08**
Module-3 **RESONANT PULSE INVERTERS**: Introduction. Series Resonant Inverters, Frequency Response of Series Inverters, Parallel Resonant Inverters, Voltage Controlled Resonant Inverters, Class E Resonant Inverter, Zero – Current Switching (ZCS) Resonant Converters, Zero Voltage Switching Resonant Converters (ZVS). SSC: Comparison between ZCS and ZVS Resonant Converters. Text book 3: Chapter 8	**08**
Module-4 **POWER SUPPLIES**: Introduction, DC power supplies: fly back converter, forward converter, push-pull converter, full bridge converter. AC power supplies: switched mode ac power supplies, resonant ac power supplies, and bidirectional	**08**

ac power supplies. Magnetic design considerations: Transformer design & DC inductor. SSC: Switched-Mode DC power supplies, Half bridge converter Text Book 3: 14.1 to 14.3.3	
Module-5 **Residential and Industrial Applications**: Introduction, Residential Applications, Industrial Applications. **Electrical Utility Applications**: Introduction, High Voltage DC Transmission, Static VAR Compensators, Interconnection of Renewable Energy Sources and Energy Storage systems to the Utility Grid. SSC: Active filters Text Book 2: Chapter 16 & 17	**08**

Text Books:

1. Power Electronics, Daniel.W.Hart, TMH, First Edition,2010.
2. Power Electronics - converters, application & design, Mohan N, Undeland T.M., Robins, W.P,John Wiley ,3rd Edition 2008
3. Power Electronics-Circuits, Devices, Applications, Rashid M.H., PHI, 3rd Edition, 2008.

References

1. Power Electronics Essentials and Applications,L.Umanand, Wiely India Pvt Ltd,Reprint,2010
2. Modern Power Electronics and A.C. Drives, Bose B.K, PHI, 2009.
3. Digital Power Electronics And Applications, Muhammad Rashid, Elsevier , first edition, 2005.

COURSE OUTCOMES (COs):At the end of this Course student will be able to:

CO1	Explain the types and topologies of power converters. [L2]
CO2	Apply relevant equations to determine the parameters for a given power converter**.** [L3]
CO3	Analyze the performance of power conversion systems using relevant mathematical expressions [L4].
CO4	Simulate power converters for given specifications using MATLAB/Simulink and effectively interpret the results to provide valid conclusions. [ABA]

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	**3**														
CO3		**2**											2		
CO4			1		1										1
Avg.	2.5	**2**	**1**		**1**								**2**		**1**

SEMESTER – VI			
Course Name	: **ESTIMATING AND COSTING**	Course Code:	20EE653
Number of Lecture Hours / Week	: 03	CIE Marks:	50
Number of Tutorial / Practical Hours / Week	: 00	SEE Marks:	50
Total Number of Lecture + Tutorial/Practical Hours	: 40	SEE Duration:	03 Hours
L:T:P	: 3:0:2	CREDITS:	03

COURSE OVERVIEW:

Course give an overview about various topologies of wires, cables, domestic wiring calculation and estimation of materials, Motor wiring materials calculation, service connections and types of materials used in overhead distribution.

COURSE LEARNING OBJECTIVES (CLO) :

The objectives of this course is to:

1. Familiarize students with basics of General Principles of Estimation.
2. Discuss the principle of operation and performance parameters for a given Service Connection, Inspection and Testing of Installation, Design and Estimation of Substations.

MODULES	TEACHING HOURS
MODULE 1: **GENERAL PRINCIPLES OF ESTIMATION:** Introduction to estimation & costing, Electrical Schedule, Catalogs, Market Survey and source selection, Recording of estimates, Determination of required quantity of material, Labor conditions, Determination of cost material and labor, Contingencies, Overhead charges, Profit, Purchase system, Purchase enquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills, Tender form, **Self study** : IE Rules 29,30,50,55 **Text Book 1:1.1-1.18**	**8**
MODULE 2: **RESIDENTIAL BUILDING ELECTRIFICATION:** General rules guidelines for wiring of residential installation, accessories, Earthing of residential Installation, Preparation of detailed estimates and costing of residential installation. Distribution boards main switch etc, Earthing of the electrical installation, wiring system and layout, of detailed estimate and costing. **Self-study**: Types of PVC conductors, load calculation **Text Book 1:2.1-2.5**	**8**
MODULE 3: **SERVICE CONNECTION, INSPECTION AND TESTING OF INSTALLATION:** Concept of service connection, Types of service connection and their features, Method of installation of service connection, Estimates of under ground and overhead service connections. **ELECTRICAL INSTALLATION FOR POWER CIRCUITS:** Introduction, IE rules for power installation, Important considerations regarding motor installation wiring, Determination of size of Conduit, distribution Board main switch and starter**.** **Self-study:** Determination of input power, Determination of input current to motors, Determination of rating of cables, determination of rating of fuse, **Text Book 1:3.1-3.16**	**8**

