Academic Program: UG

Academic Year 2023-24 Syllabus

V & VI Semester B. E.

Electrical & Electronics Engineering

SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF ENGINEERING & TECHNOLOGY,
DHARWAD – 580 002

An Autonomous Institution Approved by AICTE & Affiliated to VTU, Belagavi
Department Accredited by NBA under Tier-1 (July 2022-June 2025)

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SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for V & VI semester B.E. in Electrical &Electronics Engineering is recommended by the Board of Studies of Electrical and Electronics Engineering Department and approved by the Academic Council, SDM College of Engineering & Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2023-24 till further revision.

Principal

Chairman BoS & HoD

SDM College of Engineering & Technology, Dharwad
Department of Electrical & Electronics Engineering
*(**Our motto:** Professional **C**ompetence with **P**ositive **A**ttitude)*

College Vision and Mission

Vision

To develop competent professionals with human values

Mission

- To have contextually relevant Curricula.
- To promote effective Teaching Learning Practices supported by Modern Educational Tools and Techniques.
- To enhance Research Culture
- To involve Industrial Expertise for connecting classroom content to real life situations.
- To inculcate Ethics and impart soft-skill leading to overall Personality Development.

QUALITY POLICY:

In its quest to be a role model institution, committed to meet or exceed the utmost interest of all the stake holders.

CORE VALUES:

Competency

Commitment

Equity

Team work and

Trust

DEPARTMENT VISION AND MISSION

Vision:

To develop globally acceptable Electrical and Electronics Engineering professionals with human values.

Mission:

- Adopting the state of the art curricula
- Practicing effective and innovative teaching-learning methodologies
- Initiating complementary learning activities to enhance competence
- Inculcating positive attitude and commitment to society.

Program Educational Objectives (PEOs)

I. To impart the domain knowledge and soft skills to secure employment or become entrepreneur or pursue higher studies.

II. To provide training for teamwork, leadership qualities, lifelong learning and adaptability to achieve professional growth.

III. To develop sense of positive attitude and practice ethics to contribute positively to the society as a responsible citizen.

POs and PSOs

PO 1.**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO 2.**Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3.Design/Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4.**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5.**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6.**The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7.**Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8.**Ethics:** Apply ethical principles and commit to professional ethics responsibilities and norms of the engineering practice.

PO 9.**Individual and Team work:** Function effectively as an individual and as a member or leader in diverse teams and individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11.**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12.**Life-long Learning:** long learning: Recognize the need for and have the Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PSO-1 Enhancement of professional competence in cutting edge domain through value addition activities.

PSO-2 Ability to demonstrate the skill of carrying out operation and Maintenance of electrical distribution system effectively.

PSO-3 Design and implement the electronic circuits/programs for practical applications.

SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD

Department of Electrical & Electronics Engineering

V Semester

Scheme of Teaching and Examinations 2023 – 24

Course Code	*Course Category	Course Title	Teaching		Examination				
			L-T-P (Hrs./Week)	Credits	CIE	Theory(SEE)		Practical (SEE)	
					Max. Marks	**Max Marks	Duration in Hrs.	Max. Marks	Duration in Hrs.
21UHUC540	HU	Management, Entrepreneurship and IPR	3 - 0 - 0	3	50	100	3	-	-
21UEEC500	PC	Electrical Machines-II	3 - 0 - 0	3	50	100	3	-	-
21UEEC501	PC	Control Systems	2 - 2 - 0	3	50	100	3	-	-
21UEEC502	PC	Programing with Python	3 - 0 - 0	3	50	100	3	--	--
21UEEE51X	PE	Program Elective-1	3 - 0 - 0	3	50	100	3	--	--
21UEEL503	PC	Electrical Machines-I Lab	0 - 0 - 2	1	50	--	--	50	3
21UEEL504	PC	Power Electronics Lab	0 - 0 -2	1	50	--	--	50	3
21UAEE541	AE	Power Electronics	2 - 0 - 0	2	50	50	2	--	--
21UEEL505	PC	Minor Project-1	0 - 0 - 2	1	50	--	--	--	--
21UEEL506	PC	Internship-I	Minimum 2 weeks	1	50	--	--	--	--
		Total	**16- 2 -6**	**21**	**500**	**550**		**100**	

* BS- Basic science ES- Engineering Science HU- Humanities, languages and Management AE- Ability enhancement course PC- Program core

** Semester End Examination conducted for 100 marks will be reduced to 50 marks

Program Elective-1

Course code	Course Title
21UEEE511	Linear ICs and Applications
21UEEE512	Machine Learning

SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD

Department of Electrical & Electronics Engineering

VI Semester

Scheme of Teaching and Examinations 2023 – 24

Course Code	*Course Category	Course Title	Teaching		Examination				
					CIE	Theory (SEE)		Practical (SEE)	
			L-T-P (Hrs/Week)	Credits	Max. Marks	**Max. Marks	Duration in Hrs.	Max. Marks	Duration In Hrs.
21UEEC600	PC	Power System Analysis and Stability	3 - 0 - 0	3	50	100	3	-	-
21UEEC601	PC	High Voltage Engineering, Switchgear & Protection	2 - 2 - 0	3	50	100	3	-	-
21UEEC602	PC	Digital Signal Processing	3 - 0 - 0	3	50	100	3	-	-
21UEEE6XX	PE	Program Elective-2	3 - 0 - 0	3	50	100	3	-	-
21UEEE6XX	PE	Program Elective-3	3 - 0 - 0	3	50	100	3	-	-
21UEEO6XX	OE	Open Elective-1	3 - 0 - 0	3	50	100	3	--	--
21UEEL603	PC	Sensors, Control Systems and Simulation Lab	0 - 0 - 2	1	50	--	--	50	3
21UEEL604	PC	Electrical Machines-II Lab	0 - 0 - 2	1	50	--	--	50	3
21UEEL605	PC	Minor Project-2	0 - 0 -3	1	50	--	--	50	3
21UHUL606	HU	Soft skills and Aptitude	0 - 0 -2	1	50	--	--	--	--
		Total	**17 - 2 - 9**	**22**	**500**	**600**		**150**	

* BS- Basic science ES- Engineering Science HU- Humanities, languages, and Management AE- Ability enhancement course PC- Program core

** Semester End Examination conducted for 100 marks will be reduced to 50 marks

Program Elective-2

Course Code	Course Title
21UEEE611	Computer Communication and Networking
21UEEE612	Data Structures and Algorithm
21UEEE613	Internet of Things (IoT)
21UEEE614	Object Oriented Programming

Program Elective-3

Course Code	Course Title
21UEEE621	Energy Auditing and Demand Side Management
21UEEE622	Electrical Estimation Specification Codes and Practices
21UEEE623	ARM Processor
21UEEE624	VLSI Circuits

Open Elective-1 (All Branches)

Course Code	Course Title
21UEEO641	Digital System Design using HDL
21UEEO642	Computer Organization
21UEEO643	Renewable Energy System

V Semester

21UHUC540 Management, Entrepreneurship and IPR (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn the evolution of Management, the organization structure encompassing planning, organizing, decision making and execution. They will also learn about the concept and scope of entrepreneurship in small, medium, large and Government owned Industries and the issues related to copyright, patents, in all, protection of Intellectual property.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Describe the Engineering and Management history and planning.	11	2	
CO-2	Explain the concepts of organizing, staffing, motivating and controlling.	11	2	
CO-3	Recite the foundations of entrepreneurship, small scale industry, Government and Institutional Support.	11		
CO-4	Exhibit the skills of writing project report and describe issues related to IPRs.	11		12
CO-5	Comprehend the concepts of patents, trademarks and industrial design.	11		

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
Mapping Level		2.0									3.0	1.0			

Prerequisites: 1.A course on Humanities (preferred)

Contents:

Unit-I

Engineering and Management: Historical Development of Engineering, Management, and synthesis.

Planning, Forecasting and Decision Making: Nature of Planning, the foundation of planning, some planning concepts, forecasting, nature of decision making, management science, tools for decision-making, CPM/PERT-Examples. **07 Hrs.**

Unit-II

Organizing and staffing: Nature of organizing, traditional organizational theory, technology, and modern organization structures, staffing technical organization, authority, and power; delegation of power, meeting & committees.

Motivating: Motivation, leadership, motivating and leading technical professionals.

Controlling: Process of control, financial controls, non-financial controls, Examples. **08 Hrs.**

Unit-III

Foundations of Entrepreneurship: Meaning, functions and types of entrepreneurs. Concept of entrepreneurship, role of entrepreneurs in economic development, barriers of entrepreneurship.

Small Scale Industry: Definition, characteristics, objects, role of SSI in economic development, advantages of SSI, steps to start SSI, impact of liberalization, privatization, and globalization on SSI, definition of ancillary and tiny industry.

Government and Institutional Support: Support from government, objectives, and functions of SISI, SIDBI, DIC, single window agency, KIADB, KSSIDC, KSFC. **07 Hrs.**

Unit-IV

Preparations for Project: Meaning of project identification, project report, contents and formulation, identification of business opportunities, feasibility studies, types and purpose, Case study of project report.

Intellectual Property Right: Meaning and forms of intellectual property right, competing rationale for protection, international conventions, world court.

Copyright: Meaning and content, ownership and rights, period, assignment, relinquishment, license, infringement, fair use, offenses, and penalties.**08 Hrs.**

Unit-V

Patents: Concept, patentable inventions, procedure for obtaining patent, rights and obligations of patent holders, infringements and remedies, offenses, and penalties.

Industrial Designs: Definition, procedure for registration, rights conferred registration, infringements. **Trademarks:** Concept and significance. **08 Hrs.**

Reference Books:

1) Thomas W. Zimmerer, "Essentials of Entrepreneurship",2/e PHI, 2005.
2) Daniel L. Babcock, "Managing Engineering and Technology", 4/e, PHI,2010.
3) Peter Drucker, "The Practice of Management"1/e, Business & Economics, 26-Jul-2012.
4) N. K. Acharya, "Textbook on Intellectual Property Rights", 4/e, Asia Law House,2012.

