ACADEMIC CURRICULA

Professional Core Courses

ELECTRICAL & ELECTRONICS ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18EEC201J	Course Name	ANALYSIS OF ELECTRIC CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18EES101J*	Co-requisite Courses		Progressive Courses	
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze real-time circuits using mesh and nodal analysis and network reduction*
CLR-2 :	*Utilize solutions of AC circuits including series and parallel resonance*
CLR-3 :	*Utilize network theorems on DC & AC circuits*
CLR-4 :	*Examine circuits at transient condition*
CLR-5 :	*Solve 3 phase circuits, coupled and tuned circuits*
CLR-6 :	*Enrich the concepts of AC and DC circuits using different analysis*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Analyze circuit parameters, analyze circuits using mesh and nodal analysis and network reduction*	*3*	*75*	*75*	*H*	*H*	-	-	-	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-2 :	*Evaluate solution methods of AC circuits including series and parallel resonance*	*3*	*75*	*75*	*H*	*H*	-	-	*M*	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-3 :	*Calculate solutions of network theorems for DC and AC circuits*	*3*	*75*	*75*	*H*	*H*	-	-	-	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-4 :	*Analyze the transients of RLC circuits*	*3*	*75*	*75*	*H*	*H*	*M*	-	*M*	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-5 :	*Analyze 3 phase circuits, coupled, tuned circuits and two port networks.*	*3*	*75*	*75*	*H*	*H*	*M*	-	-	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-6 :	*Evaluate AC and DC circuits under different cases*	*3*	*75*	*75*	*H*	*H*	*M*	-	*M*	-	-	-	*M*	*M*	-	-	*M*	*M*	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to two terminal circuit passive elements*	*Introduction to AC circuits*	*Superposition theorem in DC circuits*	*Introduction: Exponentially increasing functions*	*Analysis of balanced three-phase 3 wire circuits*
	SLO-2	*Characteristics of two terminal circuit passive elements*	*Phasors*	*Problems in Superposition theorem in DC circuits*	*Exponentially Decreasing functions*	*Problems in balanced three-phase 3 wire circuits*
S-2	SLO-1	*Circuit Reduction Techniques*	*Impedance*	*Superposition theorem in AC circuits*	*RL free circuits*	*Analysis of unbalanced three-phase circuits*
	SLO-2	*Problems in Circuit Reduction Techniques*	*Admittance*	*Problems in Superposition theorem in AC circuits*	*RL Driven circuits*	*Problems in unbalanced three-phase circuits*
S-3	SLO-1	*Combination of Sources*	*Calculation of Power and Power Factor*	*Reciprocity theorems in AC circuits*	*Transients in RL circuit with DC excitation*	*Two-wattmeter method of measuring three-phase power*
	SLO-2	*Source Transformation*	*Problems in Power and Power Factor*	*Problems in Reciprocity theorems in AC circuits*	*Transients in RL circuit with AC excitation*	*Problems in Two-wattmeter method of measuring three-phase power*
S 4-5	SLO-1 SLO-2	*Lab 1: Circuit reduction and basic laws*	*Lab 4: Determine Power and Power Factor*	*Lab 7: Verify Superposition and Reciprocity Theorems*	*Lab 10: Analyze Time domain of RL transient circuit*	*Lab 13: Measure power in 3 phase circuits using two wattmeter method*
S-6	SLO-1	*Mesh current analysis of DC circuits with dependent sources*	*Steady state analysis of RL circuits*	*Thevenin's theorem in DC circuits*	*RC free circuits*	*Analysis of coupled circuits*
	SLO-2	*Problems in Mesh current analysis of DC circuits with dependent sources*	*Steady state analysis of RC circuits*	*Norton theorem in DC circuits*	*RC driven circuits*	*Problems in coupled circuits*
S-7	SLO-1	*Mesh analysis in DC circuits with*	*Steady state analysis of RLC circuits*	*Thevenin's theorem in AC circuits*	*Transients in RC circuit with DC excitation*	*Analysis of tuned circuits*

		current sources				
	SLO-2	*Problems in Mesh analysis in DC circuits with current sources*	*Phasor diagram of RLC circuits*	*Problems in Thevenin's theorem in AC circuits*	*Transients in RC circuit with AC excitation*	*Problems in tuned circuits*
S-8	SLO-1	*Nodal Voltage analysis of DC circuits with dependent sources*	*Series resonance circuits*	*Norton's theorem in AC circuits*	*Laplace transforms*	*Introduction to Two port networks*
	SLO-2	*Problems in Nodal Voltage analysis of DC circuits with dependent sources*	*Problems in Series resonance circuits*	*Problems in Norton's theorem in AC circuits*	*Transform impedance*	*Analysis of Two port networks*
S 9-10	SLO-1 SLO-2	*Lab 2: Mesh analysis in DC circuits*	*Lab 5: Real time Data Acquisition*	*Lab 8: Verify Thevenin's and Norton's theorems*	*Lab 11: Analyze Time domain of RC transient circuit*	*Lab 14: Analysis in tuned circuits*
S-11	SLO-1	*Supermesh method for mesh analysis*	*Parallel resonance circuits*	*Millman's theorem in AC circuits*	*Transients in RLC circuit with DC excitation*	*Impedance parameters*
	SLO-2	*Problems in Supermesh method for mesh analysis*	*Problems in Parallel resonance circuits*	*Problems in Millman's theorem in AC circuits*	*Problems in Transients in RLC circuit with DC excitation*	*Problems in impedance parameters*
S-12	SLO-1	*Nodal analysis in DC circuits with voltage sources*	*Mesh analysis in AC circuits*	*Maximum Power Transfer Theorem in DC circuits*	*Transients in RLC circuit with AC excitation*	*Admittance parameters*
	SLO-2	*Problems in Nodal analysis in DC circuits with voltage sources*	*Problems in Mesh analysis in AC circuits*	*Problems in Maximum Power Transfer Theorem in DC circuits*	*Problems in Transients in RLC circuit with AC excitation*	*Problems in admittance parameters*
S-13	SLO-1	*Supernodal method for nodal analysis*	*Nodal analysis in AC circuits*	*Maximum Power Transfer Theorem in AC circuits*	*Circuit transients using Laplace transform*	*Hybrid parameters*
	SLO-2	*Problems in Supernodal analysis*	*Problems in Nodal analysis in AC circuits*	*Problems in Maximum Power Transfer Theorem in AC circuits*	*Problems in Circuit transients using Laplace transform*	*Inverse Hybrid parameters*
S 14-15	SLO-1 SLO-2	*Lab 3: Nodal analysis in DC circuits*	*Lab 6: Study of series and parallel resonance circuits*	*Lab 9: Verify maximum power transfer theorem*	*Lab 12: Analyze Time domain of RLC transient circuits*	*Lab 15: Determine hybrid parameters*

Learning Resources	1. *Sudhakar A, Shyam Mohan S.P, Circuits and Networks Analysis and Synthesis, 4th ed., Tata McGraw Hill, 2010* 2. *William H. Hayt, Jack E. Kemmerly, Steven M. Durbin, Engineering circuit analysis, 8th ed., McGraw Hill, 2012* 3. *Jegatheesan R, Analysis of Electric Circuits, McGraw Hill, 2014*	4. *John Bird, Electric circuit theory and technology, 5th ed., Taylor and Francis, 2013* 5. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/lecture-notes/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr . Roosefart Mohan, Nelcast Limited, chennai,roosefart@gmail.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. R. Jegatheesan, SRMIST*
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Course	18EEC202T	Course	ELECTROMAGNETIC THEORY	Course	*C*	*Professional Core*	L	T	P	C

Code		Name		Category			3	1	0	4

Pre-requisite Courses		Co-requisite Courses		Progressive Courses	
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the concepts of Electromagnetic theory for practical applications*
CLR-2 :	*Utilize knowledge about the static electric field and its applications.*
CLR-3 :	*Utilize knowledge on static magnetic field*
CLR-4 :	*Utilize parameters involved in time varying field and Maxwell's equations*
CLR-5 :	*Enrich in the field of Electromagnetic waves*
CLR-6 :	*Create a mindset to solve various engineering problems in the field of electromagnetism*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Identify the basic laws of electromagnetics and coordinate systems*	*2*	*80*	*75*	*M*	*M*	-	-	-	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-2 :	*Solve the Electric field parameters for simple configuration under static condition*	*3*	*80*	*75*	*H*	*H*	*M*	*L*	-	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-3 :	*Examine the Magnetic field for simple configuration under static condition*	*3*	*80*	*75*	*H*	*H*	*M*	*L*	-	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-4 :	*Extend the basics of electromagnetic theory on time varying electric and magnetic field*	*3*	*80*	*75*	*H*	*H*	*M*	*L*	*M*	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-5 :	*Analyze propagation of electromagnetic waves*	*3*	*80*	*75*	*H*	*H*	*M*	*L*	-	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-6 :	*Apply electromagnetic concepts to solve real time problems*	*3*	*75*	*75*	*H*	*H*	*M*	*L*	*M*	-	-	-	*M*	*M*	-	-	*M*	*M*	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Vector analysis for three-dimensional Euclidean space*	*Current density, Ohms Law in point form*	*Fundamentals of Magnetostatics (B, H)*	*Faraday's law of Electromagnetic induction*	*Wave parameters- velocity, intrinsic impedance- propagation constants*
	SLO-2	*Stokes and Divergence theorem*	*Continuity of current equation*	*Magnetic field due to straight conductor*	*Motional and transformer EMF*	*Uniform plane waves*
S-2	SLO-1	*Three orthogonal coordinate systems – Cartesian system*	*Boundary conditions of perfect dielectric materials*	*B and H for a circular loop*	*Displacement current and conduction current*	*Electromagnetic Wave equation for free space,*
	SLO-2	*Cylindrical and spherical coordinate system*	*Boundary condition between conductor and dielectric, conductor and free space.*	*Magnetic field due to infinite sheet of current.*	*Point form of Maxwell's equation, Integral form of Maxwell's equations*	*Equation for lossy dielectric medium*
S-3	SLO-1	*Conversion from one coordinate to another coordinate system*	*Permittivity of dielectric materials*	*Magnetic materials, permeability*	*Phasor representation of time harmonic field*	*Wave equation for lossless dielectrics and conductors*
	SLO-2	*Solutions of Coulomb's law*	*Dielectric strength and dielectric polarization*	*Magnetic dipole*	*Energy in quasi-stationary Electromagnetic Fields*	*Skin effect and skin depth calculations*
S-4	SLO-1 SLO-2	*Tutorial: Quantitative analysis of coordinate system*	*Tutorial: Quantitative analysis of boundary condition problem*	*Tutorial: Quantitative analysis of B and H calculations*	*Tutorial: Quantitative analysis of Maxwell's Equation*	*Tutorial: Quantitative analysis of Electromagnetic Wave Equation*
S-5	SLO-1	*Fundamentals of electrostatics*	*Capacitance of a two-wire line.*	*Magnetization and Magnetic susceptibility*	*Magnetic Potential*	*Standing wave*
	SLO-2	*Electric field intensity (E) andflux density (D) due to point, line and surface charge*	*Solution of Laplace and Poisson's equation*	*Magnetic field in multiple media – Boundary conditions*	*Potential for time varying fields*	*Plane wave reflection and refraction*
S-6	SLO-1	*D and E for volume charge distribution*	*Applications of Laplace and Poisson's equation*	*Magnetic potential – Scalar and Vector potential. Magnetic diffusion*	*MagNet software*	*The incidence of plane wave at the boundary between two regions*
	SLO-2	*Electric field due to dipole*	*Uniqueness theorem*	*Magnetic force and stress tensor*	*MagNet software for 3D electromagnetic*	*Fresenel's coefficient*

					field simulations	
S-7	SLO-1	*Applications of Gauss law's*	*Duality theorem*	*Inductance calculation for a solenoid and toroid*	*Case study on real time applications of Maxwell's equations*	*Goos-Hanchen's effect*
	SLO-2	*Electric Potential and its calculation for different configurations*	*Method of images*	*Inductance of a coaxial cable*	*Problems on time varying field*	*Snell's law*
S-8	SLO-1 SLO-2	*Tutorial: Quantitative analysis forD, E and potential calculation*	*Tutorial: Quantitative analysis of capacitance calculations and Laplace equations*	*Tutorial: Quantitative analysis of magnetic boundary conditions*	*Tutorial: Quantitative analysis of Poynting vectors and magnetic potential*	*Tutorial: Quantitative analysis of Electromagnetic boundary conditions*
S-9	SLO-1	*Force on a moving charge and differential current element*	*Sketches of fields and field plotting.*	*Inductance derivation for two wire transmission line*	*Case study of Parallel Particle Tracing for Steady-State and Time-Varying Flow Fields*	*Reflection coefficient*
	SLO-2	*Magnetic field and induced emf in rotating machines*	*Finite difference method (FDM)*	*Problems on Inductance calculations*	*Applications of Poynting theorem*	*Transmission coefficient*
S-10	SLO-1	*Mutipole concept*	*FDM to a solution of region and boundary conditions*	*Energy density in magnetic field*	*Electromagnetic Wave Equations*	*Quantitative analysis of wave parameters*
	SLO-2	*Multipole of electrostatic expansion*	*Quantitative analysis of FDM*	*The finite element analysis- an introduction*	*Solutions of Helmholtz's equation*	*Brewster angle*
S-11	SLO-1	*Quadrupole and octupole*	*Method of moment for Electrostatic field*	*Finite element method (FEM) for magnetostatic field*	*Prototype using the concept of EM theory*	*Critical angle*
	SLO-2	*Example for multipole expansion*	*Case study on dust cloud ignition caused by static electricity*	*Case study on super conducting disk in an external magnetic field.*	*Minor Project presentation*	*Case study on fault calculations using EM wave equations*
S-12	SLO-1 SLO-2	*Tutorial: quantitative analysis of force, current and torque*	*Tutorial: Quantitative analysis of Electrostatic field calculations*	*Tutorial: quantitative analysis of magnetostatic field*	*Tutorial: quantitative analysis of electromagnetic field*	*Tutorial: Quantitative analysis of EM wave coefficients*

