Anil Neerukonda Institute of Technology & Sciences (Autonomous)
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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

III/IV B.TECH-EEE SYLLABUS

REGULATION-R20

2022-23

3rd Year

Semester - I

Course Code	Title of the course	Category	Periods						Sessional Marks	Semester end Exam marks	Total Marks	Credits
			L	T	P	E	O	Total				
EEE311	**Open Elective-I**	OE	3	0	0	1	3	7	40	60	100	3
EEE312	Embedded Systems	SC	3	0	0	1	3	7	40	60	100	3
EEE313	Pulse, Digital and Integrated Circuits	PC	3	0	0	1	3	7	40	60	100	3
EEE314	Linear Control Systems	PC	2	1	0	1	3	7	40	60	100	3
EEE315	Performance of Induction and Synchronous Machines	PC	2	1	0	1	3	7	40	60	100	3
EEE316	Power Transmission and Distribution	PC	2	1	0	1	3	7	40	60	100	3
EEE317	Quantitative Aptitude –I / Verbal Aptitude-I	HS	0	0	3	0	3	6	100	0	100	1.5
EEE318	Design Thinking	SC	2	0	2	0	0	4	0	0	0	0
EEE319	Embedded Systems Laboratory	PC	0	0	3	0	2	5	50	50	100	1.5
EEE3110	Electronics Laboratory –II	PC	0	0	3	0	2	5	50	50	100	1.5
EEE3111	Summer Internship	PR	0	0	0	0	0	0	0	0	0	2
Total			**15**	**3**	**9**	**6**	**25**	**62**	**440**	**460**	**900**	**24.5**

Open Elective-I	
S. No.	**Name of the Course**
1.	Competitive Programming
2.	Robotics
3.	Computer Architecture and Organization
	Infosys Springboard Courses
4.	Computational Problem Solving
5.	Programming Fundamentals using Python - Part 1
6.	Python - The Practical and Hands-on approach
7.	Data Structures and Algorithms: The Complete Master class
8.	Data Structures and Algorithms using Python - Part 1
9.	Machine Learning, NLP & Python
10.	Data Analysts Toolbox: Excel, Python, Power BI
11.	Advanced Python Concepts
12.	Programming Fundamentals using Python - Science Graduates - Foundation Program
13.	Hands-On Deep Learning on Artificial Neural Networks
14.	Learn Python and Ethical Hacking from Scratch
15.	Data Structures and Algorithms using Java

Semester - II											
Course Code	Title of the course	Category	Periods						Sessional Marks	Semester end Exam marks	Total Marks	Credits
			L	T	P	E	O	Total				
EEE321	**Open Elective-II**	OE	3	0	0	1	2	6	40	60	100	3
EEE322	**Professional Elective –I**	PE	3	0	0	1	3	7	40	60	100	3
EEE323	**Professional Elective –II**	PE	3	0	0	1	3	7	40	60	100	3
EEE324	Power Electronics	PC	3	0	0	1	5	9	40	60	100	3
EEE325	Power System Analysis	PC	2	1	0	1	6	10	40	60	100	3
EEE326	Engineering Economics & Management	HS	2	1	0	1	6	10	40	60	100	3
EEE327	Quantitative Aptitude –II / Soft Skills	HS	0	0	3	0	2	5	100	0	100	1.5
EEE328	Research Methodology	SC	2	0	0	0	0	2	0	0	0	0
EEE329	Control Systems Lab	PC	0	0	3	0	1	4	50	50	100	1.5
EEE3210	Electrical Machines Lab – II	PC	0	0	3	0	1	4	50	50	100	1.5
Total			**16**	**2**	**9**	**6**	**29**	**62**	**440**	**460**	**900**	**22.5**

Open Elective-II	
S. No.	**Name of the Course**
1.	Competitive Programming
2.	Robotics
3.	Computer Architecture and Organization
	Infosys Springboard Courses
4.	Computational Problem Solving
5.	Programming Fundamentals using Python - Part 1
6.	Python - The Practical and Hands-on approach
7.	Data Structures and Algorithms: The Complete Master class
8.	Data Structures and Algorithms using Python - Part 1
9.	Machine Learning, NLP & Python
10.	Data Analysts Toolbox: Excel, Python, Power BI
11.	Advanced Python Concepts
12.	Programming Fundamentals using Python - Science Graduates - Foundation Program
13.	Hands-On Deep Learning on Artificial Neural Networks
14.	Learn Python and Ethical Hacking from Scratch
15.	Data Structures and Algorithms using Java

Professional Elective –I
1. Renewable Energy Technologies
2. VLSI
3. Electrical Engineering Materials

Professional Elective –II
1. Power System Protection
2. Electrical Drives & Traction
3. Digital Control Systems
4. Digital Signal Processing

Third Year Semester-1

EMBEDDED SYSTEMS	
EEE 312	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes:

At the end of the course, students will be able to

CO1	Explore Basics of computer architecture and the binary number system
CO2	Explain the embedded systems
CO3	Identify the hardware aspects of embedded systems
CO4	Analyze the sensors, ADCs and actuators used in embedded systems
CO5	Apply the embedded systems for different real world applications

SYLLABUS

UNIT I **[10 Periods]**

Basics of computer architecture and the binary number system

Basics of computer architecture, computer languages, RISC and CISC architectures, number systems, number format conversions, computer arithmetic, units of memory capacity

UNIT-II **[12 Periods]**

8051 Micro controller and Embedded processor:

Over-view of 8051 family, 8051 assembly programming, assembling and running an 8051 program, the program counter and ROM space in the 8051, 8051 data types and directives, 8051 flag bits and the PSW register, 8051 register banks and stacks.

UNIT III **[12 Periods]**

Introduction to embedded systems

Application domain of embedded systems, desirable features and general characteristics of embedded systems, model of an embedded system, microprocessor Vs microcontroller, example of a simple embedded system, figure of merit for an embedded system, classification of MCUs: 4/8/16/32 bits, history of embedded systems, current trends.

UNIT IV **[10 Periods]**

Embedded systems-The hardware point of view

Microcontroller unit(MCU), a popular 8-bit MCU, memory for embedded systems, low power design, pull up and pull down resistors

UNIT V **[12 Periods]**

Sensors, ADCs and Actuators

Sensors: Temperature Sensor, Light Sensor, Proximity/range Sensor; Analog to digital converters: ADC Interfacing; Actuators Displays, Motors, Opto couplers/Opto isolators, relays

TEXT BOOKS:

1. Lyla B Das, *Embedded systems: An Integrated Approach*, 1st Ed., Pearson, 2013
2. Muhammad Ali Mazidi, The 8051 Microcontroller and Embedded Systems using Assembly and C, 2nd edition, Pearson, 2008

REFERENCE BOOKS:

1. Shibu, K.V., *Introduction to Embedded Systems*, 1st Ed., TMH, 2009
2. Rajkamal, Embedded Systems

PULSE DIGITAL AND INTEGRATED CIRCUITS	
EEE 313	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

COURSE OUTCOMES:

CO1: Analyze the response of linear wave shaping circuits for different types of inputs such as step input, pulse input, square input, ramp input and Non-linear wave shaping circuits when the sinusoidal input is applied.
CO2: Infer the characteristics and analyze linear and non-linear applications of an Op-Amp.
CO3: Design and analyze active filters, oscillators for given specifications using Op-Amp.
CO4: Familiarize the conversion of data from Analog to Digital and Digital to Analog.
CO5: Design circuits for several applications using IC 555 Timer and different waveform generation.