21UEEC500	Electrical Machines-II	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn the basic principle, construction, operation and performance of Induction machines, the basic principle, construction, operation and performance of synchronous machines, the transient behavior and dynamics of machines.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the Principle of operation with Phasor diagram, & Torque - slip curves, Testing, Equivalent circuit and carry out performance Analysis. Understand the operation of Induction Generators. Understand aspects of starting.	1,2		

CO-2	Explain Construction, working principle and starting of 1 phase induction motor, Speed control of 3-phase induction motor and Braking. Explain role of Deep bar rotor and double cage rotors.	1,2		
CO-3	Understand construction, working, factors affecting induced emf and phasor diagram.	1,2		
CO-4	Determine voltage regulation of synchronous generator by different methods. Understand Parallel operation and load sharing, synchronization, operation on infinite bus.	1,2		
CO-5	Understand the starting, working and performance of synchronous motor. Understand aspects of Dynamic Performance of Synchronous machine.	1,2		

PO's	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -1	PSO -2	PSO -3
Mapping Level	3.0	3.0													

Prerequisites: 1.Basic Electrical Engineering 2. Network analysis

Contents:

Unit-I

Basics and performance of 3 phase induction machine: Principle of operation of 3 phase induction motor, Phasor diagram, Torque - slip curves, Equivalent circuit, and performance calculations. No load and locked rotor tests. Circle diagram. Starting of 3 phase induction motor. Types of starters. Induction Generators. **09 Hrs.**

Unit-II

Single Phase Induction Motor: Construction, Double revolving field theory. Equivalent circuit, Determination of parameters of equivalent Circuit by tests, Methods of starting.

Control of Induction Motors: Speed control types. Electrical braking types. Deep bar rotor and double cage induction motors. **08 Hrs.**

Unit-III

Basics of Synchronous Generators: Construction, Advantages of rotating field, emf equation, effects of harmonics on generated emf. Poly-phase armature windings, armature reaction phasor diagram of a synchronous generator. **07 Hrs.**

Unit-IV

Performance of Synchronous Generators: Voltage regulation by emf, mmf, Potier triangle and ASA methods. Parallel operation. Operation on Infinite bus, operating characteristics, and Power flow equations. **08 Hrs.**

Unit –V

Synchronous Motors: Principle of operation, Methods of starting, phasor diagram, effect of variation in excitation, two reaction model, Synchronous Condensers**.**

Electrical transients in synchronous machines: Effect of damper windings. Effect of D.C. components. Expressions for reactance and time constants. Dynamics of Synchronous machines. **07 Hrs.**

Reference Books:

1) D. P Kothari & I. J. Nagrath, “Electrical Machines”, 3/e, TMH,2010.
2) M. G. Say, “Performance and Design of A.C Machines”, 3/e, CBS publications 2004.
3) P. S. Bimbra, “Electric Machinery”, 3/e, Khanna publishers, 2003.
4) Ashfaq Hussain “Electric Machines”, 2/e, Dhanpathrai & Sons, 2004.
5) Electrical Machinery fundamentals by Stephen J. Champan 4th edition TATA McGraw- Hill

21UEEC501	Control Systems	(2 -2 -0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn the definition of control system, open loop and closed loop system, electromechanical systems, differential equations of physical systems and mathematical modeling. They will learn to formulate, solve and analyze control engineering problems. Further, they learn to check the stability of control systems using different techniques and also write simple MATLAB programs for the same.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Distingush between open loop and closed loop systems, write the mathematical representation of electromechanical systems and reduction of block diagrams, demonstrate the transfer function of ac and dc servomotors	1,2	PSO 2	
CO-2	Develop the knowledge of signal flow graphs,Mason's gain formula and illustrate the time domain specifications.	1,2		4, PSO 2
CO-3	Examine the stability using Routh Hurwitz's criterion and introduction to types of controllers.	1,2		4
CO-4	Illustrate the stability analysis using root locus and get introduced to MATLABprogramming	1,2		4, 5 PSO 2
CO-5	Predict the stability analysis of frequency domain using Bode and Nyquist plots	1,2		PSO 2

PO's	**PO -1**	**PO -2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO -7**	**PO -8**	**PO -9**	**PO -10**	**PO -11**	**PO -12**	**PSO -1**	**PSO -2**	**PSO -3**
Mapping Level	3.0	3.0		1.0	1.0									1.25	

Prerequisites: 1. Basic Electrical engineering.
2. Engineering Mathematics.

Contents:

Unit-I

Introduction: Definition of control systems, open loop and closed loop system comparison with examples. Electromechanical systems. Differential equations of physical systems.

Block diagram and reduction of block diagrams: Transfer function, Block diagram representation and reduction, Transfer functions of control components dc servomotor, two- phase AC servomotor. **08 Hrs**.

Unit-II

Signal flow graphs and reduction of signal flow graphs: signal flow graph representation and reduction using Mason's Gain formula.

Time response: feedback control system, standard test signals, unit step response of first and second order systems, examples, static error analysis, examples. **08 Hrs.**

Unit-III

Stability: Concept of stability, Relative stability analysis, stability for a second order system, Routh-Hurwitz stability criterion, examples, Introduction to P, PI and PID controllers. **07 Hrs.**

Unit-IV

Root locus: Concept, steps to solve the problems with root locus, advantages of root locus, examples on determination of gain constant and damping ratio.

Introduction to MATLAB: Obtaining transient response, Root locus, Bode plot using MATLAB, Exercises. Introduction to SIMULINK, P, PI & PID controllers using SIMULINK **08 Hrs.**

Unit-V

Frequency domain Analysis: Stability analysis, Bode plot and to obtain phase margin and gain margin of third order system, examples. **08 Hrs.**

Reference Books:

1) I. J. Nagrath and M. Gopal, "Control Systems Engineering", 3/e, Wiley Eastern Ltd, 2003.
2) K. Ogata, "Modern Control Engineering", 4/e, PHI, 2004.
3) B. C. Kuo, "Automatic control systems", 7/e, PHI.2000.
4) Gopal M., "Control System - Principles & Design", 4/e,TMH, 1984.
5) http://www.nptelvideos.in/2012/11/control-engineeringprof-gopal.html

21UEEC502	Programming with Python	(3 -0 -0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): This course focuses on the following learningperspectives:

- Learn the syntax and semantics of the Python programming language.
- Illustrate the process of structuring the data using lists, tuples
- Appraise the need for working with various documents like Excel, PDF, Word andOthers.
- Demonstrate the use of built-in functions to navigate the file system.
- Implement the Object Oriented Programming concepts in Python.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will beable to:		**Mapping to POs(1-12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Demonstrate proficiency in handling loops and creation of functions.	-	1, 2, 3	-
CO-2	Identify the methods to create and manipulate lists, tuples and dictionaries.	-	1, 2, 3	-
CO-3	Develop programs for string processing and file organization	-	1, 2, 3	-
CO-4	Interpret the concepts of Object-Oriented Programming as used in Python.	-	1, 2, 3	-
CO-5	Demonstrate proficiency in handling loops and creation of functions.	-	1, 2, 3	-

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	2.0	2.0	2.0												

Contents:

Unit-I

Python Basics: Entering Expressions into the Interactive Shell, The Integer, Floating- Point, and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program, Flow control: Boolean Values, Comparison Operators, Boolean Operators, Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules, Ending a Program Early with sys.exit(), Functions: def Statements with Parameters, Return Values and return Statements, The None Value, Keyword Arguments and print(), Local and Global Scope, The global Statement, Exception Handling, A Short Program: Guess the Number. **08 Hrs.**

Textbook 1: Chapters 1 – 3

Unit-II

Lists: The List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Example Program: Magic 8 Ball with a List, List-like Types: Strings and Tuples, References,

Dictionaries and Structuring Data: The Dictionary Data Type, Pretty Printing, Using Data Structures to Model Real-World Things. **08 Hrs.**

Textbook 1: Chapters 4 – 5

Unit-III

Manipulating Strings: Working with Strings, Useful String Methods, Project: Password Locker, Project: Adding Bullets to Wiki Markup

Reading and Writing Files: Files and File Paths, The os. path Module, The File Reading/Writing Process, Saving Variables with the shelve Module, Saving Variables with the print.format() Function, Project: Generating Random Quiz Files, Project: Multi clipboard. **07 Hrs.**

Textbook 1: Chapters 6 , 8

Unit-IV

Organizing Files: The shutil Module, Walking a Directory Tree, Compressing Files with the zipfile Module, Project: Renaming Files with American-Style Dates to European-Style

Dates, Project: Backing Up a Folder into a ZIP File,

Debugging: Raising Exceptions, Getting the Traceback as a String, Assertions, Logging, IDLE‟s Debugger. **08 Hrs.**

Reference book 1: Chapters 9-10

Unit-V

Classes and objects: Programmer-defined types, Attributes, Rectangles, Instances as return values, Objects are mutable, Copying,

Classes and functions: Time, Pure functions, Modifiers, Prototyping versus planning,
Classes and methods: Object-oriented features, Printing objects, Another example, A more complicated example, The init method, The str method, Operator overloading, Type-based dispatch, Polymorphism, Interface and implementation. **08 Hrs.**
Reference book 2: Chapters 15 – 17

Reference Books:

1) Al Sweigart, "Automate the Boring Stuff with Python", 1st Edition, No Starch Press, 2015. (Available under CC-BY-NC-SA licenseat https://automatetheboringstuff.com/) (Chapters 1 to 18, except 12) for lambda functions use this link: https://www.learnbyexample.org/python-lambda-function.
2) Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at http://greenteapress.com/thinkpython2/thinkpython2.pdf(Chapters 13, 15, 16, 17, 18) (Download pdf/html files from the above link)

21UEEE511 Linear ICs and Applications (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn the basic working of Linear IC, design concepts of Linear ICs based circuits and solve relevant problems. They also learn to analyze electronic circuits even with the help of relevant software and fundamental design skills of analog systems using linear ICs which have immediate end application to Engineering problems.

Course Outcomes (COs) :

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Recall the basics and understand the stability issues of Opamp circuits.	1		

CO-2	Apply the knowledge of basic Opamps in the linear circuit design.	1		
CO-3	Apply the knowledge of basic Opamps in the non-linear circuit design.	2,3	PSO 3	
CO-4	Apply the knowledge of basic Opamps in the design of oscillators and filters.	2,3		
CO-5	Analyze the performance of different Opamp circuits from the point of view of their applications.	2	5, PSO 3	

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	3.0	3.0	3.0		2.0										2.0

Prerequisites: Basic/Analog Electronics

Contents:

Unit-I

Review of basics: Ideal and practical Opamps, Performance parameters of Opamps. Comparison of BJT and MOS based Opamps. Basic CMOS Opamps. MOS differential amplifier, **Frequency response:** Requirement of circuit stability, Barrack Hussein's criteria, Frequency compensation methods, Effects of slew rate, Circuit stability precautions. **08 Hrs.**

Unit-II

Opamp circuit design: Voltage follower, High input impedance Inverting and non-inverting amplifiers, Differentiator, Integrator, Precision rectifiers (half wave and full wave), Clippers, Clampers, Sample and hold circuits. **07 Hrs.**

Unit-III

Design & Applications of Opamp nonlinear Circuits: Comparators, voltage limiters, differential input and differential output amplifier, Schmitt trigger, Square wave generators, Monostable multivibrators, Voltage to current converter with floating load, Current to voltage converter. **08 Hrs.**

Unit-IV

Oscillators and Filters: Oscillators-Triangular wave generator, RC phase shift oscillator, Wein bridge oscillator, Phase shift oscillator and Active filters-2nd order Butterworth low pass, high pass, band pass and band elimination filters. **07 Hrs.**

Unit-V

Special ICs and applications: Phase locked loops (NE565), Analog to Digital Converters- Successive approximation, Dual slope and Flash type, Digital to Analog Converters- Binary weighted and R-2R type Regulated power supply, Voltage regulator.