Learning Resources	*1. William Hayt, Engineering Electromagnetics, 7th ed., McGraw Hill, 2014* *2. Matthew. N.O. Sadiku, Elements of Electromagnetics, 4th ed., Oxford University Press, 2010* *3. David J. Griffths, Introduction to Electrodynamics, 4th ed., Pearson publication, 2013*	*4. Joseph A Edminister, Theory and Problem of Electromagnetics, Schaum's outline series McGraw Hill, 2006* *5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-632-electromagnetic-wave-theory-spring-2003/index.htm*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss, Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. K. S. Swarup, IIT Madras, ksswarup@iitm.ac.in*	*1. Mrs. R. Rajarajeswari, SRMIST*
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Course	18EEC203J	Course	DIGITAL SYSTEM DESIGN	Course	C	*Professional Core*	L	T	P	C

Code		Name		Category			3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize digital systems*
CLR-2 :	*Utilize combinational logic circuits*
CLR-3 :	*Design and implement sequential logic circuits*
CLR-4 :	*Implement different logic functions using transistor and MOSFET*
CLR-5 :	*Analyze the types of PLD's and VHDL programming*
CLR-6 :	*Analyze and design digital logic circuits*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Simplify Boolean expression*	*2*	*75*	*75*	*H*	*M*	*M*	*M*	-	-	-	-	*M*	*M*	-	-	*L*	*M*	-
CLO-2 :	*Solve problems in combinational logic circuits*	*3*	*75*	*75*	*H*	*M*	*M*	*M*	-	-	-	-	*M*	*M*	-	-	*L*	*M*	-
CLO-3 :	*Construct sequential circuits for given requirement and verify them in laboratory*	*3*	*75*	*75*	*H*	*M*	*M*	*M*	-	-	-	-	*M*	*M*	-	-	*L*	*M*	-
CLO-4 :	*Analyze IC characteristics operation of logic gates and their families*	*2*	*75*	*75*	*H*	*M*	*L*	*L*	-	-	-	-	*M*	*M*	-	-	*L*	*M*	-
CLO-5 :	*Implement digital circuit using PLA, PAL, PROM. Write programs using VHDL*	*3*	*75*	*75*	*H*	*L*	*L*	*L*	*L*	-	-	-	*M*	*M*	-	-	*M*	*M*	-
CLO-6 :	*Apply the concepts of digital systems and experimentally validate them*	*3*	*75*	*75*	*H*	*M*	*M*	*M*	*L*	-	-	-	*M*	*M*	-	-	*L*	*M*	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Minterms, Canonical SOP form*	*Binary multiplier*	*Introduction to latches/Flip flop*	*Introduction to asynchronous sequential circuit*	*Memory organization and operation*
	SLO-2	*Simplification of switching function using K maps-SOP method*	*Binary divider*	*Flip flop: SR flip flop*	*Steps involved in design of asynchronous sequential circuit*	*Classification of memories ROM, PROM, EPROM, RAM*
S-2	SLO-1	*Simplification of Incompletely specified function using K maps- SOP method*	*Arithmetic logic unit (ALU)*	*Flip flops: D flip flop*	*Merger graph*	*Content addressable memory, Charge decoupled device memory*
	SLO-2	*Simplification of switching function with Don't care using K maps-SOP method*	*Elementary ALU design*	*Flip flops: JK & T flip flops*	*Problems in design of asynchronous sequential circuit*	*Commonly used memory chips*
S-3	SLO-1	*Maxterms, Canonical POS form*	*Multiplexer*	*Realization of D, JK, T flip flops using SR flip flops*	*Cycles*	*Programmable Logic Array(PLA)*
	SLO-2	*Simplification of switching function using K maps-POS method*	*Implementation of Boolean expression using multiplexer*	*Realization of D flip flop using T flip flop, Realization of T flip flop using D flip flop, Realization of JK flip flops using D flip flop*	*Critical and non-critical Races, Hazards*	*Implementation of Boolean function using PLA*
S 4-5	SLO-1 SLO-2	*Lab 1: Simplification of switching function using K maps and implementation using logic gates*	*Lab 4: Realization of MUX, Realization of Boolean expression using MUX*	*Lab 7: Realization of one flip flop using another flip flop*	*Lab 10: Design and implementation of Hazard free circuit*	*Lab 13: Realize Boolean algebra using PLA*
S-6	SLO-1	*Quine-McCluskey method for 4 variable problem*	*Demultiplexer*	*Design of synchronous sequential circuits-Moore Model using D flip flop*	*Problems in design of asynchronous sequential circuit including races*	*Programmable Array Logic (PAL)*
	SLO-2	*Quine-McCluskey method for4 variable problem with Don't care*	*Implementation of Boolean expression using demultiplexer*	*Design of synchronous sequential circuits-Moore Model using JK flip flop*	*Analysis of asynchronous sequential circuits*	*Implementation of Boolean function using PAL*

S-7	SLO-1	Quine-McCluskey method for5 variable problem	Decoders,	Design of synchronous sequential circuits- Moore Model using T flip flop	Analysis of asynchronous sequential machines with latches	Complex programmable logic device (CPLD), FPGA
	SLO-2	Quine-McCluskey method for5 variable problem with Don't care	BCD to 7 segment decoders, drivers for display devices	Design of synchronous sequential circuits- Mealy Model using D flip flop	Asynchronous up Counters, Asynchronous down Counters design	Introduction to VHDL programming
S-8	SLO-1	Adder: Half adder, Full adder	Encoder	Design of synchronous sequential circuits- Mealy Model using JK flip flop	Design of asynchronous up/down counter	VHDL design flow
	SLO-2	Subtractor: Half subtractor, Full subtractor	Priority encoder	Design of synchronous sequential circuits- Mealy Model using T flip flop	Design of asynchronous MOD-n Counter	VHDL types and operators
S 9-10	SLO-1 SLO-2	Lab 2: Realization of combinational circuits: Half adder, Full adder, Half subtractor, Full subtractor	Lab 5: Design of BCD to 7 segment decoders	Lab 8: Design and implementation of synchronous sequential circuits	Lab 11: Design of asynchronous Counters	Lab 14: Verification of gates using FPGA
S-11	SLO-1	Parallel binary adder and parallel binary subtractor	Parity generator	Analysis of synchronous sequential circuits using D,T flip flops	Digital logic families: Characteristics of Digital logic families	Structural and Behavioral Modelling
	SLO-2	Parallel adder/subtractor	Parity checker	Analysis of synchronous sequential circuits using JK flip flop	TTL Logic, Schottky TTL Logic, CMOS Logic	Data flow Modelling
S-12	SLO-1	Carry look ahead adder	Code Converter: Binary to Grey	Synchronous counters: up, down, up-down counters	ECL logic	Packages, subroutines
	SLO-2	BCD adder	Code Converter: Grey to Binary	MOD-n, Random counters	Interfacing CMOS with TTL	Test bench
S-13	SLO-1	Magnitude Comparator for 1,2-bit Comparator	Code Converter: BCD to Excess 3	Shift registers, Serial to parallel converter, Parallel to serial converter, Universal shift register	Tristate logic	Simple VHDL program: Combinational logic circuits
	SLO-2	Magnitude Comparator for 4-bit Comparator	Code Converter: Excess 3 to BCD	Ring counter, Johnson counter	Comparison between various logic circuits	Simple VHDL program: counters
S 14-15	SLO-1 SLO-2	Lab 3: Realization of BCD adder and 2-bit Magnitude Comparator	Lab 6: Realization of Code Converters	Lab 9: Design of Synchronous Counters, Design of shift registers and ring counters	Lab 12: Mini Project Presentation: Realization of digital control circuits	Lab 15: Verification of Combinational logic circuits using FPGA

Learning Resources	1. M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to Verilog HDL, VHDL and System Verilog, 6th ed., Pearson, 2018 2. Thomas L.Floyd, Digital Fundamentals, 11th ed., Pearson India, 2014	3. Charles H. Roth, Lizy K. John, Digital System Design Using VHDL, 2nd ed., Cengage learning, 2012 4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

1. Mr. Roosefart Mohan, Nelcast Limited, Chennai, roosefart@gmail.com	1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com	1. Dr. C. S. Boopathi, SRMIST
2. Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	2. Dr. B. ChittiBabu, IIITD, Kanchipuram, chittibabu@gmail.com	2. Ms. D. Anitha, SRMIST

Course Code	18EEC204J	Course Name	ELECTRICAL MACHINES I	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze the characteristics of different types of DC generators*
CLR-2 :	*Identify the working, starting and speed control of DC motors*
CLR-3 :	*Analyze transformers and derive its equivalent circuit*
CLR-4 :	*Test DC machines and transformers as per standard practice*
CLR-5 :	*Model DC machines*
CLR-6 :	*Analyze the performance of the DC machine and transformer*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Analyze the principle and fundamentals of DC generator*	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-2 :	*Analyze the principle and fundamentals of DC motor*	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-3 :	*Identify the different types of transformers and analyze its performance using equivalent circuit*	2	75	75	H	M	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	*Investigate and interpret the performance of DC machines and transformers performing suitable tests*	3	75	75	H	M	-	-	-	-	-	M	M	M	-	-	M	M	M
CLO-5 :	*Analyze DC machines by mathematical modeling*	3	75	75	H	M	L	L	L	-	-	-	M	M	-	-	M	M	-
CLO-6 :	*Evaluate characteristics of transformers, DC Machines and evaluate their performance by applying various testing methods*	3	75	75	H	M	L	L	L	-	-	L	M	M	-	-	M	M	L

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Energy in magnetic system*	*Torque equation of DC motor*	*Transformers: Types and Construction*	*Testing of DC machines: Brake test*	*Modeling of dc machines: Basic two pole DC machine*
	SLO-2	*Field energy and mechanical force*	*Emf equation of DC motor*	*Principle of operation, emf equation*	*Swinburne's test*	*Analysis of DC machine using Primitive two axis machine equation*
S-2	SLO-1	*Single excited systems*	*Voltage equation of various types of DC motor*	*Ideal transformer and Practical transformer on no load*	*Problems in Swinburne's test*	*Modelling of voltage equation*
	SLO-2	*Multiple excited systems*	*Current equation of various types of DC motor*	*Practical transformer on load*	*Retardation test*	*Modelling of torque equation*
S-3	SLO-1	*Torque and Force equations*	*Speed equation and regulation of DC motor*	*Equivalent circuit of transformer*	*Hopkinson's test*	*Mathematical model of separately excited DC machine*
	SLO-2	*Energy conversion via electric fields*	*Power flow in DC motor, Losses & efficiency*	*Transformer regulation, losses, efficiency*	*Problems in Hopkinson's test*	*Problems in mathematical model of separately excited DC machine*
S 4-5	SLO-1 SLO-2	*Lab 1: Demo on Single & Multiple excited systems*	*Lab 4: Load test on DC motors*	*Lab 7: Load test on single-phase transformer*	*Lab 10: Swinburne's test and Hopkinson's test on DC machine*	*Lab 13: Study of impulse test in transformer*
S-6	SLO-1	*Dynamic equation of electromechanical systems*	*Review of mechanical starter- 3-point starter*	*Phasor diagram of transformer*	*Open circuit test on single phase transformer*	*Mathematical model of shunt connected DC machine*
	SLO-2	*DC generator- lap and wave winding, Major considerations in design of windings*	*4-point starter, 2-point starter*	*EMF in power transformers*	*Short circuit test on single phase transformer*	*Problems in mathematical model of shunt connected DC machine*
S-7	SLO-1	*DC generator-EMF equation-circuit model*	*Electronic soft starters for DC motor with*	*All day efficiency, Per unit representation of*	*Sumpner's test*	*Mathematical model of series connected*

			energy saving	transformer		DC machine
	SLO-2	Methods of excitation	Speed control: Field control, Armature control	Three phase transformers connections, Scott connection	Equivalent circuit, efficiency and regulation from OC & SC test	Problems in mathematical model of series connected DC machine
S-8	SLO-1	Losses in DC generator	Speed control: voltage control	Phasing of transformer	Equivalent circuit, efficiency and regulation from Sumpner's test	Mathematical model of compound connected DC machine
	SLO-2	Power flow in DC generator, efficiency	Problems in DC motors	Parallel operation of single phase and three phase transformers	Problems in OC & SC test	Problems in Mathematical model of compound connected DC machine
S 9-10	SLO-1 SLO-2	Lab 2: Open circuit and load characteristics of Separately Excited DC generator	Lab 5: Speed Control of DC Motor: Field control, Armature control	Lab 8: Load test on three phase transformer	Lab 11: Open circuit and short circuit test and Sumpner's test on single phase transformer	Lab 14: Study of zero sequence impedance and noise level test in transformer
S-11	SLO-1	Effect of armature flux on field flux in DC generator	Speed control: Thyristor control	Auto transformer	Routine test on transformer	Time domain model of shunt connected DC machine
	SLO-2	Use of compensating windings, Ampere-Turns calculations	Speed control: Converters control	Tap changing transformers- tertiary winding	Dielectric and parametric test on transformer	State equations of shunt connected DC machine
S-12	SLO-1	Commutation in DC generator, construction of commutator,	Speed control: choppers control	Variable frequency transformer, audio frequency transformer	Type test on transformer	Problems in state equations of shunt connected DC machine
	SLO-2	Methods to improve commutation	Braking of DC motors	Phase shifting transformer, dry type transformer	Temperature rise and impulse test on transformer	Time domain model of permanent magnet DC machine
S-13	SLO-1	Voltage and current equation, Residual voltage, Critical Resistance	Permanent magnet DC motor	Grounding transformer, traction transformer	Unbalance current, magnetic balance test on transformer	State equations of permanent magnet DC machine
	SLO-2	Problems in DC generator	Problems in speed control	Welding transformer, rectifier transformer	Zero sequence impedance and noise level test on transformer	Problemsin state equations of permanent magnet DC machine
S 14-15	SLO-1 SLO-2	Lab 3: Open circuit and load characteristics of Self Excited DC generator	Lab 6: Speed Control of DC Motor: Thyristor, converter and chopper control	Lab 9: Parallel operation of single phase and three phase transformers	Lab 12: IEC/IEEE standard practice on transformer testing	Lab 15: Simulation of separately and self-excited DC machine

