Study Scheme Structure for Five-Year Integrated M. Tech. Programme in Electrical Engineering

SEMESTER-III							
S.N.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	BSMA-501	Numerical and Statistical Methods	3	0	0	3	3
2	BSBL-501	Biology for Engineers	2	0	0	2	2
3	PCEE-511	Electrical Circuit Analysis and Synthesis	3	1	0	4	4
4	PCEE-512	Electronic Devices and Circuits	3	1	0	4	4
5	PCEE-513	Electrical Machines-I(Transformer and DC Machines)	3	1	0	4	4
6	MCUG-501	Universal Human Values-II: Understanding Harmony	3	0	0	3	3
7	BSMA-502	Numerical and Statistical Methods Lab	0	0	2	2	1
8	PCEE-514	Electrical Machines-I Lab	0	0	2	2	1
9	PCEE-515	Electrical Circuit Lab	0	0	2	2	1
		Total	**17**	**3**	**6**	**26**	**23**
Total credits at the end of Semester III: 65							

SEMESTER-IV A							
S.N.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	ESME-501	Engineering Mechanics	3	1	0	4	4
2	PCEE-521	Digital Electronics	3	0	0	3	3
3	PCEE-522	Electrical Machines-II (Asynchronous and Synchronous Machines)	3	1	0	4	4
4	PCEE-523	Signals and Systems	3	1	0	4	4
5	HSMC-501	Principles of management	3	0	0	3	3
6	PCEE-524	Analog and Digital Electronics Lab	0	0	2	2	1
7	PCEE-525	Electrical Machines-II Lab	0	0	2	2	1
8	MCMH-501	Indian Constitution	3	0	0	3	0 (S/US)
		Total	**18**	**3**	**4**	**25**	**20**

SEMESTER-IVB							
S.N.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	TPID-521	Academic Research Internship/ Industrial Training (02 weeks)				80	1 (S/US)
2	EAA-521+	Fractional credit course/Extra Academic Activity +GROUP A/B/C				40	1 (S/US)
Total credits at the end of Semester IV: 87							

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Subject Code : PCEE-511
Title of the course : Electrical Circuit Analysis and Synthesis

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

CO1 be familiar with the fundamental concepts of network analysis.
CO2 know about the network theorems and application on analysis of AC and DC networks.
CO3 determine network functions and system stability using network stability criteria.
CO4 be familiar with the fundamental concepts of synthesis of two-port passive networks.
CO5 learn various characteristics of Attenuators and Filters.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL2, BL3	BL3, BL4	BL1, BL2	BL2, BL4

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
	Program Outcomes (POs)/Program Specific Outcomes (POs)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	1	-	-	1	1	1	3	3	1
CO2	3	-	2	-	2	-	-	-	3	-	-	2	3	1
CO3	3	3	-	3	3	1	-	-	3	2	1	-	3	2
CO4	3	2	3	2	-	1	-	-	2	2	-	3	3	1
CO5	3	2	3	-	3	1	-	-	2	-	1	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit -1	**Graph Theory:** Graph of a network, definitions, tree, co tree, link, basic loop and basic cut set, incidence matrix, cut set matrix, tie set matrix duality, loop and node methods of analysis.	6
	Network Theorems (Applications to AC Networks): Super-position theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, reciprocity theorem. Millman's theorem, compensation theorem, Tellegen's theorem.	8
	Network Functions: Concept of complex frequency, transform impedances network functions of one port and two port networks, concept of poles and zeros, properties of driving point and transfer functions, time response and stability from pole zero plot, frequency response and bode plots.	10
Unit -2	**Two Port Networks:** Characterization of LTI two port networks ZY, ABCD and h parameters, reciprocity and symmetry, inter-relationships between the parameters, inter-connections of two port networks, Ladder and Lattice networks. T & Π Representation.	10
	Network Synthesis: Positive real function; definition and properties; properties of LC, RC and RL driving point functions, synthesis of LC, RC and RL driving point immittance functions using Foster and Cauer first and second forms.	8
	Filters: Image parameters and characteristics impedance, passive and active filter fundamentals, low pass, high pass, band pass, band elimination filters.	6