Self-learning component: Usage of modern tool for the simulation of Opamp based circuits. **09 Hrs.**

Reference Books:

1) Roy & Choudary, "Operational amplifiers and Linear Integrated circuits", 2/e, New Age International 01-Jan-2003
2) Ramakanth A. Gayakwad, "Operational Amplifiers and Linear IC's"3/e, Prentice Hall,2000.
3) David A. Bell," Operation Amplifiers and Linear IC's",2/e, PHI, 2005.
4) Behzad Razavi, "Design of analog CMOS Integrated circuit ", Tata McGraw-Hill Education, 01-Oct-2002

21UEEE512	**Machine Learning**	**(3-0-0) 3**

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to explain Machine Learning aspects. They will be Illustrating ML algorithm and their use in appropriate applications

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Recall the basics and understand the verify the aspects of machine learning.	1		
CO-2	Comprehend the fundamentals of numerical optimization		1,2	
CO-3	Understand and analyze Regression and		1,2	

	Classification with respects to ML algorithms.			
CO-4	Understand and analyze feature learning concepts in ML		1,2	

Prerequisites: Data Structures, Knowledge on statistical methods.

Contents:

Unit I

Introduction: Definitions, Predictive models - basic building blocks; Feature design and learning ; Numerical optimization . **08 Hrs.**

Unit II

Fundamentals of numerical optimization: Calculus defined optimality, Using calculus to build useful algorithms**;** Gradient descent, Newton's method **08 Hrs.**

Unit III

Regression: Linear regression - applications in climate science, feature selection, compression, neuroscience, and marketing, Knowledge-driven feature design for regression Nonlinear regression,The L-2 regularizer **08 Hrs.**

Unit IV

Classification: The perceptron, Logistic regression/Support Vector Machines, Multiclass classification, Knowledge driven feature design for classification-examples from computer vision (object/face detection and recognition), text mining, and speech recognition. **08 Hrs.**

Unit V

Feature learning: Function approximation and bases of features, Feed-forward neural network bases, deep learning, and kernels, Cross-validation. **07 Hrs.**

Text books: .

1) Watt, R. Borhani, and A. K. Katsaggelos, Machine Learning Refined: Foundations, Algorithms, and Applications, Cambridge University Press, 2016
2) Machine Learning – Tom M. Mitchell, – MGH

Reference Books:

1) Saroj Kaushik, Artificial Intelligence, Cengage learning
2) Stuart Rusell, Peter Norving , Artificial Intelligence: A Modern Approach,

Pearson Education 2nd Edition
3) AurÈlienGÈron,"Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, Shroff/O'Reilly Media, 2017.
4) Trevor Hastie, Robert Tibshirani, Jerome Friedman, h The Elements of Statistical Learning, 2nd edition, springer series in statistics.
5) Ethem Alpaydın, Introduction to machine learning, second edition, MIT press
6) Srinvivasa K G and Shreedhar, " Artificial Intelligence and Machine Learning", Cengag

21UEEL503 Electrical Machines- I Lab (0–0–2) 1

Contact Hours: 24

Course Learning Objectives (CLOs):

The students are expected to learn realization of theoretical concepts and verify practically. They will be learning to conduct experiments on DC machines, single phase and three phase transformers to determine the performance characteristics.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Conduct experiments to determine the performance parameters of DC machines	9	2	4,8
CO-2	Conduct experiments to determine the performance parameters of single-phase transformers.	9	2	4,8
CO-3	Conduct experiments to determine the performance parameters of three phase transformers.	9	2	4,8
CO-4	Carry out phase conversion	9	2	4,8

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level		2.0		1.0				1.0	3.0						

Prerequisites: 1. Electrical machines

Contents: Minimum of 10 experiments to be conducted from the list given below.

Prescribed Experiments:

OCC and external characteristics of DC shunt generator.

1. Speed control of DC shunt motor by a) Rheostat control b) Flux control.
2. Load test on DC shunt motor.
3. Field test on DC series machines.
4. Swinburne test.
5. Hopkinson test.
6. Ratio and Polarity test on transformer.
7. OC and SC tests on 1- Φ transformers.
8. Sumner's test.
9. Scott connection.

10 .Parallel operation of 1- Φ transformers.

11 .Load test on 3-phase transformers.

Reference Books:

1) Lab. Manual.
2) D.P. Kothari & I.J. Nagrath- "Electrical Machines", 3/e, TMH,2010.
3) Ashfaq Hussain- "Electric Machines", 2/e, Dhanpatrai & Sons, 2004.

21UEEL504	Power Electronics Lab	(0 - 0 - 2) 1

Contact Hours: 24

Course Learning Objectives (CLOs):

The students are expected to learn conducting experiments on power semiconductor devices plot the characteristics and compare the same with the theoretical characteristics. They will learn to rig up different triggering circuits and commutation circuits. They learn to verify for the waveforms and other performance parameters of the converter circuits with different loads.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Relate the theoretical concepts to the experiment	1,2,3	5	4
CO-2	Choose and use appropriate equipment's, tools and procedures for the execution of the experiment	5		4
CO-3	Design and conduct the experiments and infer results	3	5	4
CO-4	Committed to professional ethics, self-learning, punctual and confident	8,9,12	5	4
CO-5	Neat representation of the experiment in oral and written form	10	5	4

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
Mapping Level	3.0	3.0	3.0	1.0	2.2			3.0	3.0	3.0		3.0			

Prerequisites: Power Electronics.

Contents: Minimum of 10 experiments to be conducted from the list given below.

Prescribed Experiments:

1) Static Characteristics of SCR and MOSFET.
2) SCR turn-off circuits using (i) LC Circuit(ii) Auxiliary Commutation.
3) Synchronized UJT firing circuit for HWR circuits.
4) AC voltage controller using Triac – Diac combination.
5) Single phase FWR with R and RL loads.
6) Simulation of Chopper using MOSFET in MATLAB.

7) Voltage (Impulse) commutated chopper – both constant frequency and variable frequency operations.
8) Speed control of a separately excited DC motor.
9) Speed control of single-phase induction motor.
10) Parallel/Series Inverters.
11) Generation of firing pulses using TL494 IC.
12) Simulation of single phase full bridge inverter using MATLAB.

Reference Books:

1) Lab. Manual.
2) M. H. Rashid, "Power Electronics", 3/e, Prentice Hall of India Pvt. Ltd, Pearson, 1988.
3) G. K. Dubey, S. R. Doradla, A Joshi & Sinha, "Thyristorised Power Controllers", New Age International (P) Ltd., Publishers, 2003.

21UAEE541 Power Electronics (2 - 0 - 0) 2

Contact Hours: 26

Course Learning Objectives (CLOs):

The students are expected to learn the concept of Power Electronics and different types of switching devices, their control, performance characteristics & applications. They also learn about the principle of commutation of SCRs, the working principles of AC-AC, AC-DC, DC-DC and DC-AC converters and to analyze the working of various types of converter circuits with different types of loads connected across them.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Describe the basics and significance of Power Electronics with the important devices &circuits.	1		
CO-2	Analyze the performance and protection aspects of power MOSFET and IGBT.	1,2		

CO-3	Describe the performance of SCR and its firing circuits.	1,2		
CO-4	Carry out performance analysis of AC Voltage Controllers.	1,2		
CO-5	Carry out performance analysis of DC Choppers.	1,2		
CO-6	Carry out performance analysis of 1-phase & 3-phase Controlled Rectifiers.	1,2		
CO-7	Carry out performance analysis of1-phase & 3-phase inverters and explain PWM technique and CSI.	1,2		

Prerequisites: 1. Basic Electronics

PO's	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -1	PSO -2	PSO -3
Mapping Level	3.0	3.0													

Contents:

Unit-I

Introduction: Types of Power Electronic circuits; Important Power semiconductor devices and their control characteristics; Applications of Power Electronics;

Power Transistors: Power MOSFET and Power IGBT: Switching characteristics; **05 Hrs.**

Unit-II

Thyristors: SCR: Working; Characteristics; Firing circuits and commutation circuits. **05 Hrs.**

Unit-III

AC Voltage Controllers: Single-phase bi-directional controllers with R, R-L loads; Principle of working Cycloconverter.

DC Choppers: Step-down chopper: Principle of operation; Applications. Step-up chopper: Principle of operation; Analysis **06 Hrs.**

Unit-IV

Controlled Rectifiers: Principle of operation of controlled rectifier; Performance of Single-phase semi converters and full converters. **05 Hrs.**

Unit-V

Inverters: Single phase inverters: Bridge configuration; Principle of operation; Performance parameters; Current Source Inverter: Working; Applications. **05 Hrs.**

Reference Books:

1) M. H. Rashid “Power Electronics”, 3/e, Prentice Hall of India Pvt. Ltd, Pearson, 2009.
2) G. K. Dubey, S. R. Doradla, A Joshi &Sinha ”Thyristorised Power Controllers”, 2/e, New Age International (P) Ltd., Publishers, 2003.
3) M. D. Singh and Khanchandani K. B. Power Electronics, 2/e TMH, 2001.
4) Daniel W. Hart “Power Electronics”,1/e, McGraw-Hill, 2011.
5) P. C. Sen–“Power Electronics”,1/e, Tata McGraw-Hill Education, 1987.

21UEEL505	Minor Project-1	(0-0-2) 1

Contact Hours: 24

Course Learning Objectives (CLOs):

Minor project – 1 is undertaken to focus on the domain related problem definitions, building prototypes which can lead to take up the project in the higher semester(s). The work based on the core courses studied shall be used to formulate the problem. The team consisting of 6-8 students shall be asked to identify the problems related to community and try to propose a solution. The faculty members handling the courses for that semester along with other faculty members shall guide the students.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO’s(1 to 12)/PSO’s(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the domain related problem and formulate a problem statement	6		9
CO-2	Propose the technical approach towards the solution.	11	4	9
CO-3	Implement the solution.	4	11	9,10
CO-4	Prepare the report in a specified format.	10		9

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level				2.5		3.0			1.0	2.0	2.5				

Contents:

Domain related problems, Technical solutions, and recommendations.