Learning Resources	1. D. P. Kothari, I. J. Nagrath, Electrical Machines, 5th ed.,Tata-McGraw Hill, 2017 2. A. E. Fitzgerald, C. Kingsley, Electric Machinery, 6th ed., McGraw Hill Education, 2013	3. Paul C. Krause, Oleg Wasynezuk, Scott D. Sudhoff, Analysis of electric machinery and Drive systems 3rd ed., IEEE Series, John Wiley & Sons, 2013 4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination(50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
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1. Dr. S. Paramasivam, Danfoss Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. C. S. Boopathi, SRMIST*
2.Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. B. ChittiBabu, IIITD, Kanchipuram, chittibabu@gmail.com*	*2. Dr. K. Vijayakumar, SRMIST*

Course Code	18EEC205J	Course Name	ELECTRICAL MACHINES II	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning				Program Learning Outcomes (PLO)														
		1	2	3		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Identify the need of rotating magnetic field in three phase induction motor and draw its equivalent circuit																			
CLR-2 :	Evaluate performance of three phase induction motor using circle diagram, identify its starting, speed control methods																			
CLR-3 :	Develop an equivalent circuit of single phase induction motor and explain the operation of single phase AC machines																			
CLR-4 :	Construct an equivalent circuit and phasor diagram of an alternator and obtain its voltage regulation																			
CLR-5 :	Analyze the working and characteristics of salient pole alternator and synchronous motor																			
CLR-6 :	Utilize the construction, operation and performance of AC machines																			
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)		Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO – 1	PSO - 2	PSO - 3
CLO-1 :	Analyze the working of three phase induction motor, its torque slip characteristics and hence obtain its equivalent circuit	2	75	75		H	H	M	-	-	-	-	-	M	M	-	-	L	M	-
CLO-2 :	Identify the starting and speed control methods of three phase induction motor and evaluate its performance	3	75	75		H	H	M	-	-	-	-	-	M	M	-	-	M	M	-
CLO-3 :	Analyze the different single phase AC machines and model a single-phase induction motor	3	75	75		H	M	L	-	-	-	-	-	M	M	-	-	L	M	-
CLO-4 :	Model alternators and compute its voltage regulation	3	75	75		H	H	M	-	-	-	-	-	M	M	-	-	L	M	-
CLO-5 :	Identify the operation and control of salient pole alternator and synchronous motor	2	75	75		H	L	L	-	-	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Analyze the performance of an AC machine by modeling and by carrying out laboratory experiments	3	75	75		H	M	M	-	-	-	-	-	M	M	-	-	L	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Review of poly phase distributed AC winding, Production of EMF	Construction of circle diagram for 3-phase induction motor	Constant magnetic field, Pulsating magnetic field	Alternators- Constructional features and types, Short pitch and full-pitch coils	Salient pole synchronous machine
	SLO-2	Flux and mmf waves in induction motor	Performance calculation from circle diagram	Alternating current in winding with spatial displacement	Concentrated and distributed winding, Coil span factor, Winding distribution factor	Blondel's two reaction theory
S-2	SLO-1	Constructional details of three-phase induction motor	Problems in circle diagram	Magnetic field produced by single winding-fixed current and alternating current	Air gap MMF distribution with fixed current	Phasor diagram using Xd, Xq
	SLO-2	Principle of operation of three-phase induction motor	Determination of maximum quantities from circle diagram	Pulsating fields produced by spatially displaced windings	Air gap MMF distribution with sinusoidal current	Slip test, Voltage regulation using slip test
S-3	SLO-1	Slip, Effect of slip on rotor parameters	Need for speed control	Windings spatially shifted by 90 degrees	EMF equation of alternator	Power output of Salient pole synchronous machine
	SLO-2	Torque equation, Starting torque equation, Maximum torque	Speed control of three-phase induction motor: Stator side	Addition of pulsating magnetic fields	Armature reaction, Alternator on load, phasor diagram	Problems in voltage regulation
S 4-5	SLO-1 SLO-2	Lab 1: Load test on 3 phase induction motor	Lab 4: Speed control of three-phase induction motor: stator side	Lab 7: Demo of spatially displaced windings	Lab 10: Load test on 3 phase alternators	Lab 13: Determination of Xd and Xq of salient pole machine
S-6	SLO-1	Torque-slip characteristics, Generation and breaking region in Torque-slip characteristics	Speed control of three-phase induction motor: rotor side	Constructional detail of single phase induction motor	Equivalent circuit and phasor diagram	Synchronous motor: Principle of operation, Methods of starting
	SLO-2	Starting characteristics of 3 phase induction motor, Effect of Rotor resistance	Speed control by solid state devices	Double revolving field theory	Synchronous Impedance, voltage regulation	Torque and power equations

		on Torque-slip characteristics				
S-7	SLO-1	Power Stages	Necessity of Starters	Torque equation	Pre-determination of voltage regulation using EMF method	Synchronous motor on load, Synchronous motor on constant excitation variable load
	SLO-2	Relation between rotor input, rotor copper losses and rotor output	Types of starters	Torque- speed characteristics	Problems in EMF method	Synchronous motor on constant load variable excitation, 'V', inverted 'V' curves
S-8	SLO-1	Problems in power stages	Induction generator, Self-excited Induction generator	No load blocked rotor tests	Pre-determination of voltage regulation using MMF method	Synchronous condenser, Hunting and its suppression
	SLO-2	No load and blocked rotor tests	Doubly-Fed Induction generator	Equivalent circuit	Problems in MMF method	Short circuit transient in synchronous machine
S 9-10	SLO-1 SLO-2	Lab 2: No load and blocked rotor test on 3-phase squirrel cage induction motor	Lab 5: Speed control of three-phase induction motor on rotor side	Lab 8: No load and blocked rotor test on 1-phase induction: To draw equivalent circuit	Lab 11: Voltage regulation of alternators by EMF and MMF methods	Lab 14: Determination of 'V' and inverted 'V' curves in synchronous motor
S-11	SLO-1	Steady state analysis-Equivalent circuit	Harmonics in induction motor	Making single phase induction self-starting	Pre-determination of voltage regulation using ZPF method	Capability curves in synchronous machine
	SLO-2	Motor efficiency, rotor efficiency	Crawling, Cogging	Shaded pole induction motor	Problems in ZPF method	Positive, Negative and Zero sequence reactance of synchronous machines
S-12	SLO-1	Equivalent circuit from No load and blocked rotor tests	Electric Braking: Regenerative braking, Plugging Braking	Linear Induction motor, Universal motor	Pre-determination of voltage regulation using ASA method	Synchronous induction motor
	SLO-2	Problems in no load and blocked rotor test	Electric Braking: AC, DC dynamic braking	Reluctance motor	Problems in ASA method	Brushless DC motor
S-13	SLO-1	Double cage rotor	Slip power recovery scheme	AC series motor, Repulsion motor	Parallel operation of alternators, Load sharing	Permanent Magnet Synchronous Motor
	SLO-2	Equivalent circuit of double cage rotor, Performance calculation	Difference in starting and blocked rotor characteristics	Stepper motor	Voltage and frequency control, Synchronization to infinite bus-bar	Tacho generator
S 14-15	SLO-1 SLO-2	Lab 3: No load and blocked rotor test on 3-phase slip ring induction motor	Lab 6: Characteristics of 3 phase Induction generator	Lab 9: Load test on single phase induction motor	Lab 12: Voltage regulation of alternators by ZPF method, Synchronization and parallel operation of alternators	Lab 15: Determination of Positive, Negative and Zero sequence reactance of synchronous machines

Learning Resources	1. H.Wayne Beaty&Jame. L.Kirtley.Jr, Electric Motor Handbook, McGraw-Hill, USA, 1st Edition, 1998 2. M.G.Say, The Performance and Design of Alternating Current machines, Tata-McGraw Hill, 1st Edition, 2004	3. J. B. Gupta, Theory & Performance of Electrical Machines, 15th ed., S. K. Kataria & Sons, 2015 4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/index.htm

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination(50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. C. S. Boopathi, SRMIST*
2. Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. R. Ramesh, CEG, rramesh@annauniv.edu*	*2. Dr. K. Vijayakumar, SRMIST*

Course Code	18EEC206J	Course Name	ANALOG ELECTRONICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know the basic amplifier circuits.
CLR-2 :	Acquire knowledge on different power amplifiers.
CLR-3 :	Construct different waveform generating circuits.
CLR-4 :	Discuss the basics of operational amplifiers.
CLR-5 :	Understand different analog to digital and digital to analog converters
CLR-6 :	Design amplifier circuits using transistor and operational amplifiers.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	Analyze the amplifier circuits using small signal model and hybrid model	2	75	75	H	H	H	H	-	-	L	-	M	M	-	-	M	H	-
CLO-2 :	Recognize the different power amplifiers	2	75	75	H	H	H	H	-	-	-	-	M	M	-	-	M	H	-
CLO-3 :	Design oscillators and multivibrators.	3	75	75	H	H	H	M	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	Apply different operational amplifiers.	2	75	75	H	M	M	-	-	-	-	-	M	M	-	-	M	M	-
CLO-5 :	Evaluate filters and converter circuits	3	75	75	H	H	H	M	H	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Demonstrate electronic modern tools in various electronic fields.	2	75	75	H	H	H	M	M	-	L	-	M	M	-	-	M	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	BJT -Biasing methods -Base bias, base bias with emitter feedback	Power amplifiers: Types. Determine efficiency for class A, B power amplifier	Oscillators and classification of oscillators	Introduction to Linear Integrated Technology	Filters basics and types
	SLO-2	Base bias with collector feedback and voltage divider bias	Frequency response of RC coupled class A amplifier	Design and Analysis of RC Phase shift oscillator	Fabrication process for Integrated Circuits	Design of I and II Order LPF
S-2	SLO-1	Emitter bias using BJT in CE configuration	Frequency response of Transformer coupled class A amplifier.	Operation of Hartley's oscillator	Dc characteristics of op amp and input bias current.	Design of I Order HPF
	SLO-2	Transistor biasing stability using BJT in CE configuration	Operation of Class B push pull power amplifier	Analysis of Hartley's oscillator	Input offset voltage, Thermal Drift	Design of II Order HPF
S-3	SLO-1	Operation of BJT as an amplifier	Operation of Differential amplifier	Operation of Armstrong oscillator	AC characteristics of op-amp and Frequency Compensation	Design of BPF and BRF
	SLO-2	CE, CB, CC Amplifier –Evaluation of h-parameters	Analysis of Differential amplifier	Operation of UJT Relaxation oscillator	Slew rate	Switched variable filters and state variable filters.
S 4-5	SLO-1 SLO-2	Lab 1: Determination of hybrid parameters of a CE amplifier.	Lab 4: Determination of gain of an amplifier.	Lab 7: RC Phase shift oscillator	Lab 10: and AC characteristics of IC 741 Op-amp	Lab 13: Design of Low pass and High Pass Filters.
S-6	SLO-1	Small signal analysis of CE Amplifier	Self–biased active load differential amplifier	Operation of Cross Coupled oscillator	Inverting amplifier and Non-inverting amplifier	Oscillators- Wein bridge Oscillator using IC 741.
	SLO-2	Small signal analysis of CB and CC amplifier	Source degenerated common source amplifier	Integrators	Summer and Subtractor.	Amplitude control and Quadrature Control Oscillator
S-7	SLO-1	Large signal analysis of CE Amplifier	Classification of class C power amplifiers	Differentiators	Voltage follower and	Introduction to simple MOSFET based op-