MODULE 4: **DESIGN AND ESTIMATION OF OVERHEAD TRANSMISSION & DISTRIBUTION LINES** Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports, Factors governing height of pole, Conductor materials, Determination of size of conductor for overhead transmission line, Cross arms, Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Points to be considered at the time of erection of overhead lines, Erection of supports, Setting of stays, Fixing of cross arms, Fixing of insulators, Dead end clamps, Positioning of conductors and attachment to insulators, Jumpers, Earthing of transmission lines, **Self-study:** Overhead line insulators, Types of insulators, Lightning Arrestors, Phase plates, Danger plates, Anti climbing devices, Bird guards, Beads of jumpers, **Text Book 1:10.6-10.34**	**8**
MODULE 5: **DESIGN AND ESTIMATION OF SUBSTATIONS:** Introduction, Classification of substation, Indoor substations, Outdoor substations, Selection and location of site for substation, Main Electrical Connections, Graphical symbols for various types of apparatus and circuit elements on substation main connection diagram, Key diagram of typical substations, Equipment for substation and switchgear installations, Substation auxiliaries supply. **Self-study**: Classification of substation, Substation Earthing. **Text Book 1:13.1-13.11**	**8**

Text Books:

1. **Electrical Installation Estimating & Costing,**J.B.Gupta,VIII Edition S.K. Katria & Sons New Delhi

Reference Books:

1. **Electrical Design Estimating and Costing,** K.B.Raina S.K.Bhattacharya, New Age International.
2. **Electrical Wiring Estimating and Costing,** Uppal, Khanna Publishers Delhi.
3. **I.E.Rules and Act Manuals**

COURSE OUTCOMES (COs) :
At the end of this Course student will be able to:

CO1	**Explain** the purpose of estimation and costing, processes involved in Estimating and arriving at final cost(L2).
CO2	**Apply** the concepts of estimation to distribution of energy in a building, wiring accessories and fittings required for installation and fuse selection for an application(L3).
CO3	**Analyze** the estimation carried out in residential building, overhead lines, substation and service main connection of building(L4**)**
CO4	**Prepare** an estimation for the overhead transmission system and distribution system for given specification.

CO – PO PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2											2		
CO4										1	2				
Avg.	**2.5**	**2**								**1**	**2**		**2**		

SEMESTER – VI			
Course Name	**: PLC & SCADA**	**Course Code :**	**20EE654**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial Hours / Week	**: 00**	**SEE Marks :**	**50**
Total No. of Lecture Hours	**: 40**	**SEE Duration :**	**3 Hours**
L:T:P	**: 3:0:0**	**Credits :**	**3**

COURSE OVERVIEW: This course deals with the concepts of PLC, its programming for various industrial applications, PLC interfacing and the overview of SCADA.

COURSE LEARNING OBJECTIVES (CLO):

The objectives of this course is:

1. To acquaint students with the key concepts of PLC & its programming.
2. To give an overview of applications of PLC & SCADA.