Evaluation and rubrics:

A committee consisting of minimum 3 faculty members shall evaluate for CIE at the end considering the parameters such as problem definition and its relevance, depth of knowledge, work carried out, quality of the report, Presentation & communication and interaction (questions and answers) with preferably equal weightage to all parameters. However, the departments can have little flexibility in the rubrics to be used based on the suitability. The students are required to submit a report on the project carried out. There is no SEE for Minor project-1.

21UEEL506	Internship-I	2 Weeks

Internship-I (Intra College): The students are required to undergo internship in any of the relevant department including Centre of excellences & incubation centers in the college for a period of minimum two weeks in vacation between IV and V semesters to get an exposure to the Engineering establishment and activities of the other departments. The students are required to prepare a report on the internship-I undergone.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to PO's (1 to12)/ PSO's (1 to 3)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Know the industrial environment.	1,10	7, 9,11	6,12
CO-2	Acquire knowledge and skill to use in professional career.	1	2, 4, 5	3
CO-3	Acquire the ability of report preparation and presentation skills.	8,10		

CO-4	Follow the code of practice in Electrical & Electronics Engineering related activities.	1		6, 8

PO's	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -1	PSO -2	PS O-3
Mapping Level	3.0	2.0	1.0	2.0	2.0	1.0	2.0	2.0	2.0	3.0	2.0	1.0			

Prerequisites: Knowledge of both theory and practical courses learnt in all the previous Semesters and relevant value-added information.

Evaluation and rubrics: A faculty shall guide and monitor the internship activity of a batch consisting of 4 to 6 students. A committee consisting of two faculty members shall evaluate the internship work considering the parameters such as nature and extent of exposure, understanding, report preparation, presentation, knowledge gained etc. There is no SEE for internship – I. The performance shall be communicated to the CoE office at the end of V semester and shall reflect in V semester grade card.

VI Semester

21UEEC600	Power System Analysis and Stability	(3 - 0- 0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn the importance of per unit computation. How to draw per unit diagram of a given power system. How to analyze symmetrical three phase short circuit on an unloaded synchronous generator. How the circuit breakers are rated? About the symmetrical components of currents and voltages. How to analyze the unsymmetrical faults in a power system. About the steady state & transient stability analysis of power system.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to PO's(1 to 12)/PSO's(1 to 3)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Describe the basics of power system and compute per unit representation.	1,2		
CO-2	Analyze symmetrical faults.	1,2		
CO-3	Describe concepts of symmetrical components & sequence network and solve related numerical.	1,2		
CO-4	Analyze unsymmetrical faults.	1,2		
CO- 5	Analyze steady state and transient stability.	1,2		

PO's	PO -1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO - 1	PSO - 2	PSO - 3
Mapping Level	3.0	3.0													

Prerequisites:

1.Network Analysis
2.Switchgear and Protection
3.Electrical Power Generation & Transmission
4. Electrical Machines.

Contents:

Unit-I

Representation of Power system Components: Standard symbols of power system components, one line diagram, impedance, and reactance diagram, per unit quantity-definition, per-unit impedance of three phase components, selection of base value, change of base, equivalent load impedance, per unit impedance of two- winding transformer referred to primary and secondary, method to draw p. u. impedance diagram of a power system and advantages of p. u. computations. **08 Hrs.**

Unit-II

Symmetrical 3 - Phase faults:3-phase short circuit at the terminals of unloaded generator, definition of sub- transient, transient and steady state reactance, examples on sub- transient current calculations in unloaded power systems, internal emfs of loaded machines, selection of circuit breaker ratings-momentary current and interrupting capacity. **07 Hrs.**

Unit-III

Symmetrical components: Definition of symmetrical components as applied to 3-phase unbalanced systems, operator 'a' and its properties, resolution of unbalanced phasors into their symmetrical components. Expressions for sequence components, examples on calculations of symmetrical components of unbalanced load against balanced 3-phase supply. Phase shift of symmetrical components in star-delta transformer bank, Power in terms of symmetrical components.

Sequence Networks: Sequence impedances and sequence networks. Sequence impedance of power system elements, positive, negative and zero sequence networks of 3-phase generator, transmission lines, 3-phase loads, and transformers**.** **09 Hrs.**

Unit-IV

Unsymmetrical faults: L-G, L-L, L-L-G faults on an unloaded alternator without and with fault impedance, Derivation of connection of sequence networks, Unsymmetrical faults on power system without and with fault impedance, Derivation of connection of sequence networks, examples on calculation of unsymmetrical fault currents. **08 Hrs.**

Unit-V

Power System Stability: Definition of Steady state stability – Transient state stability, Stability limits, Assumptions made in Transient Stability studies, classification, power angle equation, swing equation, synchronizing power co-efficient, equal area criterion (EAC) of stability and EAC applications, numerical problems, factors affecting transient stability and recent trends. **07 Hrs.**

Reference Books:

1) W. D. Stevenson, "Elements of Power System Analysis", 4/e, TMH, 1982.
2) I. J. Nagrath and D. P. Kothari, "Modern Power System Analysis", 4th Edition, TMH, 2011.

3) Hadi Saadat, "Power System Analysis", 2nd Edition, TMH, 2005.
4) Stag, G. W., and EI-Abiad A. H., "Computer Methods in Power System Analysis", International Student Edition, McGraw Hill, 1988.
5) P .M. Chandrashekaraiah, "Power System Analysis and Stability", First Edition, 2009.
6)V. Neelakantan "Power System Analysis and Stability", First Edition, 2002.

21UEEC601 High Voltage Engineering, Switchgear & Protection (2–2–0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn the advantages high voltage systems, applications and generation of high voltages. They will learn different methods of measuring high voltages, breakdown mechanism in dielectrics. They are also expected to learn need for protection, different types of relays and circuit breakers,

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Classify high voltage systems and describe applications.	1		
CO-2	Explain different types of generation of and demonstrate different methods of measuring HVAC and HVDC.	1, 2		
CO-3	Explain the different breakdown phenomenon occurring in dielectrics and describe the need for protection of power system.	1, 2		
CO-4	Explain arcing in CBs, importance of arcing, arc quenching theories and types of circuit breakers	1, 2		

CO-5	Describe and analyze different types of relays.	1, 2		

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	3.0	3.0													

Prerequisites: 1.Electrical Power Distribution & Utilization
2. Electrical Measurements

Contents:

Unit-I

HV Systems: Classification, important applications of high voltage.
Generation of HV for testing: HVDC: voltage doubler circuit, Cockcroft-Walton type. Calculation of percentage voltage regulation, percentage ripple and optimum number of stages, examples. HVAC:HV transformer - working of transformer connected in cascade. Series resonant circuit. Tesla coil.

06+02T Hrs.

Unit-II

Generation of Impulse Voltage and Current: Introduction to standard lightning and switching impulse voltages, Analysis of single stage impulse generator, Multistage impulse generator working of Marx impulse generator and components. Generation of switching impulse voltage and high impulse current.

Measurement of high voltages: Measurement of Voltage and currents using voltage divider, current shunt, rogowski coils. Standard sphere gap measurements Electrostatic voltmeter-principle & construction. Generating voltmeter- Principle of operation & construction. Series resistance micro ammeter **06+02T Hrs.**

Unit–III

Breakdown phenomena: Classification and Properties of HV insulating media. Gaseous dielectrics, Ionizations, primary and secondary ionization processes. Townsend's theory, Streamer's theory. Corona discharges. Expression for disruptive and visual critical voltages and corona power loss. Breakdown in electro negative gases. Panchen's law.
Power system protection: Principles, Block diagram of power system protection, Switchgears, Zones of protection, Requirement of good protection system, Types of protection schemes, Power transformer protection.

06+02T Hrs.

Unit-IV.

Circuit breakers: Initiation, maintenance and interruption of arc, arc interruption theories, arc chopping. problems encountered in DC circuit breaking. Rating of CBs. Air break and Air blast CBs, Bulk oil & minimum oil CBs, SF6 CBs, vacuum CB voltage, restriking voltage and recovery voltage, resistance switching, current characteristics, HVDC CBs. **06+02T Hrs.**

Unit-V

Relays: Relay settings, Torque equations and characteristics of Over current relay, Directional over current relay, Differential relay, Percentage differential relay, Impedance relay, Mho relay. **05+02T Hrs.**

Reference Books:

1) E. Kuffel and W. S. Zaengl, "High voltage engineering fundamentals", 2/e, Elsevier, press, 2005.
2) M. S. Naidu and Kamaraju, "High Voltage Engineering", 3/e, THM, 2007.
3) C. L. Wadhwa, "High voltage engineering", New Age International Private limited, 1995.
4) Sunil S. Rao–"Switch Gear & Protection", 1/e, Khanna Publication, 2004.
5) Ravindranath & Chander - Power System Protection & Switch Gear, New Age Publications, 2005.
6) Chakraborthy, Soni, Gupta &Bhatnagar–"A Course in Electrical Power",3/e, Dhanapat Rai Publication, 1999

21UEEC602	Digital Signal Processing	(3- 0 - 0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn to analyze sampled data, compare DFT and FFT algorithms in terms of computation burden and memory requirement. Further, they learn to design IIR filters, FIR filters, make use of IIR and FIR filters for different Applications, realize filters in different forms and about the Architecture and capabilities of DSP.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to exhibit :		**Mapping to PO's(1 to12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Computation of DFT, IDFT by direct method. Application of properties. Computation of circular and linear convolution.	2		
CO-2	Computation of DFT, IDFT using DIT and DIF algorithms. Comparison of algorithms with direct method with direct method.	2		

CO-3	Realization of digital systems.	2		
CO-4	Design IIR filters for given specifications.	3		
CO-5	Design FIR filters for given specifications. Architecture of Fixed point and floating-point Digital signal processors and their applications.	3		

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level		3.0	3.0												

Prerequisites: 1. Engineering Mathematics 2. Signal and Systems 3. Network Analysis

Contents:

Unit-I

Discrete Fourier transforms (DFT) and its properties-linearity, shift and symmetry etc., circular convolution-periodic convolution, use of tabular arrays, circular arrays, stock ham's methods, linear convolution-two finite duration sequences, one finite & one infinite duration. **08 Hrs.**

Unit-II

Fast Fourier transforms (FFT) algorithm: Decimation in time algorithm, decomposition, number of computations, continuation of decomposition, number of multiplications, computational efficiency, decimation in frequency algorithm. **08 Hrs.**

Unit-III

Realization of digital systems using block diagrams & SFGs, matrix representation, realization of IIR systems-direct form, cascade form, parallel form, realization of FIR systems-direct form, cascade form, linear phase realizations. **08 Hrs.**

Unit-IV

Design of IIR Digital filters by Impulse Invariant & Bilinear Transformations, all pole analog filters – Butterworth &Chebyshev, design of digital Butterworth & Chebyshev filters, frequency transformations. **08 Hrs.**

Unit-V

Design of FIR Digital filters by using rectangular, modified rectangular, Hamm, Hamming, generalized hamming windows, Kaiser window, frequency sampling technique. Fixed and floating DSP processors and their applications.