			(Tuned amplifiers)		ac amplifiers	amp circuits.
	SLO-2	Large signal analysis of CB and CC amplifier.	Frequency response of Single,Double and Staggered Tuned Class C power amplifier	Schmitt trigger	V to I and I to V converters	Analog to Digital converters, classification. Counter and Sigma Delta type ADC.
S-8	SLO-1	JFET –Common source (CS) amplifier - operation	Cascode and Cascade circuits	Multivibrator, Classification Operation of Astable Multivibrator	Instrumentation amplifier	Successive approximation type ADC
	SLO-2	CS Amplifier – small signal analysis	Feedback amplifiers –Barkhausen criterion and Types of feedback amplifier	Analysis of Astable Multivibrator	Log and Antilog amplifiers	Digital to Analog converters and Pulse width modulator DAC
S 9-10	SLO-1 SLO-2	Lab 2: Analysis of JFET amplifier	Lab 5: Frequency response of RC coupled amplifier	Lab 8: AstableMultivibrator	Lab 11: Applications of op-amp	Lab 14: Wein bridge oscillator using IC 741.
S-11	SLO-1	JFET – Common Drain (CD) Amplifier – operation	Analysis of voltage series feedback amplifier	Operation of Monostable Multivibrator.	Comparators and classification of comparators	R -2R Ladder DAC
	SLO-2	Small signal analysis of MOSFET	Analysis of voltage shunt feedback amplifier	Analysis of Monostable Multivibrator.	Applications of Comparators : Summer, Subtractor, Voltage follower	Binary coded DAC
S-12	SLO-1	Biasing of MOSFET	Analysis of current series amplifier	Operation of Bistable Multivibrator.	Basics of IC 555 Timer and Pin Details	Case study: Minor project on any advanced application based circuit using IC 741 or IC 555 Timer or IC 723.
	SLO-2	CD Amplifier – small signal analysis	Analysis of current shunt feedback amplifier	Analysis of Bistable Multivibrator.	Astable operation using IC 555 Timer with applications	
S-13	SLO-1	Problems on biasing of circuits.	Problems on power amplifiers.	Voltage and time-based circuits.	Monostable operation using IC 555 Timer with applications	Case study: Minor project on any advanced application based circuit using IC 741 or IC 555 Timer or IC 723.
	SLO-2	Problems on hybrid parameters	Problems on feedback amplifiers	Series and shunt voltage regulator	Voltage regulator using IC 723	
S 14-15	SLO-1 SLO-2	Lab 3: Analysis of MOSFET amplifier	Lab 6: Frequency response of Class C Power amplifier	Lab 9: Transistor series voltage regulator	Lab 12: Voltage Regulator Using IC 723	Lab 15: R -2R Ladder DAC

Learning Resources	1. Jacob Millman, Christos C.Halkias, SatyabrataJit, Millman's Electronic Devices and Circuits, 4th ed., Tata McGraw Hill, 2015 2. Boylestead, Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson, 2015 3. David A. Bell, Electronic Devices and Circuits, 5th ed., Prentice Hall, 2004	4. Sergio Franco, Design with operational amplifiers and Analog Integrated circuits, 5th ed., McGraw-Hill, 2014 5. Roy Choudhary and Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014 6. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/syllabus/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination(50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. B. Nliranjithkumar, BEL, Chennai., niranjithkumarb@bel.co.in	2. Dr. S. Kamalakannan, Anna University, kamalakannan1612@gmail.com	2. Dr. K. Mohanraj, SRMIST

Course	18EEC207J	Course	ELECTRICAL AND ELECTRONICS MEASUREMENTS AND	Course	C	Professional Core	L	T	P	C

Code		Name	INSTRUMENTATION	Category			3	0	2	4

Pre-requisite Courses		Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the knowledge of various types of measuring instruments, DC and AC bridge.*
CLR-2 :	*Utilize the working of analog meters for power, energy and harmonic measurements*
CLR-3 :	*Utilize different measuring and display devices*
CLR-4 :	*Compare the measurement of non- electrical quantities.*
CLR-5 :	*Analyze the functions of biomedical instruments and data acquisition system*
CLR-6 :	*Utilize the knowledge about measurements, measuring instruments for practical applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Solve the problems in measuring instruments and bridges*	*3*	*75*	*75*	*H*	*L*	-	-	*L*	-	-	-	*M*	*M*	-	-	*L*	*M*	-
CLO-2 :	*Apply the different analog meters for power, energy and harmonic measurements.*	*2*	*75*	*75*	*H*	*L*	-	-	-	-	-	-	*M*	*M*	-	-	*L*	*M*	-
CLO-3 :	*Design the operation of different measuring and display devices*	*2*	*75*	*75*	*H*	*L*	-	-	-	-	-	-	*M*	*M*	-	-	*L*	*L*	-
CLO-4 :	*Identify the measurement of non- electrical quantities.*	*2*	*75*	*75*	*H*	-	-	-	*L*	-	-	-	*M*	*M*	-	-	*L*	*L*	-
CLO-5 :	*Describe the working of biomedical instruments and data acquisition system*	*2*	*75*	*75*	*H*	-	-	-	-	-	-	-	*M*	*M*	-	-	*L*	*M*	-
CLO-6 :	*Interpret the acquired knowledge of measuring instruments*	*2*	*75*	*75*	*H*	*L*	-	-	*L*	-	-	-	*M*	*M*	-	-	*L*	*M*	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Functional elements of instrument*	*Special type of transformers -Current Transformer*	*Construction and working of synchro scope – Western type*	*Methods of pressure measurements- Dead-weight gauges and Manometers*	*Over view of biomedical measurements*
	SLO-2	*Static characteristics of measurement*	*Potential Transformer- Measurement of voltage*	*Nalder-Lipman type*	*Pressure measuring system*	*Sources of bio electric potentials, Electrodes*
S-2	SLO-1	*Dynamic characteristics of measurement*	*Principle of operation, construction, Torque equation of induction type single phase energy meter*	*General principle and performance equations of Ballistic Galvanometer*	*Elastic transducer, Vibrating cylinder*	*Measurement of blood pressure-direct methods*
	SLO-2	*Errors in measurement*	*Three phase energy meter*	*D'Arsonval Galvanometer*	*Resonant transducer.*	*Working of X- ray Instrumentation*
S-3	SLO-1	*Kelvin's Double Bridge, measurement of Low value of Resistances*	*Creeping adjustments, testing of energy meters*	*General principle and working of Hall effect sensors*	*Measurement of Flow: Flow visualization from Pitot-static tube, Yaw tube.*	*Applications of X- ray Instrumentation*
	SLO-2	*Wheat -stone Bridge, measurement of Medium value of Resistances.*	*Calibration of energy meter using direct loading.*	*Encoder-Laser based methods.*	*Positive displacement method, Obstruction methods.*	*Working and applications of Electrocardiograph (ECG)*
S 4-5	SLO-1 SLO-2	*Lab 1: Measurement of R, L and C using bridge circuit*	*Lab 4: Measurement of power and energy*	*Lab 7: Measurement of liquid flow rate*	*Lab 10: Measurement of water level using capacitive Transducer*	*Lab 13: Real time monitoring of ECG wave analysis using simulator*
S-6	SLO-1	*Maxwell's Inductance Bridge, Measuring Unknown value of Inductance*	*Digital energy meter*	*Graphical methods of measurement: Cathode ray oscilloscope*	*Drag effect methods, hot-wire anemometers.*	*Block diagram of data acquisition system*
	SLO-2	*Anderson's Bridge, measurement of Un known value of Inductance.*	*Net metering*	*Digital storage oscilloscope*	*Measuring Devices: Vacuum and sound*	*Block diagram of Signal conditioning*
S-7	SLO-1	*Schering's Bridge measurement of Un*	*Measurement of reactive power using*	*Storage devices: Strip chart recorder*	*McLeod gauge, Knudsen gauge*	*Telemetry and working.*

		known value of Capacitance.	wattmeter in single phase circuit.			
	SLO-2	Principle of operation of Thermal type instruments	Measurement of reactive power using wattmeter in Poly phase circuits	X-Y recorder	Diaphragm and ionization gauges	Respiratory instrumentation – Mechanism of respiration, spirometry
S-8	SLO-1	Principle of operation, construction, working of single phase power factor meter	Measurement of Volt Ampere reactive power using VAR meter	Principle of operation and applications of Phase sequence indicator	Motion measurement-Fundamentals standards.	Working of different types of Pacemakers
	SLO-2	Three phase power factor meter	Principle of operation, and construction of Maximum demand indicator	Principle of operation and applications of Display devices: LED, LCD, Dot matrix display	Temperature measurement using Liquid in glass thermometers	Applications of Pacemakers
S 9-10	SLO-1 SLO-2	Lab 2: Power factor measurement	Lab 5: Measurement of power and energy	Lab 8: Measurement of harmonics using Power quality analyser.	Lab 11: Measurement of temperature to estimate the response time using temperature measuring instruments	Lab 14: Study of Pacemaker Module
S-11	SLO-1	Solving Problems in error measurements	Solving Problems in single phase energy meter	Solving Problems in Phase sequence indicator.	Solving Problems in transducers	Interfacing instruments –General purpose interfacing bus (GPIB)
	SLO-2	Solving Problems in bridge circuits	Solving Problems in three phase energy meter	Solving Problems in Galvanometer	Solving Problems in Pressure measurement.	Working of GPIB Hardware Components
S-12	SLO-1	Principle of operation, construction, Torque equation of Dynamometer type instruments	Frequency meters, Electrical resonance type	Measurement of LCD screen size	Measurement of Pressure thermometers	GPIB / SCPI Programming Elements and specifications
	SLO-2	Principle of operation of Rectifier type instruments	Frequency meters - Mechanical Resonance Type.	Operation of an analogue actuator: the DC Servo motor	Properties of analogue sensors for temperature	Interfacing instruments –USB
S-13	SLO-1	Principle of operation and applications of Digital voltmeter.	Principle of operation of spectrum analyser	Radio frequency identification (RFID) reader	Properties of analogue sensors for pressure	Instrumentation for medical imaging
	SLO-2	Principle of operation and applications of Digital Multimeter.	Principle of operation of Harmonic analyser	Data loggers	Laser based measurement of liquid temperature	Instrumentation for Therapeutic Devices
S 14-15	SLO-1 SLO-2	Lab 3: Demo on Universal bridge	Lab 6: Demo on Frequency meter	Lab 9: Identification of phase sequence using Synchroscope	Lab 12: Study of temperature and pressure sensor	Lab 15: Analysis of Instrumentation for medical imaging

Learning Resources	1. Ernest O Doebelin, Dhanesh N Manik, Measurements Systems Application and Design, 5th ed., McGraw Hill, 2006 2. Sawhney A. K, A Course in Electrical and electronic Measurement and Instrumentation, Dhanpat Rai & Sons, 2015 3. Rajendra Prasad, Electrical Measurements & Measuring instruments, 10th ed., Khanna Publishers, 1989	4. Albert D Halfride & William D Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson, 2015 5. John G Webster, Medical instrumentation: Application and design ,4th ed., Wiley, 2010 6. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination(50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Thiyagarajan, TANGEDCO, athiyagu3177@yahoo.com.	*1. Dr. S. Senthilkumar, NIT, Trichy, skumar@nitt.edu*	*1. Ms. C. Anuradha, SRMIST*
2. Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. Bindu, Govt. College of Engineering, Vayanadu, Kerala, bgr100@gmail.com*	*2. Ms. S. Vijayalakshmi, SRMIST*