Recommended Books: -

1. A. Chakrabarti, "Circuit Theory", 6thEdition, Dhanpat Rai Co., 2010.
2. E. Donald Scott, "An Introduction to Circuit analysis: A System Approach", New York Mc-Graw Hill, 1987
3. D. Roy Choudhary, "Networks and Systems", 2nd Edition, New Age International Publication, 2010.
4. M.E. Van Valkenburg, "Network Analysis", 3rd Edition, Prentice Hall of India/Pearson Education,2002

5. VK Aatre, "Network Theory and Filter Design," Wiley and Sons
6. Sundararajan, D. Introductory Circuit Theory. Germany, Springer International Publishing, 2019.
7. Bakshi, Uday A., and Bakshi, Late Ajay V. Network Synthesis and Filter Design. India, UNICORN Publishing Group, 2020.
8. Prof. S.C. Dutta Roy, Circuit Theory, IIT Delhi, NPTEL course code 108102042

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Subject Code : PCEE-512

Title of the course : Electronic Devices and Circuits

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1 be familiar with the structure of basic electronic devices.
CO2 be exposed to the operation of electronic devices.
CO3 implement applications of electronic devices.
CO4 be familiar with the Operational amplifier characteristics and applications.
CO5 be familiar with the multivibrators.

Mapping COs/Bloom's Taxonomy Level (BLs)					
Cos	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL2, BL3	BL3, BL4	BL2, BL3	BL1, BL2

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
	Program Outcomes (POs)/Program Special Outcome (PSO's)													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	-	-	1	2	-	-	-	2	1	-	3	1
CO2	3	3	2	3	3	-	1	-	2	2	2	2	3	1
CO3	2	3	2	-	2	2	1	1	2	2	-	2	3	1
CO4	3	-	2	2	-	2	-	-	2	2	3	-	3	1
CO5	2	3	3	3	2	-	-	1	2	2	2	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**PN Junction Devices:** PN junction diode: structure, operation, V-I characteristics, Transition & diffusion capacitances, Special purpose diodes: Zener diode, light emitting diaode, photodiode, laser diode, Schottky diode, Varactor diode and Tunnel diode. Diode applications like rectifiers: half wave and full wave rectifier, Filters: capacitor, LC, π-filter, Clipping & clamping circuits, Voltage multipliers	08
	Bipolar Junction Transistor: Transistors-construction, operation, characteristics, parameters, transistor as an amplifier at low frequency, hybrid model and re model of BJT, analysis of amplifier using hybrid model and re model, amplifier types-CE, CB, CC. DC operating point, Biasing circuits fixed bias, emitter bias, voltage divider bias, bias stabilization.	10
	FET and MOSFET: Introduction to FET, MOSFET, their construction, operation and characteristics	06
Unit-2	**Feedback Amplifier and Oscillators:** Feedback concept, advantages of negative feedback, voltage / current, series, shunt feedback, positive feedback, Criterion for oscillations, phase shift, Wien bridge, Hartley, Colpitts and crystal oscillators.	08
	Introduction to Op-Amps: Op-amp- analysis, Ideal op-amp building blocks, open loop op-amp configurations, practical op-amp, offset voltage, input bias and offset current, CMRR. Applications of op-amps. Specialized ICs: 555 Timer-monostable multivibrator, astable multivibrator, PLL.	16

Recommended Books-

1. Bell, David "Electronic Devices and Circuits", Prentice Hall of India, 2004.
2. Sedra and Smith, "Microelectronic Circuits", Oxford University Press, 2004.

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3. RA Gayakwad, "Op-amps and Linear Integrated Circuits", 4th Edition, Pearson Education.
4. Rashid, "Micro Electronic Circuits" Thomson Publications, 1999.
5. Floyd, "Electron Devices" Pearson Asia 5th Edition, 2001.
6. Yawale, Sangita, and Yawale, Shrikrishna. Operational Amplifier: Theory and Experiments. Singapore, Springer Singapore, 2021.
7. Yawale, Sangita, and Yawale, Shrikrishna. Operational Amplifier: Theory and Experiments. Singapore, Springer Singapore, 2021.
8. By Prof. Sanjiv Sambandan, Semiconductor Devices and Circuits, IISC Bangalore, NPTEL course.