SYLLABUS

UNIT-I **[10 Periods]**

Linear wave shaping: High pass, low pass RC circuits, their response for sinusoidal, step, pulse, square and ramp inputs.
Clippers and Clampers: Shunt Clippers, Series Clippers, Two-level Clippers, Positive and negative Clampers.

UNIT-II **[10 Periods]**

Operational amplifiers
OP-AMP and Applications: Block diagram of OP-AMP, ideal and practical characteristics of OP-AMP, Open and closed loop configurations of op-amps. Basic application of OP-AMP-Adders, Subtractors, Differentiators and Integrators, Comparators, Schmitt Trigger, Logarithmic amplifier, Sample and Hold circuit

UNIT-III **[10 Periods]**

Active Filters & Oscillators using Op-Amps:
Introduction, 1st order and higher order LPF, HPF filters, Band pass and Band reject filters Oscillator types and principle of operation – RC phase shift ,Wien-bridge and All Pass Filter .

UNIT IV **[10 Periods]**

Analog to Digital and Digital to Analog Converters:
Introduction, Basic DAC techniques, Different types of DACs-Weighted resistor DAC, R-2R ladder DAC, Inverted R-2R DAC, Different Types of ADCs – Parallel Comparator Type ADC, Counter Type ADC, Successive Approximation ADC, Single slope and Dual Slope ADC, DAC and ADC Specifications..

UNIT-V **[10 Periods]**

Waveform Generators using Op-Amp & 555 Timers:
waveform generators – triangular and square wave , Monostable multivibrator using Op-Amp, Introduction to 555 timer, functional diagram, monostable and astable operations and applications, Voltage Controlled Oscillator(IC 566).

Text books:

1. Jacob Millman & Herbert Taub, "Pulse Digital & Switching Waveforms" McGraw-Hill Book Company Inc.
2. Linear Integrated Circuits, D. Roy Chowdhury, New Age International (p) Ltd.
3. Op-Amps & Linear ICs, Ramakanth A. Gayakwad, PHI.

Reference books:

1. Operational Amplifiers & Linear Integrated Circuits, R.F. Coughlin & Fredrick F. Driscoll, PHI.
2. Operational Amplifiers & Linear Integrated Circuits: Theory & Applications, Denton J. Daibey, TMH.
3. Digital Fundamentals – Floyd and Jain, Pearson Education

LINEAR CONTROL SYSTEMS	
EEE 314	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO 1	**Apply** signal flow graph and block diagram reduction techniques to **Develop** Transfer function for Linear time invariant systems.
CO 2	**Apply** the relationship between the variables of electrical and mechanical systems to **Develop** mathematical models of electrical and mechanical systems.
CO 3	**Analyze** the performance of 1st and 2nd order Linear time invariant systems with and without feedback control to **Determine** time domain specifications and error for standard inputs.
CO 4	**Apply** Routh-Hurwitz criterion and Root locus technique to **Analyze** the stability for LTI systems in time domain frame.
CO 5	**Apply** bode, polar and Nyquist plots to **Analyze** the stability for LTI systems in frequency domain frame.

CO 1: Action Verb from Blooms Taxonomy-**Apply** / Cognitive level- Application (BL-3)
CO2: Action Verb from Blooms Taxonomy-**Develop** / Cognitive level- Application (BL-3)
CO3: Action Verb from Blooms Taxonomy-**Analyze**/Cognitive level- Analysis (BL-4)
CO4: Action Verb from Blooms Taxonomy-**Analyze**/Cognitive level- Analysis (BL-4)
CO 5: Action Verb from Blooms Taxonomy-**Analyze**/Cognitive level- Analysis (BL-4)

Program Matrix

	Program Outcomes (POs)												**PSOs**	
COs	**Domain Specific POs**					**Domain Independent POs**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	1	-	-	-		-		2		2
CO 2	3	3	2		2	-	-	-		-		2		2
CO 3	2	2	3	1	2	-	-	-		-		2		2
CO 4	2	2	3		2	-	-	-		-		2		2
CO 5	2	2	3		2	-	-	-		-		2		2

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UNIT I: **[14 Periods]**

Transfer functions of linear systems-impulse response of linear systems-block diagrams of control systems-signal flow graphs-reduction techniques for complex block diagrams and signal flow graphs.

UNIT II: **[8 Periods]**

Introduction to mathematical modelling of physical systems-equations of electrical networks-modelling of mechanical systems- equations of mechanical systems.

UNIT III: **[12 Periods]**

Time domain analysis of control systems-time response of first and second order systems with standard input signals-steady state performance of feedback control systems-steady state error constants-effect of derivative and integral control on transient and steady state performance of feedback control systems.

UNIT IV: **[12 Periods]**

Concept of stability and necessary conditions for stability-Routh-Hurwitz criterion, relative stability analysis, the concept and construction of root loci, analysis of control systems with root locus.

UNIT V: **[14 Periods]**

Correlation between time and frequency responses - polar plots, **b**ode plots-log magnitude versus phase plots-all pass and minimum phase systems-Nyquist stability criterion-assessment of relative stability-constant M&N circles.

Text Books:

1. Control Systems Engineering by I.J. Nagrath& M.Gopal, Wiley Eastern Limited.
2. Automatic Control Systems by Benjamin C. Kuo, Prentice Hall of India.

Reference Book:

1. Modern Control Engineering by Ogata, Prentice Hall Of India.

PERFORMANCE OF INDUCTION AND SYNCHRONOUS MACHINES	
EEE 315	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Prerequisites:

1. Fundamentals of EEE (EEE 215)
2. Network Theory (EEE 214)
3. Electromagnetics (EEE 213)
4. Performance Electrical Machines-I (EEE 223)

Course Outcomes:

CO	BL	CO Statement
CO1	BL-3	**EXPLAIN** the working of 3-phase induction motor, generator & **ANALYZE** the performance charactiristics of 3-phase induction motor
CO2	BL-3	**DISCUSS** the working of 1-phase induction motor, other special motors & **ANALYZE** the performance charactiristics of 1-phase induction motor
CO3	BL-3	**EXPLAIN** the working of 3-phase alternator & **DETERMINE** the emf induced, regulation of alternator by different methods
CO4	BL-3	**ANALYZE** the synchronization process & parallel operation of alternators in detail.
CO5	BL-3	**EXPLAIN** the working of 3-phase synchronous motor & **DISCUSS** the effects of change in excitation & load on the machine when connected to infinite bus bar.

Mapping of course outcomes with program outcomes:

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	1	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

SYLLABUS

UNITI: **[14 Periods]**

Induction motor: Principle of operation of three phase induction motor, rotating magnetic field, types of rotor, torque expression, vector diagram, equivalent circuit and performance equations and calculations, slip-torque characteristic, circle diagram and performance calculations. Starting methods of induction motors, crawling and cogging, double squirrel cage induction motor, methods of speed control of induction motors, induction generator and principle of operation, self-excitation of induction generator, Schrage motor, two phase motors.