Course Code	18EEC208T	Course Name	GENERATION, TRANSMISSION AND DISTRIBUTION	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses		Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	*Utilize the basics of electric power generation, transmission and distribution*
CLR-2 :	*Solve the various transmission line parameters for single and three phase transmission system*
CLR-3 :	*Analyze the performance of transmission line and to learn the different voltage compensation techniques*
CLR-4 :	*Utilize insulators, cables and estimate the string efficiency*
CLR-5 :	*Analyze the basics of substation components and DC distribution systems*
CLR-6 :	*Create overall structure of power system starting from generation to power transmission and distribution*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Identify the layout of various energy sources and its economics of power generation*	2	80	75	H	M	M	-	-	-	M	-	-	-	-	-	H	M	H
CLO-2 :	*Calculate the line parameter for single and multi-phase power transmission system*	3	80	75	H	H	M	M	M	-	M	-	-	-	-	-	M	M	M
CLO-3 :	*Compute the performance of various types of transmission lines*	3	80	75	H	H	H	M	-	-	-	-	M	M	-	-	H	M	M
CLO-4 :	*Acquire knowledge on insulators, cables and evaluate stress and sag*	3	80	75	H	M	H	M	-	-	-	-	-	-	-	-	H	H	M
CLO-5 :	*Identify the substation components and compute the DC distribution systems*	3	80	75	H	H	M	M	-	-	-	-	-	-	-	-	H	M	M
CLO-6 :	*Design a power system using components like generators, transmission lines and distributors*	3	80	75	H	H	M	M	M	-	M	-	M	M	-	-	H	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Sources of energy*	*Calculate Resistance in a single-phase transmission line*	*Analyze performance of short line*	*Classify insulators for transmission and distribution purpose*	*Classification, major components of substations, Bus-bar arrangements*
	SLO-2	*Structure of power system*	*Calculate Inductance in a single-phase transmission line*	*Analyze performance of medium transmission line (end condenser method)*	*Voltage distribution in insulator string*	*Substation bus schemes- single bus, double bus with double breaker*
S-2	SLO-1	*Basic layout of PV power generation*	*Calculate Capacitance in a single-phase transmission line*	*Calculate efficiency,regulation of voltage for medium line by end condenser method*	*Improvement of string efficiency*	*Double bus with single breaker*
	SLO-2	*Basic layout of wind power generation*	*Calculate Inductance and capacitance of three phase transmission lines*	*Analyze Performance of medium line using T method*	*Calculation of voltage distribution and string efficiency*	*Main and transfer bus schemes*
S-3	SLO-1	*Basic layout of Ocean Thermal Energy Conversion (OTEC)*	*Calculate Inductance and capacitance in a Symmetrically spaced conductor*	*Calculation of efficiency and regulation of voltage for medium line by T method*	*Testing of insulators*	*Double bus-bar scheme with bypass isolators*
	SLO-2	*Types of OTEC*	*Calculate inductance and capacitance in an Unsymmetrical spaced conductor (transposed)*	*Analyze Performance of medium line using πmethod*	*Construction features of LT and HT cables, Insulation resistance*	*Introduction to substation earthing*
S-4	SLO-1	*Basic layout of Biomass power plant*	*Calculate inductance of Single circuit lines*	*Calculation of efficiency and regulation of voltage for medium line by π method*	*Calculate Capacitance, dielectric stress*	*Substation safety*
	SLO-2	*Load curve & Load duration curve*	*Calculate capacitance of Single circuit lines*	*Analyze Performance of long line using Rigorous method*	*Grading cables*	*Qualitative treatment to neutral grounding*
S-5	SLO-1	*Calculation of total power generation*	*Calculate inductance in double circuit lines*	*Ferranti effect – surge impedance*	*Fault in underground cables*	*Feeders, service mains and distributors*

	SLO-2	*Load, demand and diversity factors*	*Calculate capacitance in double circuit lines*	*Attenuation constant and phase constant*	*Location of fault in underground cables*	*DC Distribution*
S-6	SLO-1	*Plant capacity and plant use factors*	*Calculate inductance in Stranded and bundled conductors*	*Real power flow in transmission lines*	*Tan δ and power loss*	*Types of DC distributors*
	SLO-2	*Calculation of Plant capacity and plant use factors*	*Calculate capacitance in Stranded and bundled conductors*	*Reactive power flow in transmission lines*	*Thermal characteristics of cables*	*Quantitative analysis of radial distribution fed at one end*
S-7	SLO-1	*Choice of type of generation, choice of size and number of units*	*Application of self GMD*	*Power circle diagrams*	*Calculate Stress of towers with equal heights*	*Quantitative analysis of radial distribution fed at both the ends*
	SLO-2	*Cost of energy generated*	*Application of mutual GMD*	*Receiving end power circle diagrams for finding the maximum power transfer*	*Calculate Sag of towers with equal heights*	*Quantitative analysis of Ring main distribution*
S-8	SLO-1	*Tariffs*	*Skin and Proximity effect*	*Series compensation*	*Calculate Stress of towers with unequal heights*	*Design of rural distribution, planning and design of town electrification schemes*
	SLO-2	*Types of tariffs*	*Inductive interference, Corona*	*Shunt compensation*	*Calculate Sag of towers with unequal heights*	*Kelvin's law for the design of feeders and limitations*
S-9	SLO-1	*Transmission systems*	*Implementation of distribution system using software*	*Seminar Presentations on ABCD constants*	*Effect of wind on overhead transmission line*	*Smart grid*
	SLO-2	*Distribution systems*	*Implementation of distribution system using software*	*Seminar Presentation on surge impedance loading*	*Effect of ice loading on overhead transmission line*	*Power system restructuring*

Learning Resources	1. *D.P. Kothari, I.J. Nagrath Power System Engineering Mc Graw-Hill Publishing company limited, New Delhi, 2nd ed., 2008* 2. *C. L. Wadwa, Electric Power Systems, 7th ed., New Age International Publishers,2016*	3. *Luces M. Fualkar berry, Walter Coffer Electrical Power Distribution and Transmission, Pearson Education, 2007* 4. *S.N.Singh, Electric power generation, transmission and distribution, 2nd ed., PHI, 2011* 5. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science*

Learning Assessment

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		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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ACADEMIC CURRICULA

Professional Core Courses

ELECTRICAL & ELECTRONICS ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18EEC301J	Course Name	CONTROL SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Educate the students on mathematical model of a physical system.*
CLR-2 :	*Provide knowledge on time domain response and stability of a system.*
CLR-3 :	*Explain the concept of frequency domain using mathematical and graphical approach*
CLR-4 :	*Design various controller / compensator to meet system requirement.*
CLR-5 :	*Understand the concept of state space analysis.*
CLR-6 :	*Gain knowledge on the design, control and analysis of physical system.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Interpret a physical system in s domain representation.*	3	75	75	H	H	M	M	-	-	-	-	M	M	-	-	M	H	-
CLO-2 :	*Analyze the use of time domain specification and stability in real time application.*	3	75	75	H	H	M	H	M	-	-	-	M	M	-	-	H	H	-
CLO-3 :	*Apply various techniques to understand the frequency response of a system*	3	75	75	H	H	H	H	M	-	-	-	M	M	-	-	H	H	-
CLO-4 :	*Articulate the concept of tuning and design a controller for the given system.*	3	75	75	H	H	H	H	M	-	-	L	M	M	-	-	H	H	L
CLO-5 :	*Comprehend the state and test the controllability, observability of a system.*	3	75	75	H	H	M	M	M	-	-	-	M	M	-	-	M	H	-
CLO-6 :	*Analysis the system stability and performance of physical system.*	3	75	75	H	H	H	H	M	-	-	L	M	M	-	-	H	H	L

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Classification of control systems.*	*Introduction to time domain analysis.*	*Introduction to frequency domain analysis.*	*Need for controller design and in systems*	*State space analysis.*
	SLO-2	*Terminology of automatic control systems.*	*Standard test signals ; Response of first order systems to standard test signals*	*Frequency response plots of dynamic systems.*	*Important for compensation in system.*	*Concepts of state, state variables, state model.*
S-2	SLO-1	*Principles and effects of feed forward control systems.*	*Step response of second order systems in detail*	*Frequency response measurements, Performance specifications in the frequency domain.*	*Effects of P,PI Controller.*	*State differential equation using physical variables;*
	SLO-2	*Principles and effects of feedback control systems.*	*Different damping conditions.*	*Log magnitude and phase diagrams.*	*Effect of PID Controller.*	*State diagram representation.*
S-3	SLO-1	*Transfer functions SISO & MIMO*	*Transient response analysis.*	*Determination of Frequency domain specifications.*	*Classical PID controller*	*Tutorial – State space analysis by using phase variable form.*
	SLO-2	*Transfer functions for simple electrical, mechanical and electro mechanical systems*	*Time domain specification.*	*Phase margin and Gain margin*	*PID controller tuning using Zigler – Nichols tuning rules.*	*Formation of state space equation.*
S 4-5	SLO-1 SLO-2	*Lab 1: Determination of transfer function parameter of DC motor*	*Lab: 4Generating standard test signals.*	*Lab 7: Frequency response characteristics of second order system.*	*Lab 10: Design, determination of transfer function and frequency response for lag, lead network.*	*Lab 13: State space model for classical transfer function and design and tuning a PID controller.*

Duration (hour)		15	15	15	15	15
S-6	SLO-1	*Tutorial: Formation of transfer functions of mechanical translational and rotational system.*	*Steady state response; Steady state error.*	*Stability Analysis using Bode Plots*	*Feedback compensation –Lead compensation*	*Relationship between state equation and transfer functions.*
	SLO-2	*Tutorial: Formation of electrical analogy of mechanical translational and rotational system.*	*Static & dynamic error coefficients*	*Procedure for plotting bode plot. .*	*Lag compensation*	*Conversion of state space to transfer function.*
S-7	SLO-1	*Block diagram algebra.*	*Effects of additional Pole on the Second-Order System Response*	*Tutorial – Bode plot problem*	*Compensator design in frequency domain using bode plot*	*Solution of state equation;*
	SLO-2	*Representation by Signal flow graph*	*Effects of additional Zero on the Second-Order System Response*	*Stability margin on the bode plot.*	*Design procedure.*	*State Transition Matrix and it's Properties*
S-8	SLO-1	*Tutorial: Block diagram reduction direct method..*	*Routh Hurwitz criterion*	*Nyquist (Polar) Plot*	*Tutorial - Compensator design*	*Importance of controllability and observability.*
	SLO-2	*Tutorial: Block diagram reduction use by Mason's gain formula.*	*Stability condition and its limitation.*	*Gain phase plot.*	*Achieved desired system specification.*	*Tutorial: Formation of controllability and observability matrix*
S 9-10	SLO-1 SLO-2	*Lab 2: Determination of transfer function parameter of AC servo motor.*	*Lab 5: Step response characteristics of second order system.*	*Lab 8: Stability analysis of second order system using time and frequency domain approach.*	*Lab 11 Stability analysis of add a pole / zero and lag lead compensator.*	*Lab 14:. Analysis of twin rotor multi input multi output system.*
S-11	SLO-1	*Linear Approximations of Physical Systems.*	*Properties of the Root Loci*	*Nyquist stability criterion*	*Pole zero cancellation design:*	*Pole zero cancellation for uncontrollability system.*
	SLO-2	*Linearization of nonlinear systems*	*Construction of root loci*	*Stability analysis using nyquist plot.*	*Notch filter*	*Design for controllable system.*
S-12	SLO-1	*Poles and zeros of a transfer function*	*Tutorial – Root locus*	*Relations between closed loop and open loop frequency response.*	*Minor loop feedback control.*	*Tutorial –Pole placement of state feedback system.*
	SLO-2	*Graphical evaluation*	*Gain limitation for stability condition.*	*M and N circle*	*Advantages and Applications*	*Design for pole placement approach.*
S-13	SLO-1	*BIBO Stability and its important*	*Effects of adding poles on the root loci.*	*Time response analysis use by Simulink/ program software.*	*Case Study: IEC61131 Standards*	*Case study: State space analysis of electric vehicle charging system.*
	SLO-2	*Location of poles and stability.*	*Effects of adding zeros on the root loci.*	*Frequency response analysis use by Simulink/ program software.*	*Programming language for industrial automation.*	*Analysis the system response.*
S 14-15	SLO-1 SLO-2	*Lab 3: Performance analysis of a motor driving a load through a gear train.*	*Lab 6. Plotting root locus of a transfer function using a simulator tank level estimation control.*	*Lab 9: Modeling and control analysis of simple electric network*	*Lab 12: Effect of feedback on disturbance and PID control design.*	*Lab 15: Design of speed control of DC motor drive.*

Learning Resources	1. *I J Nagarath and M.Gopal, Control systems Engineering, New age international publication , 6th Edition, 2017.* 2. *FaridGolnaraghi, Benjamin C. Kuo, Automatic Control Systems, McGraw-Hill Professional, 10th Edition, 2017.* 3. *Katsuhiko Ogata,Modern control engineering, Pearson publication, 5th Edition, 2017.* 4. *Stefani, shahian, savant, Hostetter, Design of Feedback control systems, Oxford university press, 4th Edition,2014,*	5. *K.P.Ramachandran, Control Engineering, Wilky India Private Limited,1st Edition,2011.* 6. *Graham C.Goodwin, Stefan F. Graebe, Mario E. Salgado, Control system design ,Pearson Education, 2nd Edition,2001.* 7. *.B.S.Manke, Control System Design, Khanna publisher, 5th Edition,2014.* 8. *Online course material: Plat form- NPTEL, Author – Prof . S.D Agashe, IIT Bombay, Web link: https://nptel.ac.in/syllabus/108101037/*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. *Mr.Senthilkumar,ATI,rskrd1962@gmail.com,*	2. *Dr. S. Ramareddy, Jerusalem College of Engineering,srr.victory@gmail.com.*	*2.Dr.N.Chellammal, SRMIST*

Course Code	18EEC302J	Course Name	POWER ELECTRONICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Emphasize on basics of various power devices
CLR-2 :	Furnish adequate knowledge about the application of power devices in rectifier circuits
CLR-3 :	Educate the students on various DC-DC converters and their design
CLR-4 :	Illustrate the types and working of DC-AC converters
CLR-5 :	Describe the classification of AC-AC converters and their working
CLR-6 :	Providebasic knowledge on different industrial applications of power electronic converters