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Subject Code : **PCEE-513**
Title of the course : **Electrical Machines-1 (Transformers and DC Machines)**

L	T	P	Credits	Weekly Load
3	1	0	4	4

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

CO1 understand the construction and working principles of single phase and auto transformers.
CO2 acquire the knowledge of three phase transformers, different type of winding connection, parallel operation and testing of transformers
CO3 explain construction and working principle of DC generator and various method of improving commutation.
CO4 describe the construction, working principles, and characteristics of DC motors.
CO5 learn various methods of starting and braking of DC motor.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2, BL3	BL2, BL3	BL2, BL3	BL2, BL3	BL2, BL3

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
COs	Program Outcomes (POs)/Program Special Outcome (PSO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	2	-	1	1	2	-	2	3	1
CO2	2	-	2	3	2	-	1	-	-	2	2	2	3	1
CO3	3	-	2	3	2	-	-	2	1	2	2	2	3	1
CO4	3	2	2	3	-	2	1	-	-	2	2	2	3	1
CO5	3	2	2	3	-	2	-	-	1	2	2	-	3	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Transformers:** Working principle, construction of single-phase transformers, EMF equation, phasor diagrams on no-load and on loaded conditions, open circuit and short circuit tests, equivalent circuit parameters estimation, voltage regulation and efficiency, back-to-back test. effect of saturation on exciting current and in-rush current phenomenon. Parallel operation of single-phase transformers.	10
	Auto Transformers: Principle of operation, equivalent circuit and phasor diagrams, comparison with two winding transformers.	04
	Three-Phase Transformers: Different types of winding connections, Voltage and current ratios, Parallel operation of three phase transformers. Three winding transformers' equivalent circuit, off-load and on-load tap changing transformers, Scott connections. Testing of transformers.	10
Unit-2	**D.C. Generator:** Working principle, construction of DC machines, armature windings, single- and double-layer winding diagrams, electro motive force (E.M.F.) and torque equations, armature reaction, effect of brush shift, compensating winding, commutation, causes of bad commutation, methods of improving commutation, methods of excitation of D.C. generators and their characteristics.	12
	D.C. Motor: Working principle, characteristics, starting of shunt and series motor, starters, speed control methods: field and armature control. Braking: plugging, dynamic	12

	and regenerative braking, Testing: Swinburn's test, Hopkinson test, Field test. estimation of losses and efficiency.	

Recommended Books-

1. A.E. Fitzgerald, C. Kingsley and S.D. Umans, Electric Machinery, 6th Edition, McGraw Hill, 2005.
2. E.H. Langsdorff, Principles of D.C. machines, McGraw Hill, 2013.
3. I.J. Nagrath and D.P. Kothari, Electrical Machines, 4th Edition, Tata McGraw Hill, 2010.
4. M.G. Say, Alternating Current Machines, 5th edition, Sir Isaac Pitman & Sons Ltd, 2005.
5. P.S. Bhimbhra, Electrical Machinery, 7th edition, Khanna Publishers, 2015.
6. Melkebeek, Jan A. Electrical Machines and Drives: Fundamentals and Advanced Modelling. Switzerland, Springer International Publishing, 2019.
7. Sen, P. C.. Principles of Electric Machines and Power Electronics. United Kingdom, John Wiley & Sons, Limited, 2021.
8. Prof. Tapas Kumar Bhattacharya, Electrical Machines - I, IIT Kharagpur, NPTEL course code 108105155.