07 Hrs.

Reference Books:

1) Proakis - Digital Signal Processing: Principle, Algorithms and Applications, 4/e, Pearson Education, PHI, 2007.
2) Oppenheim - Digital Signal Processing, 2/e, Pearson Education, PHI, 2008.
3) Salivahanan, Vallavaraj, Gnanapriya - Digital Signal Processing,2/e TMH,
4) Ifeachor & Jervis - Digital Signal Processing,3/e Pearson Education, 2004.
5) A Nagoorkani, “Digital Signal Processing”,2/e Tata McGraw Hill Education Pvt. Ltd,2013.

21UEEE611 Computer Communication and Networking (3 - 0 - 0) 3

Contact Hours:39

Course Learning Objectives (CLOs):

The students are expected to learn about the interconnection of autonomous computers making reference to OSI and TCP/IP reference models. The students will understand the need of stack of layers from physical through application layer, their design issues, functions, and significance. They are expected to know different LAN structures, MAN, WAN and Internet. They will also be aware of blue tooth, wireless LAN etc.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO’s(1 to 12)/PSO’s(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Recite the basics of computer networks, reference models and standardization of networks.	3		
CO-2	Describe the design issues such as timing, electrical, mechanical specifications at physical layer, switching techniques and transmission media.	3	4	
CO-3	Explain Data link layer design issues, medium access, data link protocols including CSMA/ CD and CSMA/CA	3	4	5

	protocols, LAN protocols & specifications &verification of protocols.			
CO-4	Explain Network layer design issues such as Routing, congestion control algorithms and Internet working .	3	4	5
CO-5	Describe design issues and protocols of transport, presentation and Application layers.	3	4	

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-13	PSO-14
Mapping Level			3.0	2.0	1.0									

Prerequisites: 1. Digital Electronics 2. A course on Basic communication

Contents:

Unit-I

Introduction: Uses of computer network, network structure, the OSI reference model. The TCP/IP reference model, services, network standardization. **08 Hrs.**

Unit-II

The Physical layer: Transmission and switching, Frequency and time division multiplexing, circuit switching, packet switching, Hybrid switching. **07 Hrs.**

Unit-III

The medium access sub layer: The local and metropolitan area networks, the protocols, LAN protocols, IEEE standard 802 for LAN, fiber optic networks, satellite networks, packet radio networks. The data link layer: Elementary data link protocols- sliding window protocols, protocols specifications and verifications. **09 Hrs.**

Unit-IV

The network layer: Network layer design issues. Routing algorithms, congestion control algorithms. Internet working, network layer in the internet and ATM networks**.** **08 Hrs.**

Unit-V

The transport, presentation, and application layers: Design issues & protocols. **07 Hrs.**

Reference Books:

1) Tanenbaum,"Computer Networks", 3/e edition PHI 1993
2) Farozan, "Data Communication"1/e, Huga Media, 2007
3) W Stalling, "Data and Computer Communications", 1/e, PHI. 2007
4) Micheal A, "Computer Communications and Network Technologies", 2/e, Hancock, Thomson Publications, 2003.

21UEEE612 Data Structures and Algorithm (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn basic features of programming language, a abstract data types and its use in solving given any problem. They will be learning how to use of data structures in application development. They are exposed to standard algorithms and analysis.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain different features of programming language in C & C++.	1	2	
CO-2	Code to implement stack and operations of stack using arrays and pointers.	5	2	
CO-3	Code to implement Queues and tree using arrays and pointers.	5	2	
CO-4	Explain the operations of searching and sorting techniques using code	5	2	
CO-5	Design an algorithm for different optimization techniques and applications.	5	2	

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
Mapping Level	3.0	2.0			3.0										

Prerequisites: Programming experience in C/C++.

Contents:

Unit-I

Basic Programming Features: Data types, Memory allocation, arrays, structures, unions, pointers, recursion, and file operations**.** **08 Hrs.**

Unit-II

Abstract Data Types: Conceptualization. Implementation of operations on Stack including display and searching using arrays and pointers (Linked List)

08 Hrs.

Unit-III

Implementation of: Queues, Circular queues, Double Ended Queue, Priority Queue and Trees using arrays and pointers(Linked List). **08 Hrs.**

Unit-IV

Searching and Sorting Techniques: Conceptualization, Implementation of: Linear and Binary search, Hashing, sorting techniques: bubble sort, insertion sort, selection sort, quick sort, merge sort, heap sort. **08 Hrs.**

Unit-V

Algorithm Design: Divide and Conquer method and applications (Max-Mm), Greedy strategy method and applications (Job sequencing, Optimal merge patterns), Dynamic Programming method and applications (Multistage graphs, travelling sales problem), Backtracking method and applications (Sum of sets) Branch and Bound method & applications (Travelling Sales problem). **07 Hrs.**

Reference Books:

1) Yedidyah, Augenstein and Tenenbaum, “Data Structures Using C and C++’,2/e, PHI- India,2011.
2) E. Balagurusamy, “Programming in ANSI C”, 4/e, Tata McGraw-Hill.
3) Sartaj Sahni, “Data Structures, Algorithms and Application in C++”, 2/e, University Press, 2005.
4) Thomas H Coreman, Charles E Leiserson& Ronald L Rivest, “Introduction to Algorithms”, 1/e, Prentice Hall of India, August 2000.
5) Adam Drozdek, “Data Structures & Algorithms in C++”, 2/e, Vikas Publishing House, 2004.

21UEEE613	Internet of Things (IoT)	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn the basic concept of Internet of things, its general architecture, technology, and the design principles behind it. The students are required to get exposure to the handling of data and understand the concept of cloud paradigm being used in IoT environment. Students are also required to understand the role of sensors in IoT and the basics of embedded computing besides understanding certain case studies on IoT application.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Describe the fundamental concept of IoT, design principles and different communication technologies used in IoT paradigm.	1,5		
CO-2	Recite the different data handling protocols and aspects of cloud computing as applicable to IoT.	1,5		2,3
CO-3	Explain the different types of sensors and the data communication protocols for these sensors as applicable to IoT.	1,5		2,3
CO-4	Select a suitable embedded platform for the IoT application.	1,5		2,3
CO-5	Analyze the smart grid technology and different other case studies based on IoT applications.	2		

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	3.0	1.5	1.0		3.0	3.0									

Prerequisites:1.Any one basic programming language 2. Digital Electronics
3. Microcontrollers

Contents:

Unit-I

Overview of IoT: Definitions, vision, smart and hyper connected devices. IoT conceptual framework, IoT architectural view. Technology behind IoT, major components of IoT system, sources of IoT. M2M communication

Design principles for connected devices: Introduction, systems, layers, and design standardization modified OSI model for IoT. ITU-T reference model.

Communication technology: Wireless communication technology, RFID, ZigBee IP, Wi-Fi, Wired communication technology, Comparison of communication technologies. **08 Hrs.**

Unit-II

Data handling and Cloud computing paradigm: Introduction to internet-based communication, protocols, version 4 and 6, TCP IP suite, IP addressing in IoT.

Data handling: Introduction, data acquiring and storage, organizing data, data analytics.

Cloud computing: Introduction, computing methods, deployment methods, everything as a service, service models, services using Nimbits, public platforms. **08 Hrs.**

Unit-III

Sensors and network: Sensor technology, analog and digital sensors, examples, sensing the things-barcodes, QR codes, motion sensors, pressure sensors, environmental monitoring sensors, participatory sensing, industrial IoT, actuators.

Data communication protocols for sensors: RFID technology-Principle, design challenges, wireless sensor networks technology. **08 Hrs.**

Unit-IV

Embedded computing basics: Embedded software and hardware units, embedded platform for prototyping-Arduino, Intel Galileo, Intel Edison, Raspberry Pi, Beagle bone, things always connected to the cloud. Prototyping embedded device software, Devices, gateways, Internet, and web/cloud services **08 Hrs.**

Unit-V

IoT applications and Case studies: Introduction to smart grid and a possible IoT based smart grid, Smart home, smart cities, Street light control and monitoring. **07 Hrs.**

Reference books:

1) Internet of Things, Architecture and design principles, Raj Kamal, McGraw Hill Publication, 2017
2) David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome
3) Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
4) Srinivasa K G, "Internet of Things", CENGAGE Leaning India, 2017
5) Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014. (ISBN: 978-8173719547)

21UEEE614 Object Oriented Programming (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

Define Encapsulation, Inheritance and Polymorphism. Solve the problem with object-oriented approach. Analyze the problem statement and build object-oriented system model. Describe the characters and behavior of the objects that comprise a system. Explain function overloading, operator overloading and virtual functions. Discuss the advantages of object-oriented programming over procedure oriented programming.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the basics of Object-Oriented Programming concepts	1,2		
CO-2	Use the concepts of Functions, Classes, and Objects	2	1,5	

CO-3	Describe the concept of Constructors, Destructors and Operator Overloading	2	1,5	
CO-4	Effectively use concept of functions and abstract class in programs.	2,5	1	
CO-5	Utilize I/O operations and file streams in programs.	2,5	1	

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	2.2	3.0			2.25										

Prerequisites: C Programming

Contents:

Unit-I

Beginning with C++ and its Features: What is C++?, Applications and structure of C++ program, Different Data types, Variables, Different Operators, expressions, operator overloading and control structures in C++ . **08 Hrs.**

Unit-II

Functions, Classes and Objects: Functions, Inline function, function overloading, friend and virtual functions, Specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, array of objects, members, pointers to members and member functions. **08 Hrs.**

Unit-III

Constructors, Destructors and Operator Overloading: Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, Defining operator overloading, Overloading Unary and binary operators, Manipulation of strings using operators. **08 Hrs.**

Unit-IV

Inheritance, Pointers, Virtual Functions, Polymorphism: Derived Classes, Single, multilevel, multiple inheritance, Pointers to objects and derived classes, this pointer, Virtual and pure virtual functions. **08 Hrs.**

Unit-V

Streams and Working with Files: C++ streams and stream classes, formatted and unformatted I/O operations, Output with manipulators, Classes for file stream operations, opening and closing a file, EOF. **07 Hrs.**

Reference Books:

1) Object Oriented Programming with C++ E. Balaguruswamy, TMHTMH 6thEdition, 2013
2) Object Oriented Programming with C++ Robert Lafore Galgotia publication 2010
3) Object Oriented Programming with C++ Sourav Sahay Oxford University 2006.