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	Understand and analyze the characteristics of different power devices	2	75	75	H	M	-	-	M	-	-	-	M	M	-	-	M	M	-
CLO-2 :	Comprehend the operation of AC-DC converters and design a converter of specific range	3	75	75	H	H	M	M	M	-	-	-	M	M	-	-	M	M	-
CLO-3 :	Apply the concept of chopper principle and design a DC-DC converter.	3	75	75	H	H	M	M	M	-	-	-	M	M	-	-	M	M	-
CLO-4 :	Articulate the concept of DC-AC conversion and model an inverter	3	75	75	H	H	M	M	M	-	-	-	M	M	-	-	M	M	-
CLO-5 :	Analyze the function of AC-AC converters	2	75	75	H	M	-	-	M	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Acquire and analyze various applications of power electronic circuits	3	75	75	H	M	M	M	M	-	-	-	M	M	-	-	M	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to Power processing	Single phase full controlled rectifiers with R, RL load	Principles of chopper circuits	Principles of power VSI and CSI inverters	Step down Cycloconverter
	SLO-2	Construction - Principle of operation of Power diodes	Estimation of average & RMS load voltage, RMS load current and input power factor for full controlled rectifiers	Control Strategies in chopper circuits	Single phase voltage source inverter under various loading conditions	Step up Cycloconverter
S-2	SLO-1	Dynamic characteristics of Power diodes	Single phase full controlled rectifiers with RLE load	Multi- quadrant operation of chopper	Working of three phase inverter circuits in 180 degree mode of conduction	Three phase to single phase Cycloconverter
	SLO-2	Construction - Principle of operation of SCR- Dynamic characteristics of SCR	Estimation of average & RMS load voltage	Types of commutation	Determination of RMS ,average values of line and phase voltage	Three phase to three phase cyclo converter
S-3	SLO-1	Construction - Principle of operation of TRIAC,GTO	Estimation of RMS load current and input power factor	Forced commutated chopper :Voltage commutated choppers	Working of three phase inverter circuits in 120 degree mode of conduction	Introduction to matrix converter
	SLO-2	Dynamic characteristics of GTO	Problems in rectifier circuits	Forced commutated chopper : Current commutated choppers	Determination of RMS ,average values of line and phase voltage	Operation of matrix converter
S 4-5	SLO-1 SLO-2	Lab 1: R-RC Triggering Circuits ; UJT Triggering Circuits; HWR-FWR HWR-FWR	Lab 4: Single phase half controlled bridge rectifier with resistive and inductive loads	Lab 7: Control of DC Voltage in chopper circuits using Time ratio & pulse width control	Lab 10: Three phase DC-AC converter for different types of loads	Lab 13: Single Phase cycloconverter
S-6	SLO-1	SCR: turn-on, methods	Three phase full controlled rectifiers with R load	Load commutated chopper	Introduction to Current source inverter	AC Voltage regulator

Duration (hour)		15	15	15	15	15
	SLO-2	SCR: turn-off methods	Working of three phase full controlled rectifiers with R load for various firing angle	Introduction to isolated and Non-isolated topologies	Auto sequential current source inverter	Active power line conditioner
S-7	SLO-1	Over voltage protection:	Three phase full controlled rectifiers with RL load	Basic non-isolated topologies: Characteristics of Buck converter	Single pulse width modulation technique	UPS
	SLO-2	Over current protection	Working of three phase full controlled rectifiers with RL load for various firing angle	Derivation of voltage gain of Buck converter	Multiple pulse width modulation technique	SMPS
S-8	SLO-1	Gate Protection	Estimation of average & RMS load voltage,	Basic non-isolated topologies: Characteristics of Boost converter	Sinusoidal pulse width modulation technique (Unipolar , bipolar schemes)	HVDC systems
	SLO-2	Design of Snubber circuits	Estimation RMS load current and input power factor	Derivation of voltage gain of Boost converter	Introduction to space vector pulse width modulation	Types of HVDC systems
S 9-10	SLO-1 SLO-2	Lab 2: Characteristics of SCR;TRIAC	Lab 5: Three phase fully controlled rectifier with resistive load	Lab 8:Study of forced commutation techniques using chopper circuits	Lab 11: Generation of PWM signals using Sine PWM technique to trigger switches in a three phase inverter	Lab 14: A.C. voltage controllers with R and RL loads
S-11	SLO-1	Construction - Principle of operation of Power MOSFET	Single phase semi converter- Construction, working	Steady-State Equivalent Circuit Modeling of dc-dc converters- Losses and Efficiency	Voltage control of inverters	Tap changing of transformers
	SLO-2	Dynamic characteristics of Power MOSFET	Estimation of average & RMS load voltage of single phase semi converter	Resonant converters	Harmonics study and its reduction techniques	Electronic ballast
S-12	SLO-1	Construction - Principle of operation of Power IGBT	Three phase semi converter –Construction	Characteristics of CUK converter	Multilevel inverters: Introduction, Types	Induction heating
	SLO-2	Dynamic characteristics of Power IGBT	Working of three phase converter for different firing angles	Derivation of voltage gain of CUK converter	Working of cascaded seven level Inverter	Light dimmer
S-13	SLO-1	Loss calculation (Switching, conduction and leakage losses)	Estimation of average & RMS load voltage of three phase semi converter	Characteristics of SEPIC converter	Working of Diode clamped five level Inverter	Role of power converters in PV systems
	SLO-2	Problems in calculation of losses of various power devices	Effect of source inductance in full converter	Derivation of voltage gain of SEPIC converter	Working of flying capacitor five level Inverter	Role of power converters in Electric vehicles
S 14-15	SLO-1 SLO-2	Lab 3: Characteristics of MOSFET, IGBT	Lab 6: Three phase semi converter	Lab 9: : case study : Design and Model a Buck-Boost converter a) using real time software b) using discrete components for specific condition	Lab 12: Case study :Design a Single phase DC-AC converter to drive a 0.5 hp Single phase induction motor	Lab 15: Case study Design and analyze a fully controlled rectifier to feed a --- kW inverter using discrete components

Learning Resources	1. Mohan N, Undeland T M, and Robbins W P, Power Electronics - Converters, Applications andDesign, Third Edition, John Wiley & Sons, Inc., New York, 2017. 2. Rashid M H, Power Electronics, Circuits, Devices and Applications, Prentice Hall PearsonEducation, Inc., Fourth Edition 2014.	3. P.S.Bimbhra, Power Electronics, Khanna Publishers, New Delhi, Fifth edition 2012;Reprint 2014 4. M.D.Singh, K.B.Khanchandani, Power Electronics, Tata McGraw Hill, New Delhi,2nd Edition,, 2006 5. https://nptel.ac.in/downloads/108105066/

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Prakash G- Lead, CoreEL Technologies , Bangalore, prakash.g@coreel.com	*1. Dr.S.Senthilkumar, NIT,Trichy;skumar@nitt.edu*	*1. Dr.N. Chellammal, SRMIST*
2. Mr. Pramod Kumar N,CoreELTechnologies, Bangalore	*2. Dr.G.Uma, CEG, Anna University, uma@annauniv.edu*	*2. Dr.R.Sridhar, SRMIST*

Course Code	18EEC303T	Course Name	POWER SYSTEM ANALYSIS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the modeling of power system*
CLR-2 :	*Examine power flow analysis using numerical techniques*
CLR-3 :	*Evaluate the behavior of the power system under symmetrical fault conditions*
CLR-4 :	*Evaluate the behavior of the power system under unsymmetrical fault conditions*
CLR-5 :	*Discuss the stability issues of power system under transient condition*
CLR-6:	*Understand the mathematical modeling and analysis of power system*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Summarize the basics of power system components, formation of network graphs and bus admittance matrix*	2	80	75	H	H	L	-	-	-	-	-	-	-	-	-	M	M	-
CLO-2 :	*Solve numerical methods in the application of power flow studies*	3	80	75	H	H	L	-	M	-	-	-	-	-	-	-	M	M	-
CLO-3 :	*Analyze the impact of symmetrical faults*	3	80	75	H	H	L	-	-	-	-	-	-	-	-	-	M	M	--
CLO-4 :	*Analyze different types of unsymmetrical faults*	3	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	M	-
CLO-5 :	*Examine transient stability analysis and solve numerical methods for transient stability*	3	80	75	H	H	L	-	-	-	-	-	-	-	-	-	M	M	-
CLO-6 :	*Analyze the power system under normal and fault conditions*	3	80	75	H	H	L	-	M	-	-	-	-	-	-	-	M	M	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Power scenario in India*	*Necessity of power flow studies*	*Symmetrical short circuit on Synchronous Machine*	*Introduction to symmetrical components*	*Introduction to stability studies*
	SLO-2	*Power system components*	*Bus classification*	*Steady state, transient and sub transient reactances*	*Sequence voltages and currents*	*Illustration of steady state stability limit*
S-2	SLO-1	*Per unit representation*	*Formulation of Power Flow problems*	*Study of symmetrical faults in power system*	*Sequence impedances and networks*	*Synchronizing power co-efficient*
	SLO-2	*Single line diagram*	*Power flow solution using Gauss Seidel method (algorithmic steps)*	*Numericals in short circuit in synchronous generator*	*Zero sequence networks*	*Review of mechanics and swing equation*
S-3	SLO-1	*Per unit quantities*	*Handling of Voltage controlled buses*	*Bus Impedance matrix by building algorithm (without mutual coupling) (algorithmic steps)*	*Types of unsymmetrical faults*	*Representation of swing curves*
	SLO-2	*p.u impedance diagram*	*Power flow solution using Gauss Seidel method excluding PV buses (quantitative analysis)*	*Bus Impedance matrix by building algorithm (without mutual coupling) (quantitative analysis)*	*Fault conditions for single line to ground fault*	*Power-Angle equation*
S-4	SLO-1	*Network graph*	*Conditions for PV buses*	*Bus Impedance matrix by building algorithm (including mutual coupling) (algorithmic steps)*	*Fault conditions for line to line fault*	*Equal area criterion*
	SLO-2	*Bus incidence matrix*	*Power flow solution using Gauss Seidel method including PV buses (quantitative analysis)*	*Bus Impedance matrix by building algorithm (including mutual coupling) (quantitative analysis)*	*Fault conditions for double line to ground fault*	*Impact of sudden load increase in synchronous motor*
S-5	SLO-1	*Primitive parameters*	*Impact of acceleration factor in convergence*	*Symmetrical fault analysis using Thevenin's theorem*	*Single line to ground fault and line to line fault in generator terminals*	*Illustrations of equal area criterion under different system conditions*

Duration (hour)		9	9	9	9	9
	SLO-2	*Graph and oriented graph*	*Power flow solution including acceleration factor*	*Symmetrical fault analysis using Thevenin's theorem (numericals)*	*Double line to ground fault in generator terminals*	*Derivation of Critical clearing angle and time*
S-6	SLO-1	*Links and trees*	*Algorithmic steps of Power Flow Solution by Newton Raphson method*	*Derivation of Bus voltages due to current injection*	*Assumptions for system representation*	*Derivation of Critical clearing angle and time (quantitative analysis)*
	SLO-2	*Bus admittance matrix using singular transformation method without mutual coupling*	*Power Flow Solution by Newton Raphson method (quantitative analysis)*	*Calculation of bus voltages and line currents*	*Formation of positive, negative and zero sequence networks*	*Classical step-by-step solution of the swing curve (theoretical approach)*
S-7	SLO-1	*Bus admittance matrix using singular transformation method without mutual coupling (quantitative analysis)*	*Algorithmic steps of Power Flow Solution by Fast Decoupled method*	*Symmetrical fault analysis through bus impedance matrix (theoretical approach)*	*Bus impedance matrices of positive, negative and zero sequence networks*	*Classical step-by-step solution of the swing curve (numerical approach)*
	SLO-2	*Bus admittance matrix using singular transformation method including mutual coupling*	*Power Flow Solution by Fast Decoupled method (quantitative analysis)*	*Symmetrical fault analysis through bus impedance matrix (quantitative analysis)*	*Analyzing Single line to ground fault and line to line fault with fault impedance*	*Algorithmic steps of swing equation using Runga Kutta method*
S-8	SLO-1	*Representation of off nominal transformer*	*Derivation of Power flow in lines*	*Short circuit level /Fault level*	*Analyzing double line to ground fault with fault impedance*	*Numeric solution of swing equation using Runga Kutta method (quantitative analysis)*
	SLO-2	*Numerical problems in off nominal transformer*	*Numerical solution of Power flow in lines*	*Fault level and short circuit MVA (numericals)*	*Analyzing unsymmetrical fault occurring at any point in a power system*	*Algorithmic steps of swing equation using modified Eulers method*
S-9	SLO-1	*Formation of bus admittance matrix for large scale system (Theoretical approach)*	*Derivation of slack bus power and line losses*	*Current limiting reactors*	*Unsymmetrical fault analysis using bus impedance matrices (algorithmic)*	*Numeric solution of swing equation using modified Euler's method*
	SLO-2	*Formation of bus admittance matrix for large scale system (quantitative analysis)*	*Numerical solution of slack bus power and line losses*	*Design of circuit breakers based on fault analysis*	*Unsymmetrical fault analysis using bus impedance matrices (quantitative analysis)*	*Factors affecting transient stability*