MODULES	Teaching hours
Module-1: **Programmable Logic Controllers**: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application. **PLC Hardware Components**: The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs). **Basics of PLC Programming**: Processor Memory Organization, Program Scan, PLC Programming Languages, Bit-Level Logic Instruction, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram. **SSC**: Modes of Operation. Textbook 1: 1.1-1.6, 2.1-2.11, 5.1-5.10	**8**
Module-2: **Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs**: Electromagnetic Control Relays, Contactors, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. **Programming Timers**: Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers. **SSC**: Motor Starters. Textbook 1: 6.1-6.12, 7.1-7.6	**8**
Module-3: **Programming Counters**: Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions. **Program Control Instructions**: Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt. **SSC**: Fault Routine, Temporary End Instruction, Suspend Instruction. Textbook 1: 8.1-8.6, 9.1-9.11	**8**

Module-4: **Data Manipulation Instructions**: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control. **Math Instructions**: Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions. **SSC**: File Arithmetic Operations. Textbook 1: 10.1-10.6, 11.1-11.7	**8**
Module-5: **Sequencer and Shift Register Instructions**: Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers. **Process Control, Network Systems, and SCADA**: Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA). **SSC**: Word Shift Operations. Textbook 1: 12.1-12.5, 14.1-14.7	**8**

Textbooks

1. Programmable Logic Controllers, Frank D Petruzella, McGraw Hill, 4th Edition, 2011.

Reference books

1. Programmable Logic Controllers an Engineer's Guide, E A Parr, Newnes, 3rd Edition, 2013.
2. Introduction Programmable Logic Controllers, Gary Dunning, Cengage, 3rd Edition, 2006.

COURSE OUTCOMES (COs)

At the end of course students will be able to

CO1	Describe the components of PLC and construction/working of field devices. [L2]
CO2	Apply program control instructions for programming PLC. [L3]
CO3	Analyze and construct PLC program for a given application. [L4]
CO4	Carryout simulation/hardware based mini project in teams [ABA]

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2												2	
CO4			1		1										1
CO Avg.	**2.5**	**2**	**1**		**1**									**2**	**1**

SEMESTER – VI			
Course Name	**: Electric Vehicle Technology**	**Course Code :**	**20EE661**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial Hours / Week	**: 00**	**SEE Marks :**	**50**
Total No. of Lecture Hours	**: 40**	**SEE Duration :**	**3 Hours**
L:T:P	**: 3:0:0**	**Credits :**	**3**

COURSE OVERVIEW: This course gives the knowledge about the Electric Vehicles, its modes of operations

COURSE LEARNING OBJECTIVES (CLO):

1. Students will be able to understand working of Electric Vehicles and recent trends.
2. Students will have the ability to analyze different power converter topology used for electric vehicle application.

MODULES	Teaching hours
Module-1: **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. **SSC**: Modes of Operation. **Textbook 1**: 1.1-1.6, 2.1-2.11, 5.1-5.10	**8**
Module-2: **Energy storage for EV and HEV**: Energy storage requirements, Battery parameters, Types of Batteries, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation. **SSC:** Supercapacitors. **Textbook 1**: 6.1-6.12, 7.1-7.6	**8**
Module-3: **Design of Electric and Series Hybrid Electric Vehicles**: Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, **SSC**: Modes of Operation in series hybrid drivetrain. **Textbook 2**: 8.1-8.6, 9.1-9.11	**8**
Module-4: **Design of Electric and Parallel Hybrid Electric Vehicles** design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design. **SSC**: Modes of Operation in parallel hybrid drivetrain **Textbook 2**: 10.1-10.6, 11.1-11.7	**8**
Module-5: **Power Electronic Converter for Battery Charging**: Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z- converter for battery charging, High-frequency transformer based isolated charger topology, **SSC:**Transformer less topology. **Textbook 1**: 12.1-12.5, 14.1-14.7	**8**

Textbooks

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

Reference books

1. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles Sheldon S. Williamson Springer.
2. Modern Electric Vehicle Technology C.C. Chan and K.T.Chau

COURSE OUTCOMES (COs)

At the end of course students will be able to

CO1	**Discuss** about the need of Electric Vehicles and requirements of a battery storage system in electric vehicles and the different energy storing devices available for usage in Electric Vehicles [L2]
CO2	**Apply** the concepts of electrical engineering and propose a suitable configuration for EV's / HEV's based on the user requirement. [L3]
CO3	**Analyze** the Design of Electric and Hybrid Electric Vehicles. [L4]
CO4	**Conduct** a survey and present report on recent technical advancements in Electrical Vehicles technology.