21UEEE621 Energy Auditing and Demand Side Management (3 - 0 - 0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

Students are expected to be aware of the current energy scenario, significance of energy management and conservation. The students are required to know the need for energy auditing and the procedure to carry out the same. The students are expected to apply the knowledge of different components of electrical system in the context of energy efficiency. They are also to be aware of energy efficient technologies.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Know about energy scenario and salient aspects of Electricity and Energy Conservation Acts.	1		
CO-2	Carry out, prepare report, and present orally a case study/project work relating to energy audit/ energy conservation demand side management.	11		
CO-3	Analyze energy related economic issues and be able to solve related numerical.	2		
CO-4	Know about energy auditing, different methods, preparing audit report and measurement of related parameters.	2, 5		

CO-5	Know about analysis of PF and its improvement, Energy efficient motor, efficient illumination, and tariff structure.	2		
CO-6	Know about Demand Side Management, Different techniques, preparing audit report and measurement of related parameters, Energy Conservation Awareness Programs	2, 5		

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	3.0	3.0			3.0						3.0				

Contents:

Unit-I

Introduction: Global and Indian Energy scenario; Energy consumption and conservation aspects. Electricity Act 2003. Energy Conservation Act 2001.
Case study /Project. Initiate a case study/project relating to energy audit/energy conservation/demand side management. This is to progress across the semester and to be completed by the end of the semester with proper reporting and presentation. **09 Hrs.**

Unit-II

Energy Economic Analysis: Payback analysis; The concept of "time value of money"; Internal Rate of Return; Cash flow models; Depreciation, Numerical. **07 Hrs.**

Unit-III

Energy Auditing: Introduction; Elements of energy audits; Energy use profiles; Measurements in energy audits; Presentation of energy audit results. **08 Hrs.**

Unit-IV

Power factor and Electrical Equipment: Power factor correction; Location of capacitors. Energy efficient motors. Lighting basics and efficient illumination approaches. Electric tariff; Factors affecting tariff. Numerical. **07 Hrs.**

Unit-V

Demand Side Management: Concept of DSM; Benefits of DSM; Different Techniques of DSM. Different approaches for load management: Time of day pricing; Availability based tariff; Strategic conservation; Energy efficient equipment. Management and organization of Energy Conservation Awareness Programs. **08 Hrs.**

Reference Books:

1) "General Aspects of Energy Management 2nd Energy Audit", Bureau of Energy Efficiency, New Delhi, Fourth Edition-2015
2) "Energy Efficiency in Electric Utilities", Bureau of Energy Efficiency, New Delhi,FourthEdition-2015
3) D. P. Sen Gupta, K. R. Padiyar, Indranil Sen, M.A. “Recent Advances in Control and Management of Energy Systems”, Interline Publishers, Bangalore, 1993.
4) Munasinghe, Mohan Desai, Ashok V –“Energy Demand: Analysis, Management and Conservation”, Wiley Eastern Ltd., New Delhi, 1990.
5) Jyothi Prakash, "Demand Side Management", TMH Publishers, 1/e, 1997.

21UEEE622 Electrical Estimation Specification Codes and Practices (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are required to learn and practice specifications, significance of specifications, power installations, industrial wiring, load calculations and estimation of wiring schemes. Further, they will come to know about costing, calculation of depreciation and valuation of machinery, materials, and goods.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO’s(1 to 12)/PSO’s(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the significance of specifications, relevant IE rules and estimate installation of wiring.	1,2	6	11
CO-2	Describe the procedure to estimate Load, select wire size and wiring materials for power installations.	1		
CO-3	Estimate Load, select wire size and wiring materials for pump, workshop & heater installations.	2,3		1

CO-4	Estimate Load and select transformers for HT and LT consumers.	3	1,2	
CO-5	Carry out cost benefit analysis.	2,11		

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	2.25	2.25	3.0			2.0					2.0				

Prerequisites: 1. Electrical Machines 2. Electrical Drawing
3. Electrical Power Distribution and Utilization

Contents:

Unit-I

Introduction: Significance of specifications, relevant Indian Electricity rules. **Interior wiring system:** Wiring system, earthing, estimation of wiring installation. **07 Hrs.**

Unit-II

Motor Installation: Load calculation, wire size selection, power circuit wiring material used and the estimate for motor installation. **08 Hrs.**

Unit-III

Pump Installation: Load calculation, wire size selection, power circuit wiring Material used and the estimate for pump set, workshop, heater etc. **08 Hrs.**

Unit-IV

Distribution Substation: Estimation of Load, capacity of transformer for LT and HT consumers, selection of transformers materials and accessories required. **09 Hrs.**

Unit-V

Depreciation and valuation of machinery, Inventory, Economic order quantity, break even analysis. **Costing:** need for costing and types of costing. **07 Hrs.**

Reference Books:

1) S.S. Chatterjee, Introduction to management, 1/e, World Press, 1962.
2) N. Narasimhaswamy, Engineering economics and management. 2/e, Dynaram Publications, 1990.
3) T.R. Banga& S.C. Sharma, "Industrial organization and engineering economics"1/e, 2003.
4) Raghavendra Rao, "Electrical Estimation Specification & Costing", 1/e, Sapna, 2002.

21UEEE623	ARM Processor	(3- 0 - 0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

To learn fundamentals of ARM architecture and ARM embedded systems. To acquire and develop logical and Assembly Programming skills. To understand about the interrupt structure in ARM and Embedded Operating system.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's (1 to12)/ PSO's (1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Recite the fundamentals of ARM architecture and embedded system.	1		
CO-2	Illustrate ARM instruction set.	1, 2	5	
CO-3	Demonstrate ARM and Thumb instructions usage and synthesize simple programs using Arm/Thumb instructions.	5	1, 2	
CO-4	Describe interrupt structure & handling, and discuss fundamentals of embedded operating system	1, 2		
CO-5	Analyse C programs to compile on ARM architecture.	3, 5		

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
Mapping Level	2.75	2.67	3.0		2.67										

Prerequisites: Microcontrollers

Contents:

Unit-I

ARM Embedded System: The RISC Design Philosophy, ARM Design Philosophy, Embedded System Hardware, and Software.
ARM Processor Fundamentals: Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Assembler directives viz AREA, DCB, DCW, DCD. EQU, ENTRY, ALIGN, END. **08 Hrs.**

Unit-II

Introduction to the ARM Instruction Set: Data Processing Instructions, Branch Instructions, Load-Store Instructions, Software Interrupt Instruction, Program Status Register Instructions, Single word and unsigned byte data transfer instructions, Half-word and signed byte data transfer instructions Loading constant, Conditional Execution. **08 Hrs.**

Unit-III

Introduction to the Thumb Instruction Set: Thumb programmer's model**,** Thumb Register Usage, ARM-Thumb Interworking, Thumb other Branch Instructions and SWI instruction, Data Processing Instructions, Single-Register Load-Store Instructions, Multiple-Register Load-Store Instructions, Stack Instructions, Software Interrupt Instruction.

Programming using ARM and Thumb Instructions: Programming examples using ARM and Thumb, SWI, Arithmetic and logical examples. **08 Hrs.**

Unit-IV

Exception and Interrupt Handling: Exception Handling Interrupts, Interrupt Handling Schemes Viz. Non-nested, Nested.

Embedded Operating Systems: Fundamental Components, Example: Simple Little Operating System. **08 Hrs.**

Unit-V

Efficient C programming: Basic C data types, C looping structures, allocation, C function calls, Pointer aliasing, structure arrangement, Inline functions and assembly, Bit fields Portability issues. **07 Hrs.**

Reference Books:

1) Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing Optimizing System Software",2/e, Morgan Kaufmann, 2004.
2) Steve Furber, "ARM System-on-Chip Architecture", 2/e, Pearson Education,2000.
3) ARM Assembly Language fundamentals and Techniques, Fourth Impression2013, by William Hohl, (CRC press).

21UEEE624	VLSI Circuits	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to recall the basics of microelectronics. Furner to know the electrical properties of different devices at different operating conditions. They are to learn regarding basics circuit concepts, scaling of MOS circuits and sub system design. They are to learn the VLSI circuit design concepts and use of CAD tools. They will also be aware of special purpose sub systems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Describe the concepts of MOS family & fabrication and Analyze basic electrical properties.	1, 2		
CO-2	Explain the concepts of pull-up, Bi-CMOS inverters, latch up in CMOS circuits and Illustrate VLSI design rules for n-MOS & CMOS circuits.	1		
CO-3	Apply the concept of sheet resistance and area capacitance to VLSI circuits design and comprehend the concept of scaling the device parameters	3	1, 2	
CO-4	Demonstrate VLSI sub system design and synthesize VLSI circuits using basic components.	3, 5	1, 2, PSO-3	
CO-5	Learn clock distribution, concept of L di/dt noise; Understand TG and CPL logic used in VLSI circuits.	5		1, 2, 3

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
Mapping Level	2.2	2.0	2.33		3.0										2.0

Prerequisites:1 Digital Electronics. 2. HDL (preferred)

Contents:

Unit-I

Review of Microelectronics: MOS family and fabrication technology, Production of E-beam masks.

Basic Electrical properties of MOS: Drain to source current Id versus V_{ds} relationships, MOS g_m derivation, pass transistor, n-MOS Inverter, Pull-up to Pull-down ratio of inverter. **06 Hrs.**

Unit-II

Forms of pull-up and Bi-CMOS inverter: Resistance pull-up, n-MOS depletion pull-up, n-MOS enhancement pull-up, CMOS pull-up; CMOS inverter, Bipolar and CMOS parameters comparison, Bi-CMOS inverters, latch up in CMOS.

MOS and Bi-CMOS circuit design processes: Stick diagrams, n-MOS and CMOS-design rules, Double metal process, CMOS λ based rules, Micron rules, Lay-outs. **09 Hrs.**

Unit-III

Basic circuit concepts: Sheet resistance concept, Silicide, Area capacitance Delay concept, Inverter delay, rise and fall time derivation of CMOS inverter, cascaded drivers, super buffers, Bi-CMOS drivers, Propagation delays, wiring capacitances, Numerical.

Scaling of MOS circuits: Scaling model and scaling factors for device parameters, Limitations of scaling, Limit due to current density. **09 Hrs.**

Unit-IV

Subsystem design and layout: Some architecture issues, Switch logic, Gate logic, other forms of CMOS logic; Structured design: parity generator, bus arbitration logic, Multiplexers, Gray to Binary code conversion; Clocked sequential circuit, Other system consideration. **08 Hrs.**

Unit-V

Special purpose subsystems: Power distribution - On chip clock distribution network, IR drops, Ldi / dt noise, chip bypass capacitance; I/O – Basic I/O pad circuits, CPL, CMOS with TG circuits. **07 Hrs.**

Reference Books:

1) Pucknell, Eshraghian, “Basic VLSI design”-3/e PHI1985.
2) Kang Leblebici, “CMOS Digital integrated circuits” ,4/e, Tata McGraw-Hill publication, 2014
3) David Harrison, Neil Weiste, Banerjee, “CMOS VLSI Design” 3/e, Pearson publication, 2011.