Learning Resources	1. *John.J.Grainger, William D. Stevenson, Jr ,Power System Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 2015.* 2. *William D. Stevenson, Jr. ,Elements of Power System Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 4th Edition, 2014.* 3. *Nagarath I.J. and Kothari D.P.,Modern Power System Analysis, 4th Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2011*	4. *Hadi Sadat, Power System Analysis,McGraw Hill Education (India) Private Limited, New Delhi, 2nd Edition,2002.* 5. *Pai M.A. and Dheeman Chatterjee, Computer Techniques in Power System Analysis,, Mc Graw Hill Education (India) Private Limited, New Delhi, 3rd Edition, 2014.* 6. *https://nptel.ac.in/courses/108105067/1*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	*-*	*30 %*	*-*	*30 %*	*-*	*30 %*	*-*	*30%*	*-*
Level 2	Apply Analyze	*40 %*	*-*	*40 %*	*-*	*40 %*	*-*	*40 %*	*-*	*40%*	*-*
Level 3	Evaluate Create	*20 %*	*-*	*30 %*	*-*	*30 %*	*-*	*30 %*	*-*	*30%*	*-*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr.K.Karthikeyan, ABB India Ltd., k.karthikeyan@in.abb.com	*2. Dr. P. Somasundaram, CEG, Anna University, mpsomasundaram@annauniv.edu*	*2. Dr. D. Suchitra, SRMIST*

Course Code	18EEC304J	Course Name	MICROCONTROLLERS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the architecture and instruction set of 8051*
CLR-2 :	*Familiarize with the programming modes of the SFRs in8051*
CLR-3 :	*Introduce 8051 programming in C*
CLR-4 :	*Outline the features of PIC microcontroller, its architecture and instruction set.*
CLR-5 :	*Explain the architecture of ARM Processor and its instruction set.*
CLR-6 :	*Acquire knowledge on microcontrollers and their applications.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Summarize and program 8051 microcontrollers*	1	75	75	H	M	M	M	M	-	-	-	M	M	-	-	M	M	-
CLO-2 :	*Program the SFRs according to the given requirements*	3	75	75	H	M	M	M	M	-	-	-	M	M	-	-	H	H	-
CLO-3 :	*Interface the various peripherals with 8051 and program 8051 using C*	3	75	75	H	M	M	M	M	-	-	-	M	M	-	-	H	H	-
CLO-4 :	*Decipher the given problem and develop simple programs using PIC microcontrollers*	3	75	75	H	M	M	M	-	-	-	-	M	M	-	-	H	H	-
CLO-5 :	*Analyze and develop simple programs using ARM processor for simple applications.*	3	75	75	H	M	M	M	M	-	-	-	M	M	-	-	H	H	-
CLO-6 :	*Update their knowledge on microcontrollers and program them for real time applications*	3	75	75	H	M	M	M	M	-	-	-	M	M	-	-	H	H	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Evolution of Microprocessors,Microcontrollers and Computers*	*Counters & timers: modes of operation*	*Introduction to interfacing peripheral devices*	*Introduction to PIC 16F84Amicrocontroller*	*The ARM processor -features*
	SLO-2	*Comparison of Microprocessor and Microcontroller*	*TMOD register*	*8255 PPI – Pin diagram and architecture*	*Applications of PIC 16F84A*	*Applications of ARM processors*
S-2	SLO-1	*Overview of 8-bit / 16-bit / 32-bit microprocessors and microcontrollers*	*TCON register*	*8255 PPI – Modes of operation*	*Architecture overview of PIC 16F84A*	*Architecture overview of ARM processor*
	SLO-2	*CISC and RISC architectures*	*Serial data transmission/ reception: modes*	*8279 keyboard interface - Pin diagram and architecture*	*PIC 16F84A - Block diagram*	*ARM processor - Block diagram*
S-3	SLO-1	*8051 – pin diagram*	*SCON register*	*8279 keyboard interface - modes of operation*	*Working register*	*The ARM programmer's model*
	SLO-2	*8051 - Internal Block Diagram*	*PCON register*	*LCD interfacing*	*Status register*	*ARM Current Program Status Register*
S 4-5	SLO-1 SLO-2	*Lab 1: Introduction to 8051 microcontroller*	*Lab 4:Boolean and logical operations (bit & byte level logical operations) using 8051 microcontroller*	*Lab 7:8 bit ADC using 8051 microcontroller*	*Lab 10:: Transfer data serially between two kits*	*Lab 13:DC motor speed measurement and control.*
S-6	SLO-1	*8051 - architecture*	*Internal Interrupts*	*Parallel and serial ADC interface*	*File selection register*	*ARM exceptions*
	SLO-2	*Internal memory organization*	*External Interrupts*	*DAC interface*	*Indirect data addressing register*	*Introduction to Thumb instructions*
S-7	SLO-1	*Register banks, PSW*	*IE register*	*Sensor interfacing*	*memory organization- Program memory*	*Pipeline ARM organization (3,5 stage)*
	SLO-2	*Ports*	*IP register*	*Stepper motor interfacing*	*Data memory*	*ARM instruction set: data processing instructions – arithmetic operations*

S-8	SLO-1	Classification of instruction set	Clock circuit	DC motor interfacing and PWM	Watch dog timer	data processing instructions –bitwise logical, register movement & comparisons operations
	SLO-2	Addressing modes	RESET circuit	RTC interfacing	Power down/ sleep mode	Data transfer instructions – single load/store
S 9-10	SLO-1 SLO-2	Lab 2:Arithmetic operation using 8051 microcontrollers	Lab 5:Square root computation	Lab 8:8 bit DAC using 8051 microcontroller	Lab 11: Internal interrupt generation	Lab 14: Basic ARM ALP(32-bit addition, subtraction, multiplication)
S-11	SLO-1	Instruction set - Data transfer,	Semiconductor memory -Types	Introduction to 8051 programming in C	PIC 16F84A parallel ports	Data transfer instructions – multiple load/store
	SLO-2	Instruction set - Logical operations, data exchange	Memory address decoding	Data types for 8051 C	Clock and oscillator circuits	Data transfer instructions –swap
S-12	SLO-1	Instruction set - arithmetic operations	8031/51 Interfacing with External ROM and RAM	I/O programming and logical operations in 8051 C	Instruction set – Arithmetic instructions	Control flow instructions – Branch, conditional branch
	SLO-2	Instruction set – Call, return	Pins PSEN, EA	Accessing code ROM space in C	logic instructions	Control flow instructions –jump
S-13	SLO-1	Instruction set – bit jump	Data memory space	Programming timers in 8051C	Instruction set – test and skip instructions	AMBA bus architecture
	SLO-2	Instruction set – byte jump	Problems on external memory interfacing	Calculation of time delays	jump instructions	ARM development tools – ARMulator
S 14-15	SLO-1 SLO-2	Lab 3:Sorting data, Code conversion using 8051 microcontroller	Lab 6:: Delay generation using an on-chip timer using 8051 microcontrollers.	Lab 9:8279 Keyboard &display using 8051 controllers.LCD Display using 8051	Lab 12: Stepper motor control using 8051	Lab 15:Basic ARM binary sorting

Learning Resources	1. Muhammad. Ali.Mazidi, the 8051 Microcontroller and Embedded Systems: Second edition, Pearson Education Limited, 2013. 2. K. J. Ayala, 8051 Microcontroller, Delmar Cengage Learning, 3rd edition,2007. 3. Subrata Ghoshal, 8051 Microcontroller Internals, Instructions, Programming and Interfacing, Second edition, Pearson Education Asia, 2014. 4. John Peatman, Design with PIC Microcontrollers,PearsonEducationAsia, 8th impression 2009	5. SteveFurber, ARM System-on-chip architecture, PearsonEducation, India, 2000. 6. Tim Wilmshurst, Designing Embedded Systems with PIC Microcontrollers: Principles and applications, Published by Elsevier, 2010 7. https://nptel.ac.in/courses/117104072/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply / Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate / Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Roosefart Mohan, Nelcast Limited, Chennai,roosefart@gmail.com	1. Dr.R.Subha, Sir MVIT, Bangalore, subha.mvit@gmail.com	1. Dr.D. Suchitra, SRMIST
2.Mr.Muralikrishna, National Instruments, emkkrishnan@gmail.com	2. Dr. A. Venkadesan, NIT, Puducherry, venkadesan@nitpy.ac.in	2. Ms. D. Anitha, SRMIST

Course Code	18EEC305T	Course Name	POWER SYSTEM PROTECTION	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the principles of modern power system protection*
CLR-2 :	*Enumerate the various protection schemes*
CLR-3 :	*Acquire the knowledge of protection of Generator, Transformer and Busbar protection system*
CLR-4 :	*Understand the various types of digital protection and relay coordination*
CLR-5 :	*Describe the protection of switchgears in sub-station and its relay setting calculations*
CLR-6 :	*Gain an overall knowledge of power system protection concepts in various applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Recognize the power system protection basics and standards*	*2*	*80*	*75*	*H*	-	-	-	-	-	-	*M*	-	-	-	-	*M*	*M*	*M*
CLO-2 :	*Employ various protective schemes and needed instruments*	*3*	*80*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*M*	*M*	-
CLO-3 :	*Explain the various equipment protection and its characteristics*	*3*	*80*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*M*	*M*	-
CLO-4 :	*Familiarise various relay algorithms and applications of digital protection*	*3*	*80*	*75*	*H*	*H*	-	-	*M*	-	-	-	-	-	-	-	*H*	*H*	-
CLO-5 :	*Analyse the use of protection and switchgears*	*3*	*80*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*M*	*M*	-
CLO-6 :	*Apply power system protection concepts in real time environment*	*3*	*80*	*75*	*H*	*H*	-	-	*M*	-	-	*M*	-	-	-	-	*H*	*H*	*M*

Duration		9	9	9	9	9
S-1	SLO-1	*Introduction to power system protection*	*Over current protection*	*Transformer protection*	*Introduction to Digital relays - Numerical relays*	*Fuses – Types*
	SLO-2	*Basic requirements*	*Characteristics of over current protection*	*Differential protection*	*Functional blocks of numerical relay*	*Construction of fuse*
S-2	SLO-1	*Main components of protections*	*Over current protection coordination*	*Percentage biased differential protection*	*Numerical over current relay algorithm*	*Fuse characteristics*
	SLO-2	*Functions of protection*	*Relay setting calculation*	*Differential protection scheme for various types of three phase transformé*	*Numerical over current relay Flow chart*	*Applicaion of fuse*
S-3	SLO-1	*IEC – IEEE standards for protection*	*Numerical problems for over current setting*	*Numerical problems for differential protection*	*Numerical differential relay algorithm*	*Theory of current interruption,*
	SLO-2	*ANSI standards for protection*	*Numerical problems for over current setting*	*Numerical problems for differential protection*	*Numerical differential relay Flow chart*	*Arc quenching – Interruption theories*
S-4	SLO-1	*Zone of protection - overlapping*	*Directional over current relay*	*Magnetizing inrush current and harmonics restraint method*	*Numerical distance relay algorithm*	*Recovery and Restriking voltages*
	SLO-2	*Primary – back up protection*	*Charcateristics of directional over current relay*	*Over fluxing protection, Incipient fault protection - Buchholz Relay*	*Numerical distance relay Flow chart*	*RRRV*
S-5	SLO-1	*Unit, Non – Unit protection*	*Principle of distance protection*	*Alternator protection*	*Fibre Optic based relaying*	*Types of circuit breakers -Bulk oil, Minimum oil circuit breakers*
	SLO-2	*Applications of unit, non-unit protection*	*Charcateristics of distance relay*	*stator protection*	*Fibre optic relay Functions - application*	*Functions - applications*
S-6	SLO-1	*Other types of protection schemes*	*Simple impedance, Reactance and Mho relay*	*Rotor protection*	*Wide Area Protection - functions*	*Air break, Air blast circuit breakers*

Duration		9	9	9	9	9
	SLO-2	Applications of protection schemes	Characteristics of impedance realy	Protection against abnormal condition - unbalanced loading, Over-speeding	Introduction to simulation of relay coordination	Functions - applications
S-7	SLO-1	Current Transformer for protection	Three step distance protection	Loss of excitation	Applications of digital signal processing tool for protection	Sulphur hexafluoride (SF6) and Vacuum circuit breakers
	SLO-2	Characteristics – numerical problems	Application of three step distance protection	Loss of prime mover	Functional blocks DSP	Applications of SF6 and vacuum circuit breakers
S-8	SLO-1	Voltage Transformer for protection	Carrier aided protection	Bus bar protection scheme	AI techniques to power system protection	Comparison of circuit breakers
	SLO-2	Characteristics of current transformer	Main components of carrier aided protection	Types of bus bar protection	Applications Of artificial intelligence in protection	Testing of circuit breaker
S-9	SLO-1	Electromechanical relays – construction	Bus bar protection scheme	Protection against over voltage - diverters,	Digital protection - Introduction to RTDS	Circuit breakers rating
	SLO-2	Relay operation - application	Types of bus bar	Lightning arrestor	Digital substation	Relay setting calculation and its operation

Learning Resources	1. Badriram & Vishwakarma, Power System Protection, Tata McGraw-Hill Education,10th reprint, 2015 2. Paithankar Y. G., S. R. Bhide., Fundamentals of power system protection', PHI Learning Pvt. Ltd.,10th reprint,2010. 3. J. Lewis Blackburn & Thomas J. Domin, Protective Relaying - Principles and Applications, Fourth 4. Edition, CRC Press.	5. Bhavesh R. Bhalja, R. P. Maheshwari, Nilesh Chothani, oxford university press, Second Edition, 2018 6. A. Kalam, D.P. Kothari, Power System Protection and Communication, New Age Science Ltd, 2009. 7. Paul M. Anderson, Power System Protection, IEEE press series on Power Engineering, 1999. 8. https://nptel.ac.in/courses/108101039/