UNIT II: **[10 Periods]**

Single phase induction motors: Types of single phase induction motor, double revolving field theory, equivalent circuit, performance analysis and characteristics of capacitor start motors, shaded pole, repulsion type, reluctance, hysteresis and ac series motors.

UNIT III: **[12 Periods]**

Synchronous Generators: Basic Concepts, types of synchronous machines, construction, armature windings, emf equation, effect of chording and winding distribution, armature reaction, regulation by synchronous impedance, mmf and potier triangle methods.

UNIT IV: **[12 Periods]**

Synchronization: Parallel operation of synchronous generators, synchronizing current and synchronizing power. Synchronizing to infinite bus-bars and operation of infinite bus. Power transfer equations, capability curve, two reaction model of salient pole synchronous machine and power angle characteristics, determination of X_d and X_q by slip test, short circuit transients in synchronous machine.

UNIT V: **[12 Periods]**

Synchronous Motor: Principle of operation, methods of starting, power developed, effects of changing load at constant excitation, and changing excitation at constant load, excitation and power circles for synchronous machine, V – and inverted V – curves, hunting and damper windings.

Text Books:

1. D.P. Kothari, I.J. Nagarath, Electrical Machines, Tata Mac Graw Hill publication, 3rd edition, 2004.
2. Dr. P.S. Bhimbra, Electrical Machinery, Khanna publishers, 7thedtion, 2010.

Reference Books:

1. Dr. P.S. Bhimbra, Generalized theory of Electrical Machines, Khanna publishers, 4thedtion, 1987.

POWER TRANSMISSION & DISTRIBUTION	
EEE 316	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-2	**Compare** various supply systems and **Determine** the most economical size of the conductor and **Estimate** the minimum voltage drop of distributors with concentrated loads.
CO2	BL-2	**Determine** the inductance and capacitance of solid, stranded and bundled conductors.
CO3	BL-3	**Analyze** the performance of short, medium and long transmission lines to **Determine** regulation and efficiency.
CO4	BL-3	**Calculate** the sag and tension of transmission tower supports at equal and unequal levels and **Determine** the string efficiency of suspended type insulators.
CO5	BL3	**Determine** the capacitance of single core and three core belted cables and **Calculate** the power loss due to corona.

CO	Bloom's Level
CO1	Action Verb from Blooms Taxonomy-**Compare/Determine**/ Cognitive level- Application (BL-2)
CO2	Action Verb from Blooms Taxonomy-**Determine**/ Cognitive level- Application (BL-2)
CO3	Action Verb from Blooms Taxonomy-**Analyze/Determine**/Cognitive level- Analysis (BL-3)
CO4	Action Verb from Blooms Taxonomy-**Calculate/Determine**/Cognitive level- Analysis (BL-3)
CO5	Action Verb from Blooms Taxonomy- **Calculate/Determine** /Cognitive level- Analysis (BL-3)

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	-	-	-	-	-	-	-	-	1	2	-
CO2	2	3	2	-	-	-	-	-	-	-	-	1	3	-
CO3	2	3	2	-	2	-	-	-	-	-	-	1	3	-
CO4	2	3	2	-	2	-	-	-	-	-	-	1	3	-
CO5	2	3	2	-	2	-	-	-	-	-	-	1	3	-

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UNIT I: **[10 Periods]**

Electric Power Supply Systems: Single line diagram of A.C power supply system, comparison between A.C and D.C systems for transmission and distribution, comparison between various supply systems, effect of system voltage on transmission, choice of working voltage for transmission, economic size of conductor – Kelvin's Law.

Power Distribution Systems: Classification of distribution systems, types of distributors, D.C and A.C distributor calculations with concentrated loads. Necessity of neutral grounding, various methods of neutral grounding.

UNIT II: **[12 Periods]**

Transmission Line Constants: Inductance of a 1-ϕ, 2-wire line, inductance of composite conductors, concept of GMR & GMD, inductance of 3-ϕ symmetrical & unsymmetrical spaced transmission lines, transposition of power lines, inductance of double circuit 3-ϕ line, bundle conductors, skin effect & proximity effect.

Capacitance of 1-ϕ 2-wire line, capacitance of 3-ϕ symmetrical and unsymmetrical spaced transmission lines, capacitance of double circuit 3-ϕ line, effect of earth on transmission line capacitance.

UNIT III: **[12 Periods]**

Performance of Transmission Lines: Short transmission lines, medium length lines, long transmission lines, surge impedance, surge impedance loading, rigorous line modelling, equivalent T & π model of a long transmission line, Ferranti effect.

UNIT IV: **[8 Periods]**

Mechanical Design of Transmission Lines: Sag and tension calculations, supports at equal & different levels, effect of ice and wind, stringing chart, sag template, vibration and vibration dampers, conductor materials.

Over Head Line Insulators: Types of insulators, composite insulators, potential distribution across the string of insulators, string efficiency, methods of equalizing the potential.

UNIT V: **[8 Periods]**

Underground Cables: Comparison between over head & underground systems, types of cables, construction of cables, insulation resistance of cables, grading of cables-H.V &E.H.V, capacitance of 3-core belted cables.

Corona: Phenomenon of corona, critical voltages, power loss due to corona, factors effecting corona loss, radio interference.

Text books:

1. A Text Book on Power System Engineering by Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpatrai & Co, Ninth Edition, 2011.
2. Power System Engineering by D.P. Kothari, I. J. Nagrath, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition, 2008.
3. Electrical Power Systems' by C.L.Wadhwa, New Age International Publications, Sixth Edition, 2010.

Reference Books:

1. Electrical Power Systems by D. Das, New Age International Publications, 2010.
2. Transmission and Distribution of Electrical Power by J. B. Gupta, ', S.K. Kataria & sons publications, 2009.

DESIGN THINKING	
EEE 318	**Credits : 0**
Instruction : 4 Periods /Week	**Sessional Marks : 00**
End Exam : 0 Hours	**End Exam Marks : 00**

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Explain** the design thinking principles & **Identify** an opportunity and scope of the project and **prepare** the problem statement
CO-2	**Apply** the empathy tools to study the user and **summarize** finding related to problem for define phase.
CO-3	**Describe** and **define** the problem specific to the user group and **apply** Ideation tools to **generate** Ideas to **solve** the problem
CO-4	**Develop** prototypes for test phase.
CO-5	**Test** the ideas and **demonstrate** Storytelling ability to present the Ideas.

SYLLABUS

UNIT - I — **Periods: 3L+3P=6**

Introduction To Design Thinking

Design Thinking, Need of design thinking, 7 characteristics that define design thinking, comparison of design thinking to other ways of thinking, tools and resources, 5 actions phases of Design thinking, 5 characteristics of action plan. Problem statement. Design principles.

Activities:

a. Case studies of General, engineering and service applications

b. Identify an opportunity and scope of the project and prepare the problem statement.