Subject Code : **PCEE-514**
Title of the course : **Electrical Machines-1 Lab**

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1 understand construction and working principle of single phase and auto transformers.
CO2 acquire the knowledge of three phase transformers, different type of winding connection, parallel operation and testing of transformers
CO3 explain construction and working principle of DC generator and various method of improving commutation.
CO4 describe the construction, working principle and characteristics of DC motor.
CO5 learn various method of starting and braking of DC motor.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2, BL3	BL2, BL3	BL2, BL3	BL2, BL3	BL2, BL3

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
COs	Program Outcomes (POs)/Program Special Outcome (PSO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	2	-	1	-	2	-	2	2	1
CO2	2	-	2	3	2	2	1	-	1	2	2	2	2	1
CO3	3	-	2	3	2	2	-	-	1	2	2	2	1	1
CO4	3	2	2	3	-	2	1	1	-	2	2	-	1	1
CO5	3	2	2	3	2	2	-	-	1	2	2	-	2	2

To understand the practicability of Electrical Machine-I, the list of experiments is given below to be performed (at least 10) in the laboratory.

1. To perform Open circuit and short circuit tests on a single-phase transformer and hence find the equivalent circuit, voltage regulation and efficiency.
2. To perform a load test on a single-phase transformer.
3. To separate the core losses of a single-phase transformer at no load.
4. To perform the parallel operation of two single-phase transformers.
5. To study the various connections of a three-phase transformer.
6. To perform Scott connections on three-phase transformers to get a two-phase supply.
7. To study the constructional details of a direct current (DC) machine.
8. To measure armature and field resistance of direct current (DC) machine.
9. To draw the open circuit characteristics (OCC) of DC shunt generator.
10. To draw the Load characteristic of DC shunt generator.
11. To perform speed control of a DC motor using field control and armature control method.
12. To perform Swinburne's test (no load test) to determine losses of direct current (DC) shunt motor.
13. To perform Hopkinson Test on DC machine.

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Subject Code : PCEE-515
Title of the course : Electrical Circuits Laboratory

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

CO1 Analyze waveforms, signals, signal superposition and Fourier transform.
CO2 Apply Laplace transforms for analyzing the networks in time and frequency domain.
CO3 Learn the characteristics of Attenuators and various types of Filters.
CO4 Understand the fundamental concepts of network analysis and synthesis of two- port passive networks.
CO5 To synthesize an electrical network from a given impedance/admittance function.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3, BL4	BL3, BL4	BL2, BL3	BL2, BL3	BL4, BL6

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
	Program Outcomes (POs)/Program Special Outcomes (PSO's)													
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	-	2	1	-	1	2	-	2	1	1
CO2	2	-	2	3	2	2	-	-	-	2	2	2	1	2
CO3	3	1	2	3	2	2	-	1	1	2	2	2	1	1
CO4	3	2	-	3	2	2	1	-	-	2	2	-	1	1
CO5	3	2	2	3	2	-	-	-	1	2	2	1	1	2

LIST OF EXPERIMENTS

1. Experimental verification of Kirchhoff's voltage and current laws
2. Experimental verification of Thevenin theorem,
3. Experimental verification of Reciprocity Theorem.
4. Experimental verification of Superposition Theorem.
5. Experimental verification of maximum power transfer Theorem
6. Experimental determination of time constant of series R-C electric circuits.
7. Experimental determination of frequency response of RLC circuits.
8. Design and Simulation of series resonance circuit.
9. Design and Simulation of parallel resonant circuits.
10. Simulation of low pass passive filters.
11. Simulation of high pass passive filters.
12. Determination of two port network parameter

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Subject Code : PCEE-521
Title of the course : Digital Electronics

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO 1: exercise various number systems, binary operation and error correction.

CO 2: interpret Boolean algebra, encoders, decoders and code conversion.

CO 3: know about working of latch, flip-flops, registers, counters and their types.

CO 4: learn A/D converter and D/A converter

CO 5: know about digital ICs, logic families, memories and programmable logic arrays.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL1, BL2	BL2	BL2	BL4

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
COs	Program Outcomes (POs)/Program Special Outcome (PSO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	1	-	-	1	1	2	2	3	2
CO2	3	3	2	2	1	-	-	-	-	3	3	3	3	2
CO3	3	-	3	-	3	1	-	-	-	3	-	3	2	2
CO4	3	3	3	2	2	-	-	-	3	3	-	3	3	3
CO5	3	-	3	-	2	1	-	-	3	3	1	2	2	3

