ACADEMIC CURRICULA

Professional Core Courses

ELECTRONICS AND COMMUNICATION 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	18ECC102J	Course Name	ELECTRONIC DEVICES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC201J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Provide a basis for understanding semiconductor material, how a pn junction is formed and its principle of operation			
CLR-2 :	Explain the importance of diode in electronic circuits by presenting appropriate diode applications			
CLR-3 :	Discuss the basic characteristics of several other types of diodes that are designed for specific applications			
CLR-4 :	Describe the basic structure, operation and characteristics of BJT, and discuss its use as a switch and an amplifier.			
CLR-5 :	Describe the basic structure, operation and characteristics of MOSFET, and discuss its use as a switch and an amplifier.			
CLR-6 :	Use modern engineering tools such as PSPICE to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Explain the operation, characteristics, parameters and specifications of semiconductor diodes and special diodes	1	60	70
CLO-2 :	Illustrate important applications of semiconductor diodes and special diodes.	2	60	70
CLO-3 :	Review bipolar transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	60	70
CLO-4 :	Review field-effect transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	60	70
CLO-5 :	Construct a circuit, then make functional measurements to understand the operating characteristics of the device / circuit.	3	70	75
CLO-6 :	Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE.	2	70	75

Program Learning Outcomes (PLO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-2 :	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-3 :	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-4 :	H	-	-	-	-	-	-	-	-	-	-	M	-	L	-
CLO-5 :	-	-	-	-	H	-	-	-	-	-	-	-	L	L	-
CLO-6 :	-	-	-	-	H	-	-	L	H	M	-	M	-	-	-

Duration (hour)		Semiconductor Diodes	Diode Circuits	Special Diodes	Bipolar Junction Transistors	MOS Field-Effect Transistors
		15	15	15	15	15
S-1	SLO-1	Basic semiconductor theory: Intrinsic & extrinsic semiconductors	HWR operation, Efficiency and ripple factor	Backward diode	Physical structure	Physical structure
	SLO-2	Current flow in semiconductors	Problem solving	Varactor diode	Device operation of BJT	Device operation of E-MOSFET & D-MOSFET
S-2	SLO-1	PN junction theory: Equilibrium PN junction	Center-Tapped Transformer FWR operation, Efficiency and ripple factor	Step recovery diode	Current-Voltage characteristics of CE BJT configuration	I-V characteristics of E-MOSFET
	SLO-2	Forward biased PN junction	Problem solving	Point-contact diode	Current-Voltage characteristics of CE BJT configuration	Problem solving
S-3	SLO-1	Reverse biased PN junction	Bridge FWR operation, Efficiency and ripple factor	Metal-semiconductor junction: Structure, Energy band diagram	Current-Voltage characteristics of CB BJT configuration	Derive drain current
	SLO-2	Relation between Current and Voltage	Problem solving	Forward & Reverse Characteristics of Schottky Diode	Current-Voltage characteristics of CB BJT configuration	Problem solving
S 4-5	SLO-1 SLO-2	Lab 1: PN Junction Diode Characteristics	Lab 4: Diode clipping and clamping circuits	Lab 7: Series and Shunt Regulators	Lab 10: BJT and MOSFET Switching Circuits	Lab 13: Repeat Experiments