UNIT - II — **Periods: 5L+5P=10**

Empathize Phases: Design Thinking Tools

Interview for empathy, Explorative interview, Ask 5x why, 5W+H questions, Stakeholder map, Emotional response cards, Empathy map, Persona/User profile, Customer journey map, AEIOU, Analysis questions builder,

Activities:

a. Study the user using empathy tools and summarize finding related to your problem for define phase.
b. Iterate the process at any stage if required

UNIT - III — **Periods: 5L+5P=10**

Define point of view & Ideate Phase: Design Thinking Tools

Define point of view :"How might we…" question, Storytelling, Context mapping, Define success, Vision cone, Critical items diagram

Ideate: Brainstorming, 2x2 Matrix, Dot voting, 6-3-5 Method, Special brainstorming, Analogies & benchmarking as inspiration

Activities:

a. Apply the define tools to your problem: Finalize the problem statement

b. Apply the ideate tools to your problem: Generate lots of Ideas

c. Iterate the process at any stage if required

UNIT - IV — **Periods: 6L+6P=12**

Prototyping Phase: Methods and Tools

Frequently used kinds of prototypes, Focused experiments – Critical Experience Prototype (CEP) & Critical Function Prototype (CFP), Crazy experiments – Dark horse prototype, Combined experiments – Funky prototype, Imagining the future – Vision prototype, Prototype with a first function - functional (system) prototype, Solutions in detail - "X is finished", (Hopefully) at the finish – Final prototype, Exploration map, Prototype to test

Activities:

a. Create prototype for best idea to your problem using any prototype method.
b. Iterate the process at any stage if required

UNIT - V	**Periods: 5L+5P=10**

Test Phase: Methods and Tools & Implementation

Test Phase: Methods and Tools Testing sheet, Feedback capture grid, Powerful questions in experience testing, Solution interview, Structured usability testing, A/B Testing

Implementation: Road map for implementation, Problem to growth & scale innovation funnel

Activities:

a. Test the developed prototype by test phase tools and finalize the solution to the problem.
b. Iterate the process at any stage if required
c. Prepare the complete project report.

TEXT BOOKS:

1.	Daniel Ling "*Complete Design Thinking Guide for Successful Professionals*", Emerge Creatives Group LLP, Print ISBN: 978-981-09-5564-9.
2.	Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, HarperCollins e-books, 2009.
3.	Jeanne Liedtka, Andrew King, And Kevin Bennett, "*Solving Problems with Design Thinking"* , Columbia University Press Publishers, E-ISBN 978-0-231-53605-9
4.	Michael Lewrick, Patrick Link, Larry Leifer, *The Design Thinking Toolbox,* John Wiley & Sons, 2020.

REFERENCE BOOKS:

1.	Michael G. Luchs, Scott Swan, Abbie Griffin , *"Design Thinking: New Product Development Essentials from the PDMA"*, ISBN-13 : 978-1118971802
2.	Beverly Rudkin Ingle, *"Design Thinking for Entrepreneurs and Small Businesses"*, Apress, ISBN: 9781430261827
3.	Jose Betancur *"The Art of Design Thinking: Make More of Your Design Thinking Workshops",* ISBN: 9781522095378
4.	Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Playbook, John Wiley & Sons, 2018

WEB RESOURCES:

1.	https://dschool.stanford.edu/resources/design-thinking-bootleg
2.	https://www.ideo.com/post/design-thinking-for-educators

3.	https://static1.squarespace.com/static/57c6b79629687fde090a0fdd/t/58890239db29d6cc6c3338f7/1485374014340/METHODCARDS-v3-slim.pdf.
4.	https://www.intel.com/content/dam/www/program/education/us/en/documents/K12/design-and-discovery/student-guide-full-curriculum-session1-18.pdf

EMBEDDED SYSTEMS LABORATORY	
EEE 319	**Credits:1.5**
Instruction: 3 Periods	**Sessional Marks:50**
End Exam: 3 Hours	**End Exam Marks:50**

S.No	LIST OF EXPEREMENTS
1	Programming using Arithmetic and logical instructions of 8051
2	Timer programming of 8051
3	Counter programming of 8051
4	Serial port programming of 8051
5	Interfacing of stepper motor
6	Interfacing of temperature sensor and relay control
7	Interfacing LED and PWM
8	Flashing of LEDS
9	BCD to seven segments
10	Counting no of pulses in the external clock using counter
11	Matrix keypad interfacing
12	ADC interfacing

ELECTRONICS LAB-II	
EEE 320	**Credits:1.5**
Instruction: 3 Practical /week	Sessional Marks:50
End Exam: 3 Hours	End Exam Marks:50

Course Outcomes:

By the end of the course student should be able to:	
CO1	Design and verify the output of non-linear wave shaping circuits and linear wave shaping circuits for different inputs
CO2	Apply op-amps fundamentals in design and analysis of op-amps applications.
CO3	Design and analyse oscillator circuits and testing of Active LPF & HPF using op-amp
CO4	Verify the operation of A/D and D/A converters.
CO5	Design and analyze multivibrator circuits using op-amp and 555Timer

LIST OF EXPERIMENTS

Cycle 1:

1. Design *High pass* and *Low pass* RC circuits for different time constants and verify their responses for a square *wave* input of given frequency.
2. Design Clippers and Clampers circuit for moulding a waveform to a required shape.
3. Verify different applications of an Operational amplifier.
4. Verify different parameters of an operational amplifier.
5. Observe the working of an operational amplifier in inverting, non-inverting modes.

Cycle 2:

1. Design and testing of Active LPF & HPF using op-amp.
2. Generate a sinusoidal signal using Wein bridge circuit.
3. Design of Schmitt Trigger using op-amp
4. Design of Astable multivibrator using a) op amp b) IC 555
5. Verify the operation of R-2R ladder DAC and flash type ADC.

Text books:

1. Jacob Millman, Christos Halkias, Chetan Parikh, "Integrated Electronics", 2nd Edition, McGraw Hill Publication, 2009.
2. Donald A. Neamon, “Electronic Circuit Analysis and Design”, 2nd Edition. TMG publications.

References:

1. Ramakanth A Gayakwad, “Op-Amps and Linear Integrated Circuits”- 4th Edition.

Third Year Semester-2

Professional Elective-I **RENEWABLE ENERGY TECHNOLOGIES**	
EEE 322	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO1	**Describe** the generation of electricity from various renewable energy technologies, **calculate** the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation.
CO2	**Explain** the concepts involved in wind energy conversion system by studying its components, types and performance to **calculate** wind power extracted.
CO3	**Illustrate** ocean and geothermal energy systems to **Analyze** the operational methods of their utilization.
CO4	**Explain** the concepts involved in biomass energy conversion system and **discuss** the merits and demerits of it.
CO5	**Describe** Magneto hydrodynamics and Fuel cell technology and **explain** the operation of hybrid energy systems.

CO1: Action Verb from Blooms Taxonomy **Describe** / Cognitive level Application (BL 2)
CO2: Action Verb from Blooms Taxonomy **Explain /** Cognitive level Application (BL 2)
CO3: Action Verb from Blooms Taxonomy **illustrate** / Cognitive level Analysis (BL 4)
CO4: Action Verb from Blooms Taxonomy **Explain** / Cognitive level Analysis (BL 2)
CO5: Action Verb from Blooms Taxonomy **Describe** / Cognitive level Analysis (BL 2)

SYLLABUS

UNIT I: **[10 Periods]**

Introduction: Introduction to Energy Conversion, Principle of Renewable Energy Systems.