4) Yuan Taun Tak HNing, “Fundamentals of Modern VLSI Devices”, Cambridge Press, South Asia Edition, 2003.

21UEEO641 Digital System Design using HDL (3– 0 – 0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to know the need for HDL, history of HDL development and capabilities of VHDL. They are required to learn the basic elements of the language, different styles of modeling used in VHDL. Further, they learn design and develop the code for combinational, sequential circuits, and Programmable Logic Devices.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO’s(1 to 12)/PSO’s(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Recite the need, evolution and capabilities of HDL, basic elements of the language, code structure and styles of modeling	3		
CO-2	Design simple systems and write the code using concurrent statements	5		12
CO-3	Design simple systems and write the code using sequential statements	5		12
CO-4	Write the code using structural style and create package	5		12
CO-5	Write the functions & procedures and write the code for simple PLDs.	5		12

PO’s	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
Mapping Level			3.0		3.0							1.0			

Prerequisites: 1. Digital Electronics.

Contents:

Unit-I

Introduction: Need for HDL, evolution of VHDL and capabilities of the language. Code structure: Fundamental building blocks; library, entity, architecture, package declaration, and package body.
Basic Elements of the Language: Object types: signal, variable, constants. Data types- Scalar, composite, access, and file types & sub types. VHDL operators, Generics, and attributes. **08 Hrs.**

Unit-II

Concurrent Code: Concurrent statements: operators, WHEN/ELSE, WITH select WHEN, simple BLOCK and Guarded BLOCK, GENERATE statements. Inertial delay, transport delay & simulation delta. Example codes for combinational and sequential circuits (Encoder, Mux, Decoder, arithmetic circuits, comparators, ALU, code converters, latches, flip flops, counters, registers etc.) **09 Hrs.**

Unit-III

Sequential Code: structure of Process**,** Sequential statements: BNF of IF, LOOP, CASE, WAIT, ASSERT, NEXT, EXIT, NULL, POSTPONE**.** Example codes for combinational and sequential circuits (Encoder, Mux, Decoder, arithmetic circuits, comparators, ALU, code converters, latches, flip flops, counters, registers etc.). Design and development of state diagram for serial adder, sequence detector, BCD to XS-3 code converter etc. **09 Hrs.**

Unit-IV

Structural Code: components, port map, generic MAPAND examples (Encoder, Mux, Decoder, arithmetic circuits, comparators etc.).
Packages: Package declaration and package body. Simple examples.**07 Hrs.**

Unit-V

Sub programs: Function: syntax, location, and examples. Procedures: syntax, location, and examples.
Introduction PLDs: Basic structure of CPLDs and FPGAs. **06 Hrs.**

Reference Books:

1) Volnei A. Pedroni, ”Circuit Design with VHDL”, Reprinted, EEE, PHI, 2005.
2) Douglas Perry, ”VHDL Programming by examples”, 4/e, TMH, 2005.
3) Bhasker, ”VHDL Primer”, 3/e, Pearson, 2002.
4) C. H. Roth, “Digital System Design using VHDL”, 8th Reprint, Brooks/Cole Publishing, 2008.

21UEEO642	Computer Organization	(3 - 0 - 0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn the basic structure of computers, machine instruction and simple programs. They will also learn the concept of Instruction Set architecture and machine level instructions, use of resources (registers and memory), the relationship between Instruction set architecture, micro architecture, and system architecture and their roles in the development of the computer.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explore the basics of computer architecture and analyze the performance issues of a computer system.	1, 2		
CO-2	Illustrate the usage of machine instructions, addressing methods, memory structure and its operation	1, 2		
CO-3	Explain pipelining and analyze various hazards affecting performance.	1	2	
CO-4	Demonstrate data representation formats and analyze processor performance for arithmetic operations	1, 2		
CO-5	Explain the functions of the processing unit and formulate control signals for instruction execution.	1	2	PSO1

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
Mapping Level	3.0	2.6											1.0		

Prerequisites: Digital Electronics (preferred), Microcontrollers and Microprocessors

Contents:

Unit-I

ALU: Understanding how to represent signed numbers in 2's complement system. Adder Circuit: Half adder, Full adder, Ripple carry/ serial/ slow adder, Carry Look Ahead adder (fast adder), adder/ subtractor circuit.

Multiplication: Complete study of Booth's algorithm with circuit diagram and examples. Division: Learn Restoring and Non Restoring Division with examples.

Floating Point Number Formats: IEEE 754 32 bit and 64 bit formats also called Single/ Double Precision and Short/ Long Real formats

Floating Point Number Conversion Numericals: Numericals on number conversion from decimal/ hex to any floating point format. **08 Hrs.**

Unit-II

Control Unit: Instruction Pipelining: Explanation of multistage pipelining. Pipeline Hazards. Data Dependency. Structural Hazard. Control Hazard.

Addressing Modes: Various addressing modes with examples

Instruction Cycle State Transition Diagram: Explanation of Fetch, decode and Execute stages.

Floating Point Addition Algorithm(ALU): Detailed explanation of FP add/sub algorithm with examples, Floating Point Extreme Cases: NaN, Infinity, Zero, Denormal. **08 Hrs.**

Unit-III

Control Unit: Micro Operations: Micro Operations for Fetch cycle and for various instructions. Hardwired Control Units:State Table Method, Delay Element Method, Sequence Counter Method. Microprogrammed CU | Wilke's Design: Wilke's Design for a microprogrammed control unit. Typical Microprogrammed Control unit: Micro instruction sequencing: Dual address field and Single address field. Horizontal v/s Vertical Microinstructions: Micro Instruction formats: Horizontal and Vertical. Introduction to Nanoprogramming. **08 Hrs.**

Unit-IV

Memory: Cache Memory Mapping Techniques :Fully associative (associative mapping), One way set associative (Direct Mapping), Two way set associative (Set associative mapping). Memory Hierarchy : Explains the need of having several levels of memories in a computer. Paging, Virtual Memory Management. Page Replacement Numericals :Numericals on FIFO, LRU, LFU, OPT page replacement policies. Higher order v/s Lower order Interleaving: Comparison between Higher order and lower order interleaving

Memory Mapped I/O v/s I/O Mapped I/O: With reference to 8085 microprocessor. **08 Hrs.**

Unit-V

I/O system: Bus Arbitration, Contention, Priority Resolving Schemes: Daisy Chaining, Polling, Independent requests

Concept of DMA and DMA transfer techniques:Explains concept of DMA and various DMA transfer techniques like Block transfer, Cycle stealing etc

Interrupts & Interrupt Driven I/O : Study of Interrupts. Understanding the difference between interrupt driven I/O and Programmed I/O. **07 Hrs.**

Reference Books:

1) Carl Hamacher, Z. Vranesic & S Zaky, “Computer Organization”, 5/e, TMH, 2002.
2) Morris Mano, “Computer System Architecture”, 2/e, PHI, 1986.
3) Heuring & H. Jordan, ”Computer System Design & Architecture”, 2/e, Addison- Wesley, 1999

21UEEO643 Renewable Energy System (3 - 0 - 0) 3

Contact Hours:39

Course Learning Objectives(CLOs):

The students are expected to know the world and Indian energy scenario, the energy storage mechanisms. Further, they will be learning the concept of power from solar, wind, biogas, ocean and other renewable energy sources and prevailing technologies.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO’s(1 to 12)/PSO’s(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the significance of renewable energy sources and Energy storage methods.	1,5		2
CO-2	Describe the basics of solar energy and analyze the performance of solar thermal systems.	1,5	2	

CO-3	Analyze the performance of solar Photovoltaic systems with relevant numericals.	1,5	2	
CO-4	Analyze the performance of wind-based power generation with relevant numericals.	1,5	2	
CO-5	Describe the operation of biomass and ocean-based power generation and solves relevant numericals.	1,5	2	

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	3.0	1.8			3.0										

Prerequisites: 1. Basic Electrical engineering
2. Electrical Power Generation &Transmission
3. Electrical Power Distribution & Utilization

Contents:

Unit-I

Fundamentals of Energy Science and Technology: Introduction, Advantages and Disadvantages of Conventional Energy Sources, Salient Features of Non-conventional Energy Sources, Environmental Aspects of Energy, World Energy Status, Energy Scenario in India.

Energy Storage: Introduction, Necessity of Energy Storage, Energy Storage Methods Numericals on flywheel energy storage.

Emerging Technologies: Introduction, Fuel Cell, Hydrogen Energy. **09 Hrs.**

Unit-II

Solar Energy Basics: Extraterrestrial and Terrestrial Radiations, Solar Time, Basic Sun-Earth Angles, Solar Day Length, Estimation of Intensity of Terrestrial Radiation, Solar Radiation on Inclined Plane Surface, Solar Radiation Data, Measurements of Solar Radiation Data. Numericals on solar day length, LST, Solar Geometry.

Solar Thermal Systems: Introduction, Solar Collectors, Solar Water Heater, Solar Thermo-Mechanical Systems. **08 Hrs.**

Unit-III

Solar Photovoltaic Systems: Introduction, Solar Cell Fundamentals, characteristics, classification. Solar Cell, Module, Panel and Array Construction. Maximizing the Solar PV Output and Load Matching, Maximum Power Point Tracker (MPPT), Balance of System Components, Solar PV Systems & Applications. **07 Hrs.**

Unit-IV

Wind Energy: Introduction, Wind Turbine location, applications, types, construction. Wind Energy Conversion Systems, Environmental Aspects, Wind Energy Program in India. Numerical on power available in wind. **07 Hrs.**

Unit-V

Biomass Energy: Introduction, Biofuels, Biomass Resources Biomass Conversion Technologies, Biomass Gasification, Biomass Energy Programme in India. Drum and Dome type digesters, simple calculations regarding drum type digester.

Ocean Energy: Introduction, Tidal Energy, Wave Energy, Ocean Thermal Energy. Numerical on energy and power from tidal plant single effect type. **08 Hrs.**

Reference Books:

1) B. H. Khan, “Non-Conventional Energy Resources”, 3/e, TMH, 2008.
2) G. D. Rai, “Non-Conventional Sources of Energy”, 2/e, Khanna publishers, 2007.
3) Twiddle, ”Renewable Energy Sources”, 1/e, ELBS, 1986.
4) Mukherjee D. & Chakraborti S, “Fundamentals of Renewable Energy Systems”, 2/e, New Age International Publishers, 2005.