S-6	SLO-1	*Calculate depletion width*	*Filters: Inductor & Capacitor Filters*	*Tunnel Diode*	*Current-Voltage characteristics of CC BJT configuration*	*Derive transconductance*
	SLO-2	*Calculate barrier potential*	*Problem solving*	*Tunnel Diode*	*Current-Voltage characteristics of CC BJT configuration*	*Problem solving*
S-7	SLO-1	*Derive diode current equation*	*Filters: LC & CLC Filters*	*Gunn Diode*	*BJT as an amplifier*	*CMOS FET*
	SLO-2	*Derive diode current equation*	*Problem solving*	*Gunn Diode*	*BJT as a switch*	*MOSFET as an amplifier*
S-8	SLO-1	*Effect of Capacitance in PN junction: Transition Capacitance*	*Diode Clippers*	*IMPATT Diode*	*BJT circuit models - h-parameter*	*MOSFET as a switch*
	SLO-2	*Diffusion Capacitance*	*Problem solving*	*IMPATT Diode*	*BJT circuit models - hybrid-π parameter*	*Problem solving*
S 9-10	SLO-1	*Lab 2: Zener diode characteristics*	*Lab 5: BJT Characteristics*	*Lab 8: MOSFET Characteristics*	*Lab 11: Photoconductive Cell, LED, and Solar Cell Characteristics*	*Lab-14: Model Examination*
	SLO-2					
S-11	SLO-1	*Energy band structure of PN Junction Diode*	*Diode Clampers*	*PIN Diode*	*BJT biasing circuits and stability analysis: Base bias and emitter bias*	*Biasing Circuits for MOSFET: Gate Bias*
	SLO-2	*Ideal diode and its current-voltage characteristics*	*Problem solving*	*PIN Photodiode*	*Problem solving*	*Problem Solving*
S-12	SLO-1	*Terminal characteristics & parameters*	*Voltage Multipliers*	*Avalanche photodiode*	*Voltage-divider bias*	*Self-bias*
	SLO-2	*Diode modeling*	*Zener diode: Characteristics, breakdown mechanisms*	*Laser diode*	*Problem solving*	*Problem Solving*
S-13	SLO-1	*DC load line and analysis*	*Zener resistances and temperature effects Zener diode as voltage regulator*	*Problem solving*	*Collector-feedback bias*	*Voltage-divider bias*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem Solving*
S 14-15	SLO-1	*Lab 3: Diode rectifier circuits*	*Lab 6: BJT Biasing Circuits*	*Lab 9: MOSFET Biasing Circuits*	*Lab 12: Simulation experiments using PSPICE*	*Lab 15: End-Semester Practical Examination*
	SLO-2					

Learning Resources	1. *David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015* 2. *Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011* 3. *Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014* 4. *Thomas L. Floyd, Electronic Devices", 9th ed., Pearson Education, 2013*	5. *Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013* 6. *Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010* 7. *Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004* 8. *Laboratory Manual, Department of ECE, SRM University*

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Mr. Manikandan AVM, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. Diwakar R Marur, SRMIST*

Course Code	18ECC103J	Course Name	DIGITAL ELECTRONIC PRINCIPLES	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18EES101J*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECC203J*
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
CLR-1 :	*Understand binary codes, digital arithmetic operations and able to simplify Boolean logic expressions*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	*Describe how basic TTL and CMOS gates operate at the component level*			
CLR-3 :	*Able to design simple combinational logics using basic gates and MSI circuits*			
CLR-4 :	*Familiarize with basic sequential logic components: flip-flops, registers, counters and their usage, and able to design and analyze sequential logic circuits and Finite State Machines.*			
CLR-5 :	*Know how to implement logic circuits using PLDs.*			
CLR-6 :	*Use modern engineering tools such as PSPICE / Logisim to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Simplify Boolean expressions; carry out arithmetic operations with binary numbers; apply parity method for error detection and correction.*	*1*	*90*	*75*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Explain the operational characteristics / properties of digital ICs; implement gates as well as other types of IC devices using two major IC technologies, TTL and CMOS.*	*1*	*80*	*70*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Identify eight basic types of fixed-function combinational logic functions and demonstrate how the devices / circuits can be used in building complete digital systems such as computers.*	*2,3*	*90*	*75*	-	*M*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Analyze and design Mealy and Moore models of sequential circuits using several types of flip-flops.*	*2,3*	*90*	*75*	-	*M*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Implement multiple output combinational logic circuits using PLDs; Explain the operation of a CPLD and FPGA.*	*2*	*80*	*75*	-	*M*	*H*	-	*L*	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE / Logisim*	*2*	*90*	*75*	-	*M*	*H*	-	*H*	-	-	-	*H*	-	-	-	*M*	-	*L*