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Number System & Codes:** Review of number systems, binary number systems, octal number system, hexadecimal number system, signed & unsigned numbers, 1's & 2's complement of a number, different types of codes & their conversions, binary operations- addition, subtraction, multiplication, division.	08
	Combinational Logic: Concept of positive & negative logic, introduction to Boolean variables. Logical functions using Karnaugh map & Quine-Macluskey methods, multiplexers, demultiplexers, encoders, decoders, adders, subtractors, parity generators, parity checkers, code converter.	06
	Sequential logic concepts and components: Flip flops - SR, JK, D and T flip flops – Level triggering and edge triggering, Shift registers, type of registers, circuit diagrams, synchronous& asynchronous counters, excitation tables, design with state equation state diagram counters, up & down counters, ring counters & mod, counters. Introduction to finite state machines.	10
Unit-2	**Digital to Analog (D/A) and Analog to Digital (A/D) Converters:** Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter ICs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs	10
	Digital Logic Families: Introduction, characteristics of digital ICs, integrated injection logic, direct coupled transistor, transistor-transistor logic, emitter coupled logic, MOS & CMOS logic, and high threshold logic families. arrays, flash memory. Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.	06
	Semiconductor Memories: Introduction, memory organization, classification & characteristics of memories, sequential memories, read only memories, read & write memories, content addressable memories, programmable array logic and programmable logic arrays, flash memory.	08

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	Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	

Recommended Books-

1. Albert Paul Malvino, "Principles of Digital Electronics", 4th Edition, Tata McGraw Hill, 1991.
2. Anand Kumar, "Fundamentals of Digital Circuits", 3rd Edition, Prentice Hall of India, 2014.
3. D.P. Kothari and J.S. Dhillon, Digital Circuits and Design, Pearson Education, 2016
4. Morris Mano, "Digital Logic and Computer Design", 2nd Edition, Prentice Hall of India, 1991.
5. R.P. Jain, Modern digital Electronics, Tata McGraw Hill, 1999.
6. R.J.Tocci, Neal S. Widmer and Gregory L.Moss, "Digital Systems: Principles and Applications", 11th Edition, Prentice Hall of India, 2010
7. S. Floyd Thomas, "Digital Fundamentals", 10th Edition, Pearson Education, 2013.
8. Natarajan, Dhanasekharan. Fundamentals of Digital Electronics. Germany, Springer International Publishing, 2020.
9. Zappa, Franco. Digital Electronics: Logic Gates and Families, Design Methodologies, Combinational Logic and Devices, Sequential Networks and Components, Memories. Italy, Società Editrice Esculapio, 2019.
10. Prof. Goutam Saha, Digital Electronic Circuits, IIT Kharagpur, NPTEL course code 108105132.

27.7.20

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Subject Code : PCEE-522

Title of the course: Electrical Machines–II (Asynchronous Machines and Synchronous Machines)

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO 1: interpret the basics of Induction machine, rotating field, torque etc.

CO 2: know the construction, operation and characteristics of poly-phase induction machine.

CO 3: simulate the steady-state and transient state performance of synchronous machines to identify performance measures.

CO 4: analyze the operation, use and characteristics of induction generator.

CO 5: select the appropriate AC motor for different large power applications

Mapping COs/Bloom's Taxonomy Level (BLs)					
Cos	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL2, BL4	BL6	BL4	BL5

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
Cos	Program Outcomes (POs)/Program Special Outcomes (PSO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	2	1	-	-	2	3	3	2	2
CO2	3	3	2	3	-	3	-	-	-	2	2	2	2	2
CO3	3	2	3	3	3	2	2	-	1	2	3	-	2	3
CO4	3	2	2	3	-	2	-	1	1	2	2	2	2	1
CO5	3	1	3	3	2	3	-	-	2	2	2	-	3	3