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er.R.PanneerSelvam, Former SE/TANGEDCO, panneer.rps@gmail.com	1. Prof.K.Shanti Swarup, IITM, ksswarup@iitm.ac.in	1. Mr.D.Ravichandran, SRMIST
2. Dr. Swaroop Gajare, Lead Engineer, Power Systems Technologies, Eaton Research Labs, swaroopgajare@eaton.com	2. Dr. P. Raja, NIT Tiruchirappalli, praja@nitt.edu	2. Dr. M. Senthilkumar, SRMIST

Course Code	18EEC401J	Course Name	POWER SYSTEM OPERATION AND CONTROL	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the control methods of frequency in power system*
CLR-2 :	*Understand voltage control methods in power system*
CLR-3 :	*Formulate the economic operation of power system*
CLR-4 :	*Discuss the different methods to reduce losses and cost in power system*
CLR-5 :	*Develop knowledge on operation and control strategies of power system*
CLR-6 :	*Summarize the operation and control of power system*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Analyze frequency control in single area and two area system*	*3*	*75*	*75*	*H*	*H*	*M*	*L*	*H*	-	-	*M*	*M*	-	-	-	*M*	*M*	*M*
CLO-2 :	*Model excitation systems and develop methods of voltage control*	*3*	*75*	*75*	*H*	*H*	*M*	*L*	*H*	-	-	*M*	*M*	-	-	-	*M*	*M*	*M*
CLO-3 :	*Examine numerical methods of economic dispatch*	*3*	*75*	*75*	*H*	*H*	*M*	*L*	*H*	-	-	-	*M*	-	-	-	*M*	*M*	-
CLO-4 :	*Solve unit commitment and optimal power flow problem*	*3*	*75*	*75*	*H*	*H*	*M*	*H*	*H*	-	-	-	*M*	-	-		*M*	*M*	-
CLO-5 :	*Analyze the functions of modern energy control centre on monitoring, data acquisition and control*	*3*	*75*	*75*	*H*	*H*	-	-	*H*	-	-	-	*M*	-	-		*M*	*M*	-
CLO-6 :	*Evaluate the strategies of operation and control*	*3*	*75*	*75*	*H*	*H*	*M*	*L*	*H*	-	-	*M*	*M*	-	-	-	*M*	*M*	*M*

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Basic concepts of operation and control of power system*	*Need for voltage control*	*Input-output characteristics of thermal units and Heat rate Curve*	*Statement of Unit Commitment problem*	*Operating strategies*
	SLO-2	*Plant and system level control*	*Requirement of reactive power*	*Input-output characteristics of Cost Curve.*	*Problem constraints*	*Control Strategies under abnormal state*
S-2	SLO-1	*Interaction of AVR and ALFC loops*	*DC Excitation system with amplidyne voltage regulator*	*Optimum generation allocation neglecting network losses and inequality constraints*	*Priority List method*	*Concept of modern control centre: monitoring, data acquisition and control*
	SLO-2	*Speed load characteristics*	*Field controlled alternator rectifier excitation*	*Optimum generation allocation neglecting network losses and inequality constraints- numerical approach*	*Priority List method-numerical approach*	*Introduction to SCADA system*
S-3	SLO-1	*Modelling of speed governing mechanisms*	*Static Excitation systems*	*Optimum generation allocation neglecting network losses and including inequality constraints*	*Dynamic programming to unit commitment problem*	*Components of SCADA system*
	SLO-2	*Regulation of two alternators in parallel*	*Brushless AC Excitation systems*	*Optimum generation allocation neglecting network losses and including inequality constraints- numerical approach*	*Algorithmic steps of Dynamic programming*	*Applications of SCADA in power systems*
S 4-5	SLO-1 SLO-2	*Lab 1: Real time data acquisition of electrical parameters*	*Lab 4: Development of voltage controllers using simulation tool*	*Lab 7: Economic dispatch neglecting losses*	*Lab 10: Unit commitment using priority method*	*Lab 13: Study of SCADA systems*
S-6	SLO-1	*Concept of Control area*	*Schematic diagram of brushless excitation system*	*Loss Coefficients*	*Dynamic programming-numerical approach*	*PLC architecture and communication links*

Duration (hour)		15	15	15	15	15
	SLO-2	*Closing ALFC loop*	*Modelling of AVR and Exciter*	*Transmission line loss formula*	*Lagrange Relaxation method*	*State estimation by weighted least square method*
S-7	SLO-1	*Static response of single area system-uncontrolled case*	*Modelling of synchronous generator*	*Incremental cost of received power*	*OPF problem formulations*	*State estimation by weighted least square method-numerical approach*
	SLO-2	*Dynamic response of single area system--uncontrolled case*	*Static performance of AVR loop*	*Penalty factors*	*Constraints in OPF problem*	*Wide area monitoring systems*
S-8	SLO-1	*Proportional plus integral controller*	*Dynamic response of AVR loop*	*Base point and Participation factor method*	*Gradient method of OPF problem*	*Introduction to phasor measurement units*
	SLO-2	*Static response of single area system-controlled case*	*Stability compensation and stability analysis using Bode Plot*	*Base point and Participation factor method-numerical approach*	*Gradient method of OPF problem-numerical approach*	*Comparison of SCADA with PMU*
S 9-10	SLO-1 SLO-2	*Lab 2: Automatic Load frequency control in single area system using simulation tool*	*Lab 5: Stability analysis of AVR loop*	*Lab 8: Economic dispatch including losses*	*Lab 11: Gradient method of OPF problem*	*Lab 14: State estimation using weighted least square method*
S-11	SLO-1	*Dynamic response of single area system-controlled case*	*IEEE Excitation models*	*Economic dispatch by gradient method*	*Linear programming OPF*	*PMU architecture*
	SLO-2	*Modelling of tie line*	*Voltage drop/rise in transmission lines*	*Economic dispatch by gradient method-numerical approach*	*Newton method of OPF*	*Levels of PDC*
S-12	SLO-1	*Modeling of Two area frequency control*	*Methods of voltage control- shunt capacitors, shunt reactors*	*Objectives and constraints in Security constrained economic dispatch*	*Security Constrained OPF-objectives*	*Mathematical formulation of optimal placement of PMUs*
	SLO-2	*Block diagram representation of two area system*	*Methods of voltage control- FACTS devices*	*Security constrained economic dispatch using linear programming*	*Security Constrained OPF-contraints*	*Optimal placement of PMU using linear programming*
S-13	SLO-1	*Static response of two area system*	*Methods of voltage control- tap changing transformer*	*Economic dispatch added to LFC control*	*Introduction to multi objective OPF*	*Need for Integration of Distributed generation*
	SLO-2	*Dynamic response of two area system*	*Numerical approach in tap changing transformer*	*Hydrothermal scheduling neglecting network losses –long term*	*Formulation of combined active and reactive power dispatch*	*Control and operation of distributed generation*
S 14-15	SLO-1 SLO-2	*Lab 3: Automatic Load frequency control in two area system using simulation tool*	*Lab 6: Study of voltage control techniques*	*Lab 9:Economic dispatch using gradient method*	*Lab 12: Study of numerical methods of OPF problem*	*Lab 15: Performance characteristics of Solar PV system and study of PV emulator*

Learning Resources	1. *Olle.I.Elgerd, Electric Energy systems theory- An Introduction, Tata Mc Graw Hill publishing Ltd, New Delhi, 27th reprint, 2007.* 2. *I.J.Nagrath and D.P.Kothari, Power system engineering, Tata Mc Graw Hill publishing Ltd, 2nd edition, 2007.*	3. *Allen J.Wood and Bruce F. Woollenburg, Gerald B.Sheble, Power generation, operation and control, 3rd edition, John Wiley and sons, 2013.* 4. *Prabha Kundur, Power system stability and control, Tata Mc Graw Hill publishing Ltd, New Delhi, 1st edition, 2006* 5. *https://nptel.ac.in/courses/108101040/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Sudharsan, L&T, sudharsand@lntecc.com	*1.Dr.D.Devaraj,Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1.Dr.J.Preetha Roselyn, SRMIST*
2. Dr.K.Karthikeyan, ABB India Ltd., k.karthikeyan@in.abb.com	*2.Dr. P. Somasundaram, CEG, Anna University, mpsomasundaram@annauniv.edu*	*2.Dr.R.Jegatheesan, SRMIST*

Course Code	18EEC350T	Course Name	COMPREHENSION	Course Category	C	Professional Core	L	T	P	C
							0	1	0	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	*Acquire skills to solve real world problems in analyzing the electric circuits, analog and digital electronics*
CLR-2 :	*Acquire skills to solve real world problems in electromagnetic theory, power electronics and control system*
CLR-3 :	*Acquire skills to solve real world problems in electrical machines, measurements and Instrumentation*
CLR-4 :	*Acquire skills to solve real world problems in Generation, Transmission and Distribution networks and its analysis*
CLR-5 :	*Acquire skills to solve real world problems in microcontrollers and its applications*
CLR-6 :	*Acquire skills to solve real world problems for competitive examinations in Electrical and Electronics Engineering*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design,	5: Modern Tool Usage	6: Society & Culture	7: Environment &	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Practice and gain confidence and competence to solve problems in analyzing the electric circuits, analog an ,digital electronics*	3	85	80	H	H	H	H	-	L	L	L	L	L	-	L	H	H	M
CLO-2 :	*Practice and gain confidence and competence to solve problems in electromagnetic theory, power electronics and control system*	3	85	80	H	H	M	M	-	L	L	L	L	L	-	L	H	H	M
CLO-3 :	*Practice and gain confidence and competence in electrical machines, measurements and Instrumentation*	3	85	80	H	H	M	M	-	L	L	L	L	L	-	L	H	H	L
CLO-4 :	*Practice and gain confidence and competence in Generation, Transmission and Distribution networks and its analysis*	3	85	80	H	H	M	M	-	L	L	L	L	L	-	L	H	H	M
CLO-5 :	*Practice and gain confidence and competence in microcontrollers and its applications*	3	85	80	H	H	H	H	-	L	L	L	L	L	-	L	H	H	L
CLO-6 :	*Practice and gain confidence and competence to solve problems for competitive examinations in Electrical and Electronics Engineering*	3	85	80	H	H	M	M	-	L	L	L	L	L	-	L	H	H	L

Duration (hour)		3	3	3	3	3
S-1	SLO-1	*Tutorial on AC and DC circuits*	*Tutorial on Electric Field, Dielectric concepts, Maxwell Equation*	*Tutorial on Transformers, generators and motors*	*Tutorial on ac and dc transmission concepts and distribution systems*	*Tutorial on 8085 microcontroller basic design*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-2	SLO-1	*Tutorial on characteristics of diode, amplifiers and OPAMP*	*Tutorial on semiconductor power devices , rectifier and inverter operation*	*Tutorial on bridges and potentiometer*	*Tutorial on per unit quantities and load flow methods*	*Tutorial on microcontroller programming*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-3	SLO-1	*Tutorial on combinational and sequential logic circuit*	*Tutorial on Controllers, transient and steady state analysis of LTI systems*	*Tutorial on phase, time and frequency measurement*	*Tutorial on protection methods and circuit breakers*	*Tutorial on interface*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*

Learning Resources	
	1. *Jegatheesan R, Analysis of Electric Circuits, McGraw Hill, 2014* 2. *Jacob Millman, Christos C.Halkias, SatyabrataJit, Millman's Electronic Devices and Circuits, 4th ed., Tata McGraw Hill, 2015* 3. *M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to Verilog HDL, VHDL and System Verilog, 6th ed., Pearson, 2018* 4. *William Hayt, Engineering Electromagnetics, 7th ed., McGraw Hill, 2014* 5. *Mohan N, Undeland T M, and Robbins W P, Power Electronics - Converters, Applications andDesign, Third Edition, John Wiley & Sons, Inc., New York, 2017* 6. *I J Nagarath and M.Gopal, Control systems Engineering, New age international publication, 6th Edition, 2017.* 9. *R.S.Goankar, Microprocessor Architecture Programming and Applications with the 8085, 6th edition, Penram International Publishing (India) Pvt.Ltd, 2013.* 10. *C. L. Wadwa, Electric Power Systems, 7th ed., New Age International Publishers, 2016* 11. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/lecture-notes/* 12. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-632-electromagnetic-wave-theory-spring-2003/index.htm* 13. *https://nptel.ac.in/downloads/108105066/*

	7. J. B. Gupta, Theory & Performance of Electrical Machines, 15th ed., S.K.Kataria & Sons, 2015 8. A.K.Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Co, 2012.	14. Online course material: Plat form- NPTEL, Author – Prof . S.D Agashe, IIT Bombay, Web link: https://nptel.ac.in/syllabus/108101037/

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40%	-	30%	-	30%	-	30%	-	-	-
Level 2	Apply Analyze	40%	-	40%	-	40%	-	40%	-	-	-
Level 3	Evaluate Create	20%	-	30%	-	30%	-	30%	-	-	-
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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