Solar Energy: Solar Radiation, Thermoelectric Conversion, Principles of Solar Energy collection, Characteristics and principles of different types of collectors and their efficiencies. Solar energy applications, water heaters, air heaters, solar cooling, solar cooking, solar drying and power generation, solar tower concept, solar pump, Introduction to Photovoltaic cells, PV array and PV module, Maximum power point tracking system.

UNIT II: **[10 Periods]**

Wind Energy: Wind energy, Characteristics, Aerodynamics, Power extraction, Types of wind machines, Performance of Wind Machines, Wind Mills, Applications, Economics of wind power.

UNIT III: **[10 Periods]**

Ocean & Geothermal Energy: Ocean Thermal Energy Conversion Systems, Tidal and Wave power applications. Principle of working of Geothermal Power Plants, Advantages and Disadvantages over other energy forms, Applications of Geothermal Energy.

UNIT IV: **[10 Periods]**

Bio-Energy: Energy from Bio-mass, Bio conversion processes. Bio-gas generation and utilization, Bio-gas plants various types, Industrial Wastes, Municipal waste, Burning, Plants, Energy from the Agricultural wastes.

UNIT V: **[10 Periods]**

Other Energy Sources: MHD Generators, Application of MHD generation, Fuel cells types, applications. Diesel Generator and Photo-Voltaic System, Wind-Diesel Hybrid System, Wind-Photovoltaic Systems.

Textbooks:

1. Non-Conventional Energy Sources by G.D.Rai, Khanna publishers, Fourth Edition, 2009.
2. Wind electrical systems by S.N.Bhadra, D. Kastha, S. Banerjee Oxford University press.

References:

1. Solar Energy: Principles of Thermal Collection and Storage by Sukhatme, S.P., Tata McGraw-Hill, New Delhi.
2. Fuel Cell Systems by James Larminie, Andrew Dicks, John Weily& Sons Ltd.
3. Wind Energy Explained by J.F.Manwell, J.G.McGowan, A.L.Rogers, John Weily& Sons
4. MHD Power Generation Engineering Aspects by E.J. Womack, Chapman and Hall Publication.
5. Wind Electrical Systems by S.N.Bhadra, D. Kastha, S. Banerjee Oxford University press.

Professional Elective-I **VLSI**	
EEE 322	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Prerequisites: Digital Electronics, ECA-I, ECA-II, IC analysis

Course Outcomes:

At the end of the course, students will be able to

1.	Delineate IC Production process, fabrication processes for NMOS, PMOS, BiCMOS Technologies.
2.	Analyze CMOS electrical properties with circuit concepts.
3.	Draw stick diagrams, layouts for CMOS circuits and compute delays of CMOS circuits using modern tools.
4.	Design and test the CMOS digital Circuits at different levels of abstraction using modern tools.
5.	Apply testing methods on the digital designs for DFT.

SYLLABUS

UNIT I **[10 Periods]**

IC Technology: MOS, PMOS, NMOS, CMOS &BiCMOS technologies- Oxidation, Lithography, Diffusion, Ion implantation, Metallization, Encapsulation, Integrated Resistors and Capacitors.

UNIT II **[10 Periods]**

CMOS Electrical Properties: Basic Electrical Properties of MOS and BiCMOS Circuits: Ids-Vds relationships, MOS transistor threshold Voltage, gm, gds, figure of merit, Pass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design, Bi-CMOS Inverters.

Basic circuit concepts:

Sheet Resistance R_S and its concept to MOS, Area Capacitance Units, Calculations-Delays, driving large Capacitive Loads, Wiring Capacitances, Fan-in and fan-out, Choice of layers

UNIT III **[10 Periods]**

VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, 2 micron CMOS Design rules, Contacts and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits, Limitations of Scaling.

UNIT IV **[10 Periods]**

Gate Level Design: Logic Gates and Other complex gates, Switch logic, Alternate gate circuits. Different CMOS logic Circuits-Pseudo, Dynamic, Domino, C^2MOS.

Subsystem Design: Subsystem Design, Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators.

UNIT V **[10 Periods]**

VLSI Testing: CMOS Testing, Need for testing, Test Principles, Design Strategies for test, Chip level Test Techniques, System-level Test Techniques, Design for testability, Practical design for test guidelines, Buil-In-Self-Test

TEXT BOOKS:

1. Douglas A, Pucknell, Kamran Eshraghian,"Basic VLSI Design",3rd Edition,Prentice Hall, l996.**(UNITS I, II, III, IV & V)**
2. Weste and Eshraghian, "Principles of CMOS VLSI Design", Pearson Education, 1999

REFERENCE BOOKS:

1. John .P. Uyemura,"Introduction to VLSI Circuits and Systems",JohnWiley, 2003.
2. Wayne Wolf, "Modern VLSI Design", 3rd Edition, Pearson Education, 1997

Professional Elective-I **ELECTRICAL ENGINEERING MATERIALS**	
EEE 322	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I: Conducting Materials: Hardening, Annealing - Low Resistive Materials – Requirements – Properties and applications of Copper and Aluminum - Comparison between Copper and Aluminum - ACSR Conductors, AAAC, High Resistive Materials – Requirements- Properties and applications.

UNIT-II: Semi and Insulating: Semi conducting Materials Semi-conductors - Intrinsic and extrinsic semi-conductors-`P' and `N' type Materials Insulating Materials Properties -Insulation resistance - Factors effecting Insulation resistance - Classification of Insulation materials - Properties – Applications.

UNIT-III: Di- electric materials: Permittivity of di -electric materials- Polarisation - Dielectric Loss – Application of Dielectrics – Colour codes.
Magnetic Materials: Classification of magnetic materials - Soft & Hard magnetic materials- B-H Curves Hysteresis loop - Hysteresis loss - Steinmetz constant - Eddy Current Loss -- Curie Point – Magnetostriction.

UNIT-IV: Special Purpose Materials: Protective materials – Thermocouple - Bi-Metals- Soldering- Fuses -Galvanizing and Impregnating - Nano Materials.

UNIT-V: Batteries: Primary cell and Secondary cells-Lead acid, Nickel iron and Nickel - cadmium-Chemical reactions during charging and discharging – Charging of Batteries- Constant current method and constant voltage method-Trickle charging - Capacity of Battery - Amperehour efficiency and watt-hour efficiency - Maintenance free batteries

REFERENCES:

1. Electronic Components -Dr. K.Padmanabham
2. Electronic Components -D.V.Prasad
3. Electrical Engineering Materials – N.I T.T.T.R Publications
4. Introduction to Engineering materials – B.K.Agarwal.
5. Materials science for Electrical and Electronic Engineers – Ian P.Jones (Oxford Publications)
6. Electrical Engineering Materials and Semiconductors-J.B.Guptha and Rena Guptha,SK Kotaria &Sons Publishers

Professional Elective-II **POWER SYTEM PROTECTION**	
EEE 323	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Compare** the construction, operation and applications of electromagnetic relays and Over Current protection. **Determine** the settings of PSM and TMS of Over Current relay. **Explain** the construction, operation and applications of Distance and Differential Protection. **Determine** the minimum value of earthing resistance and percentage of winding unprotected for Alternators. **Determine** relay setting and CT ratio of transformer protected by percentage differential protection.
CO2	BL-2	**Explain** operation of Static Over current, Distance, Differential protection and Microprocessor based relay. **Identify** the difference between electromagnetic and static relays.
CO3	BL-3	**Explain** the construction, operation and applications of various types of Lightning arresters. **Determine** reflected, refracted voltages and currents of Travelling waves.
CO4	BL-3	**Explain** the construction, operation and application of various types of Fuses and Circuit Breakers. **Determine** the TRV/RRRV. **Construct** substation layout and bus bar arrangement using single diagram.