Unit	Main Topics and Course Outlines	Hour(s)
Unit -1	**Fundamentals of AC Machine Windings:** Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn coil, full-pitch coils, concentrated winding, distributed winding, winding distribution factor, magnetic field produced by a single winding- fixed current and alternating current pulsating fields produced by spatially displaced windings, revolving magnetic field.	08
	Induction Machines: Construction, types (squirrel cage and slip-ring), principle of operation, torque and slip, torque slip characteristics, equivalent circuit. phasor diagram, torque speed characteristics (variation of rotor and stator resistances), methods of starting, braking and speed control for induction motors. effect of varying supply voltage and frequency on torque and speed, starting torque, full load torque and max. torque, torque speed curves and operating region, power loss and efficiency, rotor output, synchronous watt, max power output, induction motor testing, double cage and deep bar motor.	10
	Single-Phase Induction Motors: Constructional features, double revolving field theory, equivalent circuit, determination of parameters. split-phase starting methods and applications	06
Unit -2	**Synchronous Machines:** Constructional features, cylindrical rotor synchronous machine and salient pole machine, principle of operation, EMF equation, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.	18
	Special Machine: Introduction to various PM motors, BLDC and PMSM, reluctance motor, Hysteresis motor, linear induction motor (LIM).Projects related to this course should be given to students (in groups) in order to promote team work and ethical values.	06

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Recommended Books-

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. E.H. Langsdorff, Principles of A.C. Machines, Tata McGraw Hill, 2004.
3. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
4. P.S. Bimbhra, Electrical Machinery, 7th Edition, Khanna Publishers, 2011.
5. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.
6. Bakshi, Uday A., and Bakshi, Mayuresh V. Electrical Machines - II. India, UNICORN Publishing Group, 2020.
7. Boldea, Ion. Induction Machines Handbook: Steady State Modeling and Performance. United States, CRC Press, 2020.
8. Prof. Tapas Kumar Bhattacharya, Electrical Machines – II by IIT Kharagpur, NPTEL course.

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Subject Code : **PCEE-523**
Title of the course : **Signals and Systems**

L	T	P	Credits	Weekly Load
3	1	0	4	4

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

CO 1: interpret signals, convolution and learn various properties.
CO 2: understand the types of systems and their properties and interaction with signals.
CO 3: be conversant in Fourier Series, Fourier Transform along with their basic properties
CO 4: be conversant with the Laplace transform to analyze the continuous time signals and systems.
CO 5: be conversant with the z transform to analyze the discrete time signals and systems.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL2	BL1, BL2	BL4	BL1, BL2

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
COs	Program Outcomes (POs)/Program Special Outcome (PSO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	2	-	-	1	2	2	2	2	2
CO2	3	3	3	3	2	2	2	-	1	2	2	2	2	2
CO3	3	3	3	-	3	3	1	-	-	2	3	-	3	3
CO4	3	3	2	-	3	3	-	1	-	2	3	1	2	3
CO5	3	2	2	2	2	-	-	-	1	2	3	-	2	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to Signals and Systems:** Signals and systems as seen in everyday life, and in various branches of engineering and science. signal properties: periodicity, absolute integrability, determinism and stochastic character. some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals.system properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. examples.	10
	Behavior of Continuous and Discrete-Time LTI Systems: Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. system representation through differential equations and difference equations. state-space representation of systems. state-space analysis, multi-input, multi-output representation. state transition matrix and its role. periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.	14
Unit-2	**Fourier, Laplace and Z - Transforms:** Fourier series representation of periodic signals, waveform symmetries, calculation of Fourier coefficients. Fourier transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. the discrete-time Fourier transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's theorem. review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behaviour. the z-transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.	12
	Sampling and Reconstruction: The sampling theorem and its implications. spectra of sampled signals. reconstruction: ideal interpolator, zero-order hold, first-order hold. aliasing and its effects.	12

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	relation between continuous and discrete time systems. introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.	

Recommended Books:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006.
3. Hsu, Hwei P. Schaum's Outline of Signals and Systems, Fourth Edition. Greece, McGraw-Hill Education, 2019.
4. S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, 2007.
5. Hsu, Hwei Piao. Signals and Systems. United States, McGraw Hill Education, 2020.
6. Prof. Aditya K. Jagannatham, Principles of Signals and Systems, IIT Kanpur course code 108104100.