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1												1		
CO2	2												1		
CO3		2											1		
CO4	2				1				1	1			1		1
CO AVG	1.6	2			1				1	1			1		1

SEMESTER – VI			
Course Name	**: Energy Management and Audit**	**Course Code :**	**20EE662**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial Hours / Week	**: 00**	**SEE Marks :**	**50**
Total No. of Lecture Hours	**: 40**	**SEE Duration :**	**3 Hours**
L:T:P	**: 3:0:0**	**Credits :**	**3**

COURSE OVERVIEW: This course gives the knowledge about the current energy scenario, policies, energy audit, energy efficiency and climate change.

COURSE LEARNING OBJECTIVES (CLO)

The objective of the course is to

1. Discuss the current energy scenario and important policies for energy conservation.
2. Describe the energy management methods, audit process and action plan.
3. Discuss the impact of energy generation and consumption on climate change.

MODULES	Teaching hours
Module-1: **Energy scenario:** Introduction, primary and secondary energy, commercial and non-commercial energy, renewable and non-renewable energy, global primary energy reserves and commercial energy production, final energy consumption, Indian energy scenario, sector-wise energy consumption in India, Energy needs of growing economy, integrated energy policy, energy intensity on purchasing power parity (PPP), electricity pricing in India, energy security, energy conservation and its importance. **SSC:** Long-term energy scenario for India. Textbook-1: Chapter-1: 1.1-1.15	**8**
Module-2: **Energy conservation act-2001 and related policies:** Introduction, Salient features of the energy conservation act-2001 and the energy conservation (amendment) act-2010, schemes of BEE under the energy conservation act-2001, integrated energy policy, national action plan on climate change (NAPCC). **SSC:** Electricity act-2003. Textbook-1: Chapter-2: 2.1-2.6	**8**
Module-3: **Energy management and audit:** Definition and objectives of energy management, energy audit definition, need for energy audit, types of energy audit and approach, understanding energy costs, benchmarking, energy performance, matching energy usage to requirement, maximizing system efficiencies, optimizing input energy requirements, fuel and energy substitution, instruments and metering for energy audit. **SSC:** Bureau of energy efficiency regulations-2008. Textbook-1: Chapter-4: 4.1-4.13	**8**
Module-4: **Energy action planning:** Introduction, top management commitment and support, assessing energy profile and establishing baseline, energy policy and planning, implementation, evaluating energy performance, recognize achievements, management tools for effective implementation. **SSC:** Evaluating energy performance, recognize achievements. Textbook-1: Chapter-6: 6.1-6.8	**8**

Module-5: **Energy efficiency and climate change:** Energy and environment, global environmental issues, acid rain, ozone layer depletion, global warming and climate change and impacts, international agreements (UNFCCC), the intergovernmental panel on climate change (IPCC), conference of parties (COP), the Kyoto protocol, CDM methodology and procedure. **SSC:** European union's efforts to combat climate change, sustainable development. Textbook-1: Chapter-10: 10.1-10.13	**8**

Textbooks

1. Guidebook 'General aspects of energy management and energy audit' for National certification examination for energy managers and energy auditors, Bureau of energy efficiency, 4th edition, 2015.

Reference books

1. Energy Management Handbook, W.C. Turner, John Wiley, and Sons.
2. Energy Efficient Electric Motors and Applications, H.E. Jordan Plenum Pub Corp.
3. Energy Management W. R. Murphy, G. Mckay Butterworths.

COURSE OUTCOMES (COs)

At the end of course students will be able to

CO1	Discuss energy scenarios and energy conservation policies and strategies. L2]
CO2	Apply the knowledge of energy audit to energy action planning. [L3]
CO3	Analyze the given case and suggest Energy conservation options. [L4]
CO4	Conduct preliminary audits and submit reports including corrective measures, if any. [PO4,6,7,10]

CO – PO – PSO Mapping

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1														
CO2	3														
CO3		2													
CO4				1		1	1			1			2		
Avg.	**2**	**2**		**1**		**1**	**1**			**1**			**2**		

SEMESTER – VI			
Course Name	**: Fundamentals of Programmable Logic Controllers**	**Course Code :**	**20EE663**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial Hours / Week	**: 00**	**SEE Marks :**	**50**
Total No. of Lecture Hours	**: 40**	**SEE Duration :**	**3 Hours**
L:T:P	**: 3:0:0**	**Credits :**	**3**

COURSE OVERVIEW: This course deals with the concepts of PLC, its programming for various industrial applications, PLC interfacing and the overview of SCADA.