CO1: Action Verb (BT)-**Compare, Explain, Determine**/ Cognitive level- Application (BL-3)

CO2: Action Verb (BT)-**Explain, Identify**/Cognitive level- Understanding (BL-2)

CO3: Action Verb (BT)-**Explain**, **Determine**/Cognitive level- Application (BL-3)

CO4: Action Verb (BT)-**Explain, Determine, Construct**/Cognitive level- Application (BL-3)

Program Matrix

	Program Outcomes (POs)												**PSOs**	
COs	**Domain Specific POs**					**Domain Independent POs**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	-	-	-				-	1	3	
CO2	2	2	-	-	-	-	-				-	1	3	
CO3	2	1	-	-	-	-	-				-	1	3	
CO4	2	3	2	-	2	-	-				-	1	3	

SYLLABUS

UNIT-I **[15 Periods]**

PROTECTIVE RELAYING

Faults, causes and effects, Importance of protective relaying, Evolution of protective relays, Protective zones, Primary and backup protection, Desirable qualities of protective relaying, classification of protective relays and schemes, current transformers, potential transformers, basic relay terminology, Operating principle and construction of electromagnetic relays.

Over Current and Earth Fault Protection- Applications of over current protection, relays used in over current protection, time current characteristics, directional relays, protection of parallel feeders, and protection of ring mains. Phase fault and earth fault protection, combined earth fault and phase fault protective scheme, Directional earth fault relay.

UNIT-II **[10 Periods]**

Distance and Differential Protection:

Distance Protection - Principle of operation of distance protection, R-X diagram, universal torque equation, impedance, reactance and mho relay. Zones of protection, auto reclosing. Pilot wire protection and carrier current protection.

Differential Protection -Types, protection of generators, protection of transformers and bus-zone protection.

UNIT-III **[10 Periods]**

STATIC AND NUMERICAL RELAYS

Block diagram representation, Merits and demerits of static relays, amplitude and phase comparators, basic block diagrams of static over current, distance and differential protection. Block diagram of microprocessor based relay, advantages.

UNIT-IV **[10 Periods]**

PROTECTION AGAINST OVER VOLTAGES

Causes of over voltages, over voltages due to lightning, Protection against lightning and travelling waves – earth wire, effects of series inductances, shunt capacitance, spark gap, surge arresters, lightning arresters, insulation co-ordination.

UNIT-V **[15 Periods]**

CIRCUIT BREAKERS AND SUBSTATION LAYOUT

Fuses -Types of fuses, high voltage HRC fuses applications, selection and discrimination.

Circuit Breakers-Principle of operation, formation of arc, methods of arc extinction, transient recovery voltage, resistance switching, switching of capacitor banks and un-loaded lines, current chopping, ratings and characteristics of circuit breakers, Classification, constructional features of air circuit breakers, oil circuit breakers, air blast circuit breakers, SF-6 circuit breakers and vacuum circuit breakers, testing of circuit breakers.

Sub-Station Layout & Bus Bars: Classification of substations, substation equipment and their function, bus-bar design and schemes of layout.

TEXT BOOKS:

1. Sunil S. Rao, "Switchgear Protection and Power Systems" Khanna Publishers, 13th, edition, 2013,
2. B. Ram and D.N. Viswakarma, "Power System protection and Switchgear" TMH Publications, 2nd, edition, 2013.

REFERENCE BOOKS:

1. C.L. Wadhwa, "Electrical power Systems", New Age International Publishers, 6th edition, 2010.
2. L. P. Singh, "Protective relaying from Electromechanical to Microprocessors", New Age International Publishers, 2nd edition, 2004.

Professional Elective-II **ELECTRICAL DRIVES AND TRACTION**	
EEE 323	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes:

CO	BL	CO Statement
CO1	BL-3	**CLASSIFY** the electric drives and **ANALYZE** their stability
CO2	BL-3	**MODIFY** speed torque characteristics of three phase induction motors, d.c. motors and synchronous motors.
CO3	BL-3	**ANALYZE** in detail the starting of dc & ac motors.
CO4	BL-3	**ANALYZE** electric braking in detail employed to dc & ac motors.
CO5	BL-3	**DETERMINE** the specific energy consumption for a particular run and **EXPLAIN** the factors affecting it.

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	1	-	-

SYLLABUS

UNIT-I **[10 Periods]**

ELECTRIC DRIVE: Concept and classification of electric drives, four quadrant operation, types of loads, dynamics of motor load combination, steady-state and transient stability of drive.

UNIT-II **[15 Periods]**

CHARACTERISTICS OF MOTORS: Basic relations and characteristics and modified speed torque characteristics of D.C shunt and series motors, characteristics of 3- phase induction and synchronous motors and modification of their speed – torque characteristics

UNIT-III **[10 Periods]**

ELECTRIC STARTING: Effect of starting on power supply, motor and load, methods of starting, acceleration time, energy relations during starting, and methods to reduce energy loss during starting.

UNIT-IV **[10 Periods]**

ELECTRIC BRAKING: Types of braking, braking of D.C motors during lowering of loads, braking while stopping, braking of induction and synchronous motors, energy relations during braking.

UNIT-V **[15 Periods]**

ELECTRICAL TRACTION: General features and systems of traction electrification, traction motors, loco wheel arrangement and riding qualities, transmission of drive, traction motor control (series-parallel control), traction equipment and collection gear, train movement, speed-time curve and speed distance curve, specific energy consumption (sec) and factors affecting it.

TEXT BOOKS

1. S. K. PILLAI , “A First Course On Electric Drives”,2nd edition, 2004, wiley esastren ltd.
2. E. OPEN SHAW TAYLOR AND V.V.L. RAO ORIENTLONG man “Utilisation of electrical energy”, 2nd edition, 2004, Tata Mc Graw Hill Pub.

REFERENCE BOOKS

1. H. PARTAB , “Modern Electric Traction”. 3rd edition, 2003, DHANPAT ROY & Co.
2. VEDAM SUBRAMANYAM , “ELECTRIC DRIVES” 4th edition,2006 TMH Pub.

Professional Elective-II **DIGITAL CONTROL SYSTEMS**	
EEE 323	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO's Number	CO's Description
CO1	Able to understand the effects of sampling in performance
CO2	Able to represent sampled data system using difference equations, transfer function, block diagram
CO3	Able to understand and design discrete control system using transform techniques
CO4	Analyze discrete time systems using signal flow graph and state space analysis
CO5	Able to understand the stability of sampled data signals

Mapping of course outcomes with program outcomes:

CO's No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	2	0	0	0	0	0	0	0	0	0	0
CO2	0	0	3	2	0	0	0	0	0	0	0	0
CO3	0	0	0	3	0	0	0	2	1	0	0	0
CO4	0	3	0	0	0	0	0	2	1	0	0	0
CO5	0	3	2	0	0	0	0	0	1	0	0	0

SYLLABUS

UNIT-I

SIGNAL CONVERSION AND PROCESSING: Introduction, block diagram representation of s/h device, mathematical modelling of the sampling process, finite-pulse width sampler, folding frequency. The sampling theorem, mathematical modelling of the sampling, ideal sampler, sample and hold devices, expressions of f*(s), s-plane properties of f*(s), zero-order hold, frequency-domain characteristics of zoh, first order hold, fractional hold device.