Duration (hour)		Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Logic Families	Combinational Systems	Sequential Systems	Memory and Programmable Logic
		15	15	15	15	15
S-1	SLO-1	*Binary Codes, Digital Arithmetic and Simplification of Boolean Functions*	*Introduction*	*Binary arithmetic units*	*Flip-flop and Latch: SR latch,*	*RAM Memory decoding*
	SLO-2	*Error detecting codes*	*TTL Logic Family*	*Adder*	*JK flip-flop, T flip-flop, D flip-flop*	*ROM*
S-2	SLO-1	*Error correcting code*	*Totem-pole TTL*	*Design of Half adder*	*Master-slave RS flip-flop*	*Programmable Logic Devices (PLDs): Basic concepts*
	SLO-2	*Hamming Code*	*open-collector and tristate TTL*	*Design of Full adder*	*Master-slave JK flip-flop*	*PROM*
S-3	SLO-1	*Arithmetic number representation*	*Schottkey TTL, standard TTL characteristics*	*Subtractor*	*Registers & Counters*	*PROM as PLD*
	SLO-2	*Binary arithmetic*	*Metal Oxide Semiconductor logic families*	*Design subtractor using logic gates*	*Shift registers (SISO, SIPO, PISO, PIPO)*	*Programmable Array Logic (PAL)*
S 4-5	SLO-1	*LAB 1: Study of logic gates*	*LAB 4: Design and implement encoder and decoder using logic gates*	*LAB 7: Implement combinational logic functions using standard ICs*	*LAB 10: Design and implement Synchronous Counters*	*LAB 13: Construct combinational circuit using Logisim*
	SLO-2					

S-6	SLO-1	*Hexadecimal arithmetic*	*N-MOS*	*n-bit parallel adder & subtractor*	*Universal shift register*	*Programmable Array Logic (PAL)*
	SLO-2	*Hexadecimal arithmetic*	*P-MOS*	*look ahead carry generator*	*Counters: Asynchronous/Ripple counters*	*Programmable Logic Array (PLA)*
S-7	SLO-1	*BCD arithmetic simplification*	*CMOS logic circuits*	*Decoder*	*Synchronous counters, Modulus-n Counter*	*Programmable Logic Array (PLA)*
	SLO-2	*Minimization of Boolean Functions: Algebraic simplification*	*Characteristics of MOS logic*	*Encoder*	*Ring counter, Johnson counter*	*Design combinational circuits using PLD's*
S-8	SLO-1	*Problems on Algebraic simplification*	*Compare MOS logic circuits(CMOS) with TTL digital circuit*	*Multiplexer*	*Up-Down counter*	*Design combinational circuits using PLD's*
	SLO-2	*Karnaugh map simplification*	*Electrical characteristics*	*Demultiplexer*	*Mealy and Moore model*	*Design combinational circuits using PLD's*
S 9-10	SLO-1 SLO-2	*LAB 2: Design and implement Adder and Subtractor using logic gates*	*LAB 5: Design and implement Multiplexer and Demultiplexer using logic gates*	*LAB 8: Verify characteristic table of flip-flops*	*LAB 11: Construct and verify shift registers*	*LAB 14: Model Practical Examination*
S-11	SLO-1	*Problems on Karnaugh map simplification*	*Fan-out*	*Code converters*	*Synchronous (Clocked) sequential circuits*	*Design of combinational circuits using PLD's*
	SLO-2	*Problems on Karnaugh map simplification*	*Propagation Delay*	*Magnitude comparators*	*Synchronous (Clocked) sequential circuits*	*Design sequential circuits using PLD's*
S-12	SLO-1	*Quine McCluskey*	*Power dissipation*	*Magnitude comparators*	*Synchronous (Clocked) sequential circuits*	*Design sequential circuits using PLD's*
	SLO-2	*Tabulation method*	*Noise margin*	*Parity generators (Odd parity)*	*Analyze and design synchronous sequential circuits*	*Design sequential circuits using PLD's*
S-13	SLO-1	*Problems on Quine McCluskey or Tabulation method.*	*Supply voltage levels*	*Parity generators (Even parity)*	*State reduction*	*Design sequential circuits using PLD's*
	SLO-2	*Exercise problems using Tabulation method*	*Operational voltage levels*	*Implementation of combinational logic by standard IC's.*	*State assignment*	*Design sequential circuits using PLD's*
S 14-15	SLO-1 SLO-2	*Lab 3: Design and Implement 2-bit Magnitude Comparator using logic gates*	*LAB-6: Design and implement code converters using logic gates*	*LAB 9: Construct and verify 4-bit ripple counter, Mod-10/Mod-12 ripple counters*	*Lab 12: Construct mini project work*	*LAB 15: University Practical Exam*