COURSE LEARNING OBJECTIVES (CLO):

The objectives of this course is:

1. To acquaint students with the key concepts of PLC & its programming.
2. To give an overview of applications of PLC & SCADA.

MODULES	Teaching hours
Module-1: **Programmable Logic Controllers**: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application. **PLC Hardware Components**: The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs). **Basics of PLC Programming**: Processor Memory Organization, Program Scan, PLC Programming Languages, Bit-Level Logic Instruction, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram. **SSC**: Modes of Operation. Textbook: 1.1-1.6, 2.1-2.11, 5.1-5.10	**8**
Module-2: **Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs**: Electromagnetic Control Relays, Contactors, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. **Programming Timers**: Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers. **SSC**: Motor Starters. Textbook: 6.1-6.12, 7.1-7.6	**8**
Module-3: **Programming Counters**: Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions. **Program Control Instructions**: Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt. **SSC**: Fault Routine, Temporary End Instruction, Suspend Instruction. Textbook: 8.1-8.6, 9.1-9.11	**8**

Module-4: **Data Manipulation Instructions**: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control. **Math Instructions**: Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions. **SSC**: File Arithmetic Operations. Textbook: 10.1-10.6, 11.1-11.7	**8**
Module-5: **Sequencer and Shift Register Instructions**: Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers. **Process Control, Network Systems, and SCADA**: Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA). **SSC**: Word Shift Operations. Textbook: 12.1-12.5, 14.1-14.7	**8**

Textbooks

1. Programmable Logic Controllers, Frank D Petruzella, McGraw Hill, 4th Edition, 2011.

Reference books

1. Programmable Logic Controllers an Engineer's Guide, E A Parr, Newnes, 3rd Edition, 2013.
2. Introduction Programmable Logic Controllers, Gary Dunning, Cengage, 3rd Edition, 2006.

COURSE OUTCOMES (COs)

At the end of course students will be able to

CO1	Describe the components of PLC and construction/working of field devices. [L2]
CO2	Apply program control instructions for programming PLC. [L3]
CO3	Analyze and construct PLC program for a given application. [L4]
CO4	Carryout simulation/hardware based mini project in teams [ABA]

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	3														
CO3		2												2	
CO4			1		1										1
CO Avg.	**2.5**	**2**	**1**		**1**									**2**	**1**

SEMESTER –VI			
Course Name	**: Electric Traction**	**Course Code :**	**20EE664**
No. of Lecture Hours / Week	**: 03**	**CIE Marks :**	**50**
No. of Tutorial / Week	**: 00**	**SEE Marks :**	**50**
Total No. of Lecture + Tutorial Hours	**: 40**	**SEE Duration :**	**03 Hrs**
L:T:P	**: 03:00:00**	**Credits :**	**3**

COURSE OVERVIEW: : This course focuses on understanding the need for utilization of Electrical power in traction application, Different starting, controlling and Braking Mechanisms used in traction systems, Factors affecting the energy consumed by traction systems.

COURSE LEARNING OBJECTIVES (CLO) :

To understand the need for Electrical Power Utilization in Traction systems.
To address the concepts of Starting, Controlling and Braking mechanisms used in traction systems.
To study about the performance of traction system through speed time curve and the factors affecting the energy utilization

MODULES	TEACHING HOURS
MODULE 1: TRACTION SYSTEMS Introduction to traction systems, Requirements of an Ideal system of Traction, Different Systems of Traction, Systems of Electric Traction, Systems of Track Electrification. Text book 1: 10.1 – 10.4	**8**
MODULE 2: TRAIN MOVEMENT AND ENERGY CONSUMPTION Introduction to Speed Time Curve, Typical Speed time curves, Types of Speed in Traction Vehicle, Factors affecting Scheduled speed, Simplified speed time curve, Derivation for Crest speed in Trapezoidal speed time curve, Mechanics of Train movement, Tractive effort for Propulsion of Train. Factors affecting Energy Consumption Text book 1: 11.1 to 11.7, 11.10.1	**8**
MODULE 3: ELECTRIC TRACTION MOTORS General features of traction motors, Starting and Speed Control of DC Traction motors, starting efficiency in Rheostatic starting and Series Parallel starting, Advantages of Series Parallel starting, Transition methods. Text book 1: 12.1, 13.1 to 13.5	**8**
MODULE 4: BRAKING Introduction to braking, Requirements of Braking Systems, Plugging, Rheostatic barking, Regenerative braking, Mechanical Braking: Compressed air brakes, Vacuum Brakes, Hydraulic Braking, Magnetic track brakes, Eddy current brakes, Auxiliary Equipment. Text book 1: 14.1 to 14.7, 14.11	**8**
MODULE 5: POWER SUPPLY FOR ELECTRIC TRACTION Introduction, Current collection systems, Current collectors for over head system, Overhead Construction: Tramways & Trolley buses, Railways, DC track electrification, AC track Electrification, Power supply Arrangement for AC track Electrification. Text book 1: 15.1 to 15.9	**8**