UNIT-II

THE Z-TRANSFORM: The Z-Transform Definition, Relationship With Laplace Transform, Alternate Expression For F(Z), Evaluation Of Z-Transform, Relationship Between S-Plane And Z-Plane, Inverse Z-Transform, Non Uniqueness Of The Z-Transform, Defining Equations Of The Inverse Z-Transform, Theorems Of The Z-Transform, Limitations Of The Z-Transform.

UNIT-III

TRANSFER FUNCTION, BLOCK DIAGRAMS & SIGNAL FLOW GRAPHS: Transfer functions, block diagrams, signal flow graphs, the pulse transfer function and z-transform function, systems with cascaded elements separated by a sampler & not separated by a sampler, pulse transform function of zoh and relation between g(s) and g(z), closed loop systems, characteristic equation, physical realizability.

UNIT-IV

T**HE STATE VARIABLE TECHNIQUES:** State equations of descrete systems with sample and hold devices, state transition equations, the recursive method, the z-transform method, state equations and transfer function, characteristic equation, eigen values, eigen vectors, diagonalization of the ‘a’ matrix, jordan canonical form computing state transition matrix.

UNIT-V

CONTROLLABILITY, OBSERVABILITY, STABILITY: Definition of controllability, theorem on controllability, definition of observability, theorem on observability, relationships between controllability and observability and transfer function, stability of linear digital control systems, definition & theorem, stability tests, bi-linear transformation method, jury's stability test.

Text Books:

1. Digital control systems by B.C. Kuo, second edition, Saunders college publication-1992.
2. Digital Control Systems by Ogata.
3. Digital Control Systems (Software & Hardware) by Lay mount & Azzo.

Professional Elective-II **DIGITAL SIGNAL PROCESSING**	
EEE 323	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes:

By the end of the course, the student will be able to:	
CO1	Acquired knowledge on different types of signals and properties of systems..
CO2	Use Z - transforms and discrete time Fourier transforms to analyze a digital system.
CO3	Acquired knowledge on FFT for fast computation of DFT.
CO4	Ability to design and realize IIR using different techniques.
CO5	Ability to design and realize FIR using different techniques.

SYLLABUS

UNIT I **[12 periods]**

Introduction to Digital Signal Processing & Applications of Z-Transforms: Introduction to Digital Signal Processing: Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems. Review of Z-transforms, Applications of Z – transforms, solution of difference equations , Block diagram representation of linear constant-coefficient difference equations.

UNIT–II: **[12 periods]**

Discrete Fourier series and Discrete Fourier Transforms: Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear convolution of sequences using DFT, Computation of DFT. Relation between Z–transform and DFS.

UNIT–III: **[12 periods]**

Fast Fourier Transforms: Frequency domain representation of discrete time signals and systems – Fast Fourier transforms (FFT) – Radix–2 decimation in time and decimation in frequency FFT Algorithms – Inverse FFT – and FFT for composite N.

UNIT IV: **[12 periods]**

IIR Digital Filter Design Techniques: Introduction, Analog low pass filter design, Butterworth and Chebyshev approximations, Frequency transformations, Design of HPF, Design of IIR Digital filters from analog filters, Bilinear Transformations method, Impulse invariance method. Realization of Digital filter: Direct form-I, Direct form-II, cascade form, Parallel form.

UNIT V: **[12 periods]**

FIR Digital Filter Design Techniques: Introduction, Fourier Series method to design digital filter, Design of FIR Digital Filters using Window Techniques, Frequency Sampling technique, Comparison of IIR & FIR filters.

TEXT BOOKS:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.
2. Digital Signal Processing – Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2006
3. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House.

Reference Books:

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006
2. Digital Signal Processing: MH Hayes, Schaum's Outlines, TATA McGraw Hill, 2007.
3. DSP Primer - C. Britton Rorabaugh, Tata McGraw Hill, 2005.
4. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris,Thomson, 2007.

POWER ELECTRONICS	
EEE 324	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Discuss** thyristor operation and characteristics to **calculate** ratings and design parameters of thyristors.
CO2	BL-4	**Illustrate** the commutation circuits, triggering circuits & series-parallel operation of thyristors to **Select** the appropriate circuit & connection for a particular application of thyristor/thyristors.
CO3	BL-3	**Demonstrate** the operation and waveforms of phase controlled rectifiers to **Compute** the performance parameters of rectifiers.
CO4	BL-3	**Classify** various types of inverters to **Examine** their use in specific applications.
CO5	BL-3	**Illustrate** the operation of DC Choppers & AC to AC Converters to **Utilize** these converters for electric drive applications, **Summarize** the operation and characteristics of DIAC & TRIAC

CO	Bloom's Level
CO1	Action Verb from Blooms Taxonomy-**Calculate**/ Cognitive level- Application (BL-3)
CO2	Action Verb from Blooms Taxonomy-**Select**/ Cognitive level- Application (BL-4)
CO3	Action Verb from Blooms Taxonomy-**Compute**/Cognitive level- Analysis (BL-3)
CO4	Action Verb from Blooms Taxonomy-**Examine**/Cognitive level- Analysis (BL-3)
CO5	Action Verb from Blooms Taxonomy-**Utilize**/Cognitive level- Analysis (BL-3)

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Non-Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	1	-	2
CO2	2	3	1	-	2	-	-	-	-	-	-	1	-	2
CO3	2	3	1	-	2	-	-	-	-	-	-	1	-	2
CO4	2	3	-	-	2	-	-	-	-	-	-	1	-	2
CO5	2	3	-		2	-	-	-	-	-	-	1	-	2

SYLLABUS

UNIT I: **[8 Periods]**

Thyristors: Introduction, principle of operation, two transistor model, static V-I characteristics, dynamic characteristics, gate characteristics, turn on methods, thyristor ratings, measurement of thyristor parameters, protection circuits.

UNIT II: **[12 Periods]**

Gate Triggering Circuits and Commutation Circuits: Resistance firing, resistance-capacitor firing, UJT triggering, class A, class B, class C, class D, class E, class F commutation circuits.

Series and Parallel Operation of Thyristors: Equalizing networks, string efficiency, derating.

UNIT III: **[10 Periods]**

Phase Controlled Rectifiers: Single phase -half wave, full wave & bridge controlled rectifiers. Three phase half wave and full wave controlled rectifiers, three phase fully controlled bridge rectifier effect of source inductance on single phase and three phase converters.

UNIT IV: **[10 Periods]**

Inverters: Classification, voltage source inverters, current source inverters, the Mc-Murray inverter, series and parallel inverters,

UNIT V: **[10 Periods]**

Choppers: Principle of operation, step-up, step-down choppers, two quadrant type A chopper, four quadrant chopper, Jones chopper, Buck converter, Boost Converter and Buck-Boost converter, AC voltage controllers R, R-L loads.