Learning Resources	1. *Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson Education, 2014* 2. *Charles H Roth (Jr), Larry L. Kinney, Fundamentals of Logic Design, 5th ed., Cengage Learning India Edition, 2010* 3. *Thomas L. Floyd, Digital Fundamentals, 10th ed., Pearson Education, 2013*	4. *Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009* 5. *Donald P Leach, Albert Paul Malvino, Goutam Saha, Digital Principles and Applications, 6th ed., Tata-Mcgraw Hill, 2008* 6. *LAB MANUAL, Department of ECE, SRM University*

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
r. Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Mr. Viswanathan B, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC104T	Course Name	SIGNALS AND SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC204J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Know about requirements of signal and system analysis in communication.			
CLR-2 :	Understand the analysis of Periodic and Aperiodic Continuous time Signals using Fourier series and transforms			
CLR-3 :	Educate about Continuous time system through Laplace transform and Convolution integral			
CLR-4 :	Understand the characterization of the Discrete time signals and system through DTFT, Convolution sum			
CLR-5 :	Understand the concept of Z-Transform for the analysis of DT system			
CLR-6 :	Develop expertise in time-domain and frequency domain approaches to the analysis of continuous and discrete systems and also the ability to apply modern computation software tool for the analysis of electrical engineering problems			

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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Understand the various classifications of Signals and Systems	1	65	60	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze Periodic and Aperiodic Continuous time Signals using Fourier series and Fourier Transform	2	65	60	-	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Analyze and characterize the Continuous time system through Laplace transform and Convolution integral.	2	65	60	-	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze and characterize the Discrete time signals and system through DTFT, Convolution sum	2	65	60	-	H	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Analyze and characterize the Discrete time system using Z transform	2	65	60	-	H	M	-	-	-	-	-	-	-	-	-	-	-	L
CLO-6 :	Apply the mathematical techniques used for continuous-time signal and discrete-time signal and system analysis	2	65	60	-	H	-	M	M	-	-	-	-	-	-	-	L	-	-

		Classification of Signals and Systems	Analysis of Continuous Time Signals	Analysis of LTI CT System	Analysis of DT Signals and Systems	Analysis of LTI DT System using Z-Transform
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to signals and systems	Introduction to Fourier series	System modeling	Representation of sequences	Z transform – introduction
	SLO-2	Requirements of signal and system analysis in communication	Representation of Continuous time Periodic signals	Description of differential equations	Discrete Time Fourier Transform (DTFT) – Existence	Region of convergence of finite duration sequences-properties.
S-2	SLO-1	Continuous time signals (CT signals)	Fourier series: Trigonometric representation	Solution of Differential equation using classical method	DTFT of standard signals	Unilateral and bilateral z transforms
	SLO-2	Discrete time signals (DT signals)	Fourier series: Trigonometric representation	Differential equation: Zero state response	Properties of DTFT	Properties of z transform
S-3	SLO-1	Representation of signals: Step, Ramp, Pulse, Impulse	Fourier series: Cosine representation	Differential equation: Zero Input response	Problems on Properties of DTFT	Practice problems
	SLO-2	Representation of signals: Sinusoidal, Exponential	Fourier series: Cosine representation	Total Response using classical method	Inverse DTFT	Practice problems
S-4	SLO-1	Basic operation on the signals	Symmetry conditions	Impulse response	Impulse response of a system with DTFT	Relation between DTFT and Z transform
	SLO-2	Problems on signal operations	Properties of Continuous time Fourier series	Step response	Frequency response of a system with DTFT	Practice problems

S-5	SLO-1	*Classification of CT and DT signals: Periodic & Aperiodic signals.*	*Practice problems on Fourier series*	*Frequency response*	*Step response*	*condition for causality in Z domain-Problems*
	SLO-2	*Classification of CT and DT signals: Deterministic & Random signals.*	*Practice problems on Fourier series*	*Practice problems on solution of differential equation*	*Practice problems*	*condition for stability in Z domain-Problems*
S-6	SLO-1	*Energy signal*	*Gibb's Phenomenon*	*Convolution integral*	*Solution of linear constant coefficient difference equations*	*Inverse Z transform*
	SLO-2	*Power signal*	*Parseval's relation for power signals*	*Properties of convolution*	*Problems with and without Initial conditions*	*Power series expansion*
S-7	SLO-1	*Even & Odd signals*	*Power density spectrum,*	*Graphical method of convolution*	*Solution of difference