Text Books:

1. Utilization of Electric Power & Electric Traction by J. B. Gupta , S.K. Kataria & Sons, Tenth edition, 2012

Reference Books:

1. Utilization Of Electrical Power, Er. R.K. Rajput, Laxmi Publications, Second Edition, 2016

1	Understand the need for utilization of electrical power in different forms for Traction applications.
2	Apply the knowledge of mathematics and Engineering to understand the behaviour of traction vehicle through Speed time curves.
3	Analyze the traction system requirements and suggest appropriate Starting, Controlling and braking mechanisms.

CO – PO – PSO Matrix

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2		3													
CO3		3													
CO4	**3**	**3**											**2**		

Course Name	**:Control Systems Laboratory**	**Course Code :**	**20EE67**
No. of Lecture Hours / Week	**: 01**	**CIE Marks :**	**50**
No. of Tutorial / Practical Hours / Week	**: 02**	**SEE Marks :**	**50**
Total No. of Lecture + Tutorial / Practical Hours	**: 20**	**SEE Duration :**	**03 Hrs**
L:T:P	**: 1:0:2**	**CREDITS :**	**2**

COURSE OVERVIEW : The course deals with the linear control systems, types of controllers and the study stability of systems with the use of root locus and bode plots.

COURSE LEARNING OBJECTIVES (CLO) :

The objective of the course is

1. To examine the time and frequency domain responses of a given second order system using software package or discrete components.
2. To realize Lead, Lag and Lag – Lead compensators for given specifications.
3. To develop script files to plot root locus, bode plot and study the stability of the system along with controllers

EXPERIMENTS

A - Demonstration:

1. Experiment to draw synchro pair characteristics
2. Introduction to MATLAB tool

B – Exercise:

1. Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor
2. To simulate DC motor characteristics using MATLAB Simulink
3. Experiment to determine frequency response of a second order system
4. To develop the root locus for a given Transfer Function
5. To develop the Bode Plot for a given Transfer Function and determine the relative stability by measuring gain margin and phase margin.

C – Structured Enquiry:

1. Design of lead compensator for given specifications along with frequency response
2. Design of lag compensator for given specifications along with frequency response
3. Design of lag lead compensator for given specifications along with frequency response
4. To simulate a typical second order system along with P, PI and PID controllers and analyze step response specifications.
5. To study the effect of P, PI and PID controllers on DC Servomotor

D – Open Ended Experiments:

1. Modeling of different machines and their characteristics using MATLAB Simulink.

COURSE OUTCOMES (COs):
After conducting the experiments the student will be able to,

CO1	Conduct experiments choosing appropriate components and equipment by **applying** theoretical knowledge and practical skills. (L3)
CO2	Design, **analyze**, and interpret the data to arrive at valid conclusions through the experiments. (L4)
CO3	Engage in **independent and lifelong learning** by designing controllers/compensators to obtain desired parameters using suitable software tools.

CO-PO-PSO Mapping

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

Course Name	**:Digital Signal Processing Laboratory**	**Course Code :**	**20EE68**
No. of Lecture Hours / Week	**: 00**	**CIE Marks :**	**50**
No. of Tutorial / Practical Hours / Week	**: 02**	**SEE Marks :**	**50**
Total No. of Lecture + Tutorial / Practical Hours	**: 20**	**SEE Duration :**	**03 Hrs**
L:T:P	**: 1:0:2**	**CREDITS :**	**2**

COURSE OVERVIEW :

This subject gives an overview about the actual operation of filters, FFT and DFT Analysis, proof for sampling theorem.