Cyclo Converters: Principle of operation, single phase to single phase Cycloconverter. Principle of operation and static characteristics of Diac & Triac.

Text Books:

1. Power Electronics by Dr. P.S. Bimbra, 4th Edition, 2012, Khanna Publishers.
2. Power Electronics by M.D. Singh, K.B. Khanchandani, 2nd edition, 2006,Tata McGraw –Hill Publishing Company Limited.

Reference Books:

1. Power Electronics, Circuits, Devices & Applications by Muhammad H Rashid, 4th Edition, 2003, Pearson Education.
2. Power Electronics for Technology by Ashfeq Ahmed, Prentice hall Education, 1998.

POWER SYSTEM ANALYSIS	
EEE 325	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Apply** per unit calculations to **Develop** reactance diagram for a given single line diagram.
CO2	BL-3	**Apply** Gauss-Seidel, Newton-Raphson and Fast Decoupled methods to **Compute** different parameters of the load flow problem.
CO3	BL-4	**Analyze** symmetrical and unsymmetrical faults to **Compute** fault current of the given single line diagram.
CO4	BL-4	**Analyze** the steady state and transient stability on single machine connected to infinite bus system to **Determine** steady state and transient stability limit.

CO	Bloom's Level
CO1	Action Verb from Blooms Taxonomy-**Develop**/ Cognitive level- Application (BL-3)
CO2	Action Verb from Blooms Taxonomy-**Apply**/ Cognitive level- Application (BL-3)
CO3	Action Verb from Blooms Taxonomy-**Analyze**/Cognitive level- Analysis (BL-4)
CO4	Action Verb from Blooms Taxonomy-**Analyze**/Cognitive level- Analysis (BL-4)

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	-	-	-	-	-	-	-	-	1	2	-
CO2	2	3	2	-	2	-	-	-	-	-	-	1	3	-
CO3	2	3	2	-	2	-	-	-	-	-	-	1	3	-
CO4	2	3	2	-	2	-	-	-	-	-	-	1	3	-

SYLLABUS

UNIT-I **[8 Periods]**

Per Unit System of Representation

Single line diagram, per unit system, per unit impedance of a 3-winding transformer, per unit impedance and reactance diagram of a power system.

UNIT-II **[12 Periods]**

Power Flow Analysis

Formulation of bus admittance matrix, classification of buses, power flow problem, Gauss-Seidel Method, Newton-Raphson method, Decoupled & Fast decoupled method of solving power flow problem.

UNIT-III **[10 Periods]**

Symmetrical Fault Analysis

Formulation of bus impedance matrix, 3-phase short circuit currents and reactance of a synchronous machine, methods of calculating symmetrical fault currents, selection of circuit-breakers, fault limiting reactors.

UNIT-IV **[10 Periods]**

Un-Symmetrical Fault Analysis

Symmetrical components, 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, phase shift in delta/star Transformers.

Unsymmetrical faults –L-G, L-L, L-L-G on an unloaded alternator.

UNIT-V **[10 Periods]**

Power System Stability

Concepts of stability (steady state and transient), swing equation, steady state stability limit, equal area criterion, critical clearing angle and time for transient stability, step by step method of solution, methods of improving transient stability, Introduction to voltage stability.

Text Books:

1. Power System Analysis by Hadi Sadat, TMC Publications, 3rd edition, 2010.
2. Elements of Power System Analysis by John J. Grainger & William D. Stevenson, Jr.TMH Publications, 2014.
3. Modern Power System Analysis by I.G. Nagrath & D.P. Kothari, TMH Publications, 4th edition, 2011.

Reference Books:

1. Electric Power Systems by B. M. Weedy & B. Cory, Wiley Publications, 4th edition, 2012.
2. Power System Analysis &Design Systems by J. Duncan Glover, M.S.Sarma & Thomas J. Overbye, CLI Private Ltd., 2012.

RESEARCH METHODOLOGY	
EEE 326	**Credits : 0**
Instruction : 2 Periods /Week	**Sessional Marks : 00**
End Exam : 0 Hours	**End Exam Marks : 00**

SYLLABUS

Unit-1: Introduction, Problem Identification & Formulation

Introduction to Research: Foundation, Objectives, Motivation, Concept of Utility theory, empiricism, deductive and inductive theories. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Research Process. Problem Identification & Formulation – Research Questionnaires – Investigation Questionnaires – Measurement Issues – Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

Unit-2: Research Design & Qualitative, Quantitative Approaches

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

Unit-3: Experimental Design & Sampling

Concept of Independent & Dependent variables. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. Guidelines for designing experiments, Experiments with single factor: Analysis of Variance, Analysis of the fixed effects model, Model adequacy checking, sample computer output, Regression approach to the Analysis of Variance.

Unit-4: Data Analysis

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

Unit-5: Interpretation and Writing of Paper

Layout of a Research Paper, Journals in Mechanical Engineering, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopaedias, Research Guides, Handbook etc., Academic Data bases for Mechanical Engineering Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

REFERENCE BOOKS:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari

CONTROL SYSTEM LABORATORY	
EEE 329	**Credits : 1.5**
Instruction : 3 Periods Week	**Sessional Marks : 50**
End Exam : 3 Hours	**End Exam Marks : 50**

Course Outcomes:

At the end of the lab course student should able to

CO1	Develop the mathematical modelling of ac and dc servomotors.
CO2	Analysis of Synchro pair (error detector).
CO3	Analyse the response of 1^{st},2^{nd} and 3^{rd} order systems with and without feedback
CO4	Design a compensator to improve the response.

LIST OF EXPERIMENTS

1. Characteristics of magnetic amplifier
2. Digital control systems (microprocessor based)
3. Digital control systems (pc interface)
4. Synchro pair
5. Characteristics of ac servo motor
6. Characteristics of dc servo motor
7. Temperature controller(thermal system)
8. Linear system simulator
9. Speed-Torque characteristics of dc motor(closed loop)

ELECTRICAL MACHINES LABORATORY-II	
EEE 330	**Credits : 1.5**
Instruction : 3 Periods Week	**Sessional Marks : 50**
End Exam : 3 Hours	**End Exam Marks : 50**

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

CO1	Analyze the Transformer for 3 phase to 2 phase or 2 phase to 3 phase conversion and also separate the losses.
CO2	Analyze the speed control and performance characteristics of 3 phase Induction machine.
CO3	Analyze the voltage regulation and performance characteristics of 3 phase Synchronous machine.

LIST OF EXPERIMENTS

1. Verification of Scott connection.
2. Load test on a 3-ϕ Induction motor.
3. No load and Block rotor tests on 3-ϕ Induction motor.
4. Speed control of 3-ϕ Slip-ring Induction motor.
5. Regulation of an alternator by EMF and MMF methods.
6. Regulation of an alternator by ZPF method.
7. 'V' and 'Inverted V' Curves of Synchronous motor.
8. Slip test on Salient pole Synchronous machine.
9. 3-ϕ Induction motor runs as a 1-ϕ Induction motor.
10. Sumpner's Test on Three identical 1-ϕ Transformers connected in Δ/Δ.
11. R-L-C Load Test on a 1-ϕ Transformer.
12. Equivalent circuit of a 1-ϕ Induction motor.
13. Line-excited Induction generator
14. Separation of losses in single phase transformer