21UEEL603	Sensors, Control systems and Simulation Lab	(0 - 0 - 2) 1

Contact Hours: 24

Course Learning Objectives: (CLOs)

The automation in the power systems and also in many of the industrial applications has gained lots of importance in the recent times. Hence it is necessary to understand the operation of sensors in the measurement applications and also to have hands on experience of using the different types of sensors in control system. The students are expected to learn conducting experiments to be able to use different types of sensors for the measurement of various analog quantities specified. They are also expected to obtain the performance characteristics of the sensors used. They shall also conduct the experiments to study the response of the electrical system to different types of inputs and simulate the same using MATLAB SIMULINK.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Demonstrate the fundamental skill of using the sensors and measure their characteristics	4		9,PSO3
CO-2	Obtain the characteristics of servomotors.	4		9, PSO3
CO-3	Design and analyze the performance of the second order systems	4		3,9, PSO3
CO-4	Simulate the second order systems and obtain the time domain response.	4	5	9, PSO3

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
Mapping Level			1.0	3.0	2.0				1.0						1.0

Prerequisites:1. Control Systems 2. Microcontrollers

Contents:

Prescribed Experiments:

Note: Minimum of 10 experiments is to be conducted.

1. Study of capacitive sensors using Opamps.
2. Measurement of temperature using Opamp based sensor.
3. Measurement of displacement using LVDT.
4. Measurement of Distance using Distance sensor interfaced to Arduino.
5. Obtain parameter under consideration vs voltage characteristics of the following sensors i) Thermistor ii) LDR iii) proximity sensor
6. Obtain parameter under consideration vs voltage characteristics of the following i) Photo transistor ii) Strain gage iii) smoke sensor
7. Demonstration of a system or circuit using a sensor. Viz, timer circuit using

LDR.

8. Obtaining characteristics of DC and AC servomotors.
9. Design and performance analysis, of second order system, analytically and experimentally.
10. Obtaining frequency response of second order system & sketching Bode plot.
11. Simulation of 3rd order system using MATLAB to obtain Phase Margin & Gain Margin with the help of Bode plot.
12. Simulation of 2nd order system using MATLAB & obtaining time domain Response.

Reference Books:

1) Sensors, control systems and simulation Laboratory Manual.
2) Roy & Choudary, "Operational amplifiers and Linear Integrated circuits", 2/e, New Age International 01-Jan-2003.
3) Cooper D & A D Heifrick, "Modern Electronic Instrumentation and Measuring Techniques", PHI, 1998.
4) I. J. Nagrath and M. Gopal "Control Systems Engineering: 3/e, Wiley Eastern Ltd, 2003.
5) K. Ogata, "Modern Control Engineering", 4/e, PHI, 2004.

21UEEL604	Electrical Machines-II Lab	(0 - 0 - 2) 1

Contact Hours: 24

Course Learning Objectives (CLOs):

The students are expected to learn to conduct experiments to measure the line and phase voltages and currents in Star and delta connections. Further, they will be learning to conduct experiments on 3 phase squirrel cage and wound rotor induction motors, single phase induction motors, alternators and synchronous motors and evaluate the performance.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Test and obtain performance characteristics of single-phase induction motors.	9	2	4,8

CO-2	Test and obtain performance characteristics three phase induction motors.	9	2	4,8
CO-3	Determine regulation of large capacity alternator by different methods	9	2	4,8
CO-4	Synchronize the alternator with the busbar	9	2	4,8

PO's	PO -1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO - 1	PSO - 2	PSO - 3
Mapping Level		2.0		1.0				1.0	3.0						

Prerequisites: 1. Electrical Machines

Contents: Minimum of 10 experiments to be conducted from the list given below.

Prescribed Experiments:

1. Load test on 3-phase induction motor.
2. Load test on 1-phase induction motor.
3. Performance predetermination of 3-phase induction motor by equivalent circuit.
4. Performance predetermination of 3-phase induction motor by Circle diagram.
5. Speed control of wound rotor induction motor.
6. Load test on induction generator.
7. Regulation of alternator by emf and mmf methods.
8. Regulation of alternator by Potier triangle method and ASA methods.
9. Synchronization of alternator.
10. Slip test on alternator.
11. V and inverted V curves of synchronous motor.
12. Study of 3-phase winding and speed change by changing number of poles of induction motor.

Reference Books:

1) Lab. Manual
2) D.P. Kothari & I.J. Nagrath, "Electrical Machines", 3/e,TMH,2010.
3) Ashfaq Hussain, "Electric Machines", 2/e, Dhanpatrai & Sons, 2004.

21UEEL605	Minor Project-2	(0-0-3) 1

Contact Hours: 36

Course Learning Objectives (CLOs):

Minor project-2: It is to be taken up having had an exposure to the project work in the previous semesters. The students are expected to locate the state of the art technology in his/her domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define the problem for the project work. The problem could be defined to develop prototypes for industrial needs. A team consisting of not more than 4 students shall be guided by a faculty member. This project work is to supplement and prepare the students to take up major project work at higher semesters.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's (1 to 12)/PSO's (1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the domain related preferably real time problem and formulate a problem statement	4	6	9
CO-2	Propose the technical approach towards the solution.	4	11	9
CO-3	Implement the solution / demonstrate the working of prototype, execution of codes, etc.	4	11	9,10
CO-4	Prepare the project report in a specified format.	10		9

PO's	PO -1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO - 1	PSO - 2	PSO - 3
Mapping Level				3.0		2.0			1.0	2.0	2.0				

Evaluation and rubrics: A committee consisting of minimum 3 faculty members shall evaluate at the end for CIE with suitable rubrics. The weightage of marks shall be 50% for the committee and 50% for the guide. The committee shall consider the parameters such as problem definition and its relevance, depth of knowledge and work carried out, quality of the report, Presentation & communication and interaction (questions and answers) with preferably equal weightage to all parameters during the evaluation. However, the departments can have little flexibility in the rubrics to be used based on the suitability. The students are required to submit a report on the project work carried out. There is a semester end examination SEE (viva voce) which shall be examined by two internal examiners appointed by COE based on the suggestions by the respective HoD.

21UHUL606 Soft Skills and Aptitude (0-0-2) 1

Contact Hours: 24

Course Learning Objectives (CLOs):

Soft skills and Aptitude: This course is included with an objective of improving the communication skills, proficiency in English language and aptitude ability of the student. This is a credit course and aimed to enhance the employability. Both the internal and external resource persons shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO's(1 to 12)/PSO's(1 to 3)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the significance of communication in the profession.		10	
CO-2	Use the English language with proficiency		10	12
CO-3	Solve Aptitude related problems		9	12
CO-4	Demonstrate the competency in the placement activities.		9	

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	1.0		1.0		3.0	2.0				2.0	1.0				

Evaluation and rubrics: This course shall contain only CIE as the evaluation component. There shall be one test conducted at the end for 25 marks in Aptitude testing and there shall be one presentation by the student for 25 marks or any other suitable testing components to quantify the soft skills acquired. The arrangement for CIE evaluation is to be done by the department and maintain the relevant documents.

CIE and SEE Evaluation (from 2023-24 batch)

Courses with LTP 3-0-0 and 4-0-0 or 2-2-0/3-2-0

Continuous Internal Evaluation (CIE):

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: 3 questions of 10 marks each with maximum of two sub divisions. Q.3 is compulsory and one question to be answered from Q.1 and Q.2.
- Course Teacher Assessment (CTA): Minimum two components such as quiz, seminar, written assignment, any technical activity related to course each of 5marks. Total CTA marks-10
- CIE=40 (from tests)+10(from CTA) =50 marks

Semester End Examination (SEE):

- SEE is conducted for100 marks with 3 hours duration. It is reduced to 50 marks.
- Question Paper pattern for SEE: Five units with built in choice. Each question with maximum of three sub divisions.
- Two questions are to be set from each unit with built in choice, for example Q1 or Q2 in unit –I, Q 3 or Q 4 in unit-II and so on.
- A total of 5 full questions to be answered choosing one full question from each unit. All five units are to be answered compulsorily.
- Each question is of 20 marks.
- The Question paper is to be set for duration of 3 hours both for 3 and 4 credits courses.
- The Question paper is to be set for 100 marks for 3 and 4 credits courses.

ASC(IC)/PCC with LTP 2-0-2, 3-0-2 and 2-2-2

Continuous Internal Evaluation (CIE):

Theory CIE component:

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.

- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: 3 questions of 10 marks each with maximum of two sub divisions. Q.3 is compulsory and one question to be answered from Q.1 and Q.2.

Course Teacher Assessment (CTA): Totally based on conduction of experiments as set by the course teacher.

Laboratory component assessment:

- 5 marks: for conduction, regularity, involvement, journal writing, etc. Minimum 75% of attendance is compulsory. If the performance is not satisfactory in laboratory the student shall be detained and required to reregister for the course as a whole whenever offered next.
- 5 marks: Lab Test. A Lab test as per the class time table has to be conducted at the end for50 marks and scale down to 5 marks.
- CIE for integrated course =40 (from IA tests)+10 (from CTA i.e. lab component) =50 marks.
- There will not be any remuneration for Final Lab Test since it is CTA of integrated course.
- Copy of the Marks list to be sent to the concerned course instructor immediately after the completion of test for that batch. Original Marks list to be maintained in the department.
- CIE=40(from tests)+10(from CTA i.e. lab component) =50 marks

Semester End Examination (SEE):

- SEE is conducted for100 marks with 3 hours duration. It is reduced to 50 marks.
- Question Paper pattern for SEE: Five units with built in choice. Each question with maximum of three sub divisions.
- Two questions are to be set from each unit with built in choice, for example Q1 or Q2 in unit –I, Q 3 or Q 4 in unit-II and so on.
- A total of 5 full questions to be answered choosing one full question from each unit. All five units are to be answered compulsorily.
- Each question is of 20 marks.
- The Question paper is to be set for duration of 3 hours both for 3 and 4 credits courses.
- The Question paper is to be set for 100 marks for 3 and 4 credits courses.

AEC/HSMS/UHV Courses with LTP 1-0-0:

Continuous Internal Evaluation (CIE)

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: MCQ 20 questions
- Course Teacher Assessment (CTA): Minimum two components such as quiz, seminar, written assignment, any technical activity related to course etc. each of 5marks. Total CTA marks-10
- CIE=40(from tests)+10(from CTA) =50 marks

Semester End Examination (SEE):

- SEE is conducted for 50 marks of 1 hour duration. There will be 50 MCQs.
- Question Paper pattern for SEE: The question paper will contain 12 MCQ questions drawn from each Unit.
- Students have to answer maximum of 10 questions from each unit.
- All five units are to be answered compulsorily.