COURSE LEARNING OBJECTIVES (CLO) :

The objectives of this course are to make students:

1. To explain the use of MATLAB software in evaluating the DFT and IDFT of given sequence
2. To verify the convolution property of the DFT
3. To design, implement & realize of IIR and FIR filters for given frequency specifications.
4. To develop software skills.

EXPERIMENTS

A - Demonstration:

1. Evaluation of impulse response of a system
2. Computation of N – point DFT and to plot the magnitude and phase spectrum.

B – Exercise:

1. To perform linear convolution of given sequences
2. To perform circular convolution of given sequences
3. Design and implementation of IIR filters to meet given specification (Low pass, high pass)
4. Design and implementation of FIR filters to meet given specification using different window functions

C – Structured Enquiry:

1. Linear and circular convolution by DFT and IDFT method.
2. Calculation of DFT and IDFT by FFT
3. Realization of IIR and FIR filters

D – Open Ended Experiments:

1. Develop a MATLAB code to demonstrate the application of DSP

COURSE OUTCOMES (COs)

After conducting the experiments the student will be able to,

CO1	Apply knowledge of mathematics, science, and engineering: for visualizing the basic concepts of discrete signal representation.
CO2	Identify, formulate, analyse complex engineering problems and conduct experiments to demonstrate concepts related to Discrete time LTI System.
CO3	Design, implement, realize, and demonstrate filter algorithms for the given specification in C using MATLAB.
CO4	Implement and demonstrate an application of discrete time system concepts using Matlab software

CO-PO-PSO Mapping

CO	PO												PSO		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													3	
CO2		3												3	
CO3			3											3	
CO4					2					2					2
CO Average	**3**	**3**	**3**		**2**					**2**				**3**	**2**

SEMESTER – VI			
Course Name	**: Skilled Development 4**	**Course Code :**	**20HS61**
Number of Lecture Hours / Week	**: 00**	**CIE Marks :**	**50**
Number of Tutorial / Practical Hours / Week	**: 02**	**SEE Marks :**	**50**
Total Number of Lecture + Tutorial/Practical Hours	**: 2**	**SEE Duration :**	**02 Hours**
L:T:P	**: 0:2:0**	**CREDITS :**	**01**
COURSE PREREQUISITES: Skill Development 1, 2 and 3			

MODULES	**TEACHING HOURS**
MODULE 1: **General Aptitude 4.1:** **Quantitative Aptitude:** Probability, Alligation and Mixture Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	**6**
MODULE 2: **Interview Preparation:** **Group Discussions:** **Interview Skills:**	**6**
MODULE 3: **General Aptitude 4.2:** **Quantitative Aptitude:** Data Interpretation **Logical Reasoning:** Data Sufficiency Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	**6**
MODULE 4: **Interview Preparation:** **Resume Writing:**	**6**

LinkedIn Profiling: **Verbal Ability:** Critical Reasoning Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	
MODULE 5: **General Aptitude 4.3:** **Logical Reasoning:** Visual Reasoning, Statements and Assumptions **Verbal Ability:** Sentence Completion Introduction and explanation of concepts with their applications. Focus on concepts and different methods and shortcuts to solve problems	**6**

Textbooks:

1. Notes and Textbooks are part of learning methodology

Reference Books:

1. Bizotic Course Material, Text Bank and Hand outs
2. Quantitative Aptitude for Competitive Examinations by R.S Aggarwal
3. A Modern Approach to Verbal & Non-Verbal Reasoning by R.S. Aggarwal
4. AMCAT Preparation Guide

COURSE OUTCOMES (COs):

CO1	Understand the importance of continuous learning and implement it successfully Understand the basic concepts of the topics covered. Understand what conflict is and how it escalates within the workplace
CO2	Apply concepts of goal setting , interpersonal behaviors in life Appreciate team skills and dynamics. Identify Critical Thinking
CO3	Self-Analyze and develop self-confidence and a positive attitude Analyze common conflict resolution styles and use them effectively in teamwork
CO4	Compete in various competitive exams with positive mind set Practice Positive thinking and Attitude in walks of life