Subject Code : **PCEE-524**
Title of the course : **Analog and Digital Electronics Lab**

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO 1: basic knowledge about digital components.
CO 2: implement the Boolean algebra, coding-decoding, Multiplexing, de-multiplexing etc.
CO 3: acquire knowledge to rectify various digital circuits with logic.
CO 4: practical approach for designing digital circuits.

Mapping COs/Bloom's Taxonomy Level (BLs)				
Cos	CO1	CO2	CO3	CO4
BLs	BL1, BL2	BL2, BL3	BL1, BL2	BL6

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
COs	Program Outcomes (POs)/Program Special Outcome (PSO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	2	2	-	-	1	-	2	2	3	2
CO2	3	3	3	2	3	-	-	1	2	2	2	2	2	1
CO3	3	2	2	-	3	3	-	-	1	-	3	2	2	1
CO4	3	2	2	2	2	3	1	-	3	3	3	-	3	3

To understand the practicability of **Digital Electronics**, the list of experiments is given below to be performed (at least 10) in the laboratory.

1. Plot forward and reverse bias characteristics of Zener diode.
2. Plot input and output characteristics of BJT
3. Study of Op-amp as summer, integrator and differentiator.
4. Verification of the truth tables of TTL gates.
5. Verify the NAND and NOR gates as universal logic gates.
6. Design and verification of the truth tables of Half and Full adder circuits.
7. Design and verification of the truth tables of Half and Full subtractor circuits.
8. Verification of the truth table of the Multiplexer 74150.
9. Verification of the truth table of the De-Multiplexer 74154.
10. Design and test of an S-R flip-flop using NOR/NAND gates.
11. Verify the truth table of a J-K flip-flop (7476)
12. Verify the truth table of a D flip-flop (7474)
13. Operate counters 7490, 7493.
14. Design of 4-bit shift register (shift right).

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Subject Code : **PCEE-525**

Title of the course : **Electrical Machines – II Laboratory**

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO 1: interpret the basics of Induction machine, rotating field, torque etc.

CO 2: know the construction, operation and characteristics of poly-phase induction machine.

CO 3: simulate the steady-state and transient state performance of synchronous machines to identify performance measures.

CO 4: analyze the operation, use and characteristics of induction generator.

CO 5: select the appropriate AC motor for different large power applications

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL2	BL6	BL4	BL5

CO/PO Mapping: (Strong (3) / Medium (2) / Weak (1) indicates strength of correlation):														
COs	Program Outcomes (POs)/Program Special Outcome (PSO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	1	-	-	2	2	2	3	2
CO2	3	3	3	2	3	2	-	1	1	2	2	2	2	1
CO3	3	3	-	3	3	3	1	1	-	3	3	2	2	1
CO4	3	3	2	-	2	-	-	-	2	3	3	-	3	3
CO5	3	3	3	2	2	2	1	-	-	2	2	2	3	2

To understand the practicability of **Electrical Machines**, the list of experiments is given below to be performed (at least 10) in the laboratory.

1. To perform no-load and blocked–rotor tests on three-phase Induction motor to obtain equivalent circuit. Parameters and draw circle diagrams.
2. To perform load-test on three-phase Induction motor and to plot torque versus speed characteristics.
3. To study star- delta starters physically and **a)** to draw electrical connection diagram **b)** to start the three-phase Induction motor using it. c) to reverse the direction of three-phase Induction motor.
4. To start a three-phase slip –ring induction motor by inserting different levels of resistance in the rotor circuit and to plot torque –speed characteristics.
5. To perform no-load and blocked–rotor test on single-phase Induction motor and to determine the parameters of equivalent circuit.
6. To perform load –test on single-phase. Induction motor and plot torque –speed characteristics.
7. To perform no load test on the alternator and draw open circuit characteristics (OCC).
8. To perform short circuit test on the alternator and draw short circuit characteristics (SCC).
9. To perform load test on the alternator and draw terminal voltage characteristics
10. To find voltage regulation of an alternator by zero power factor (ZPF.) method.
11. To draw "V" and inverted "V" curves of synchronous motor.
12. To measure negative sequence and zero sequence reactance of Synchronous Machines.
13. Parallel operation of three phase alternators using • Dark lamp method • Two-Bright and one dark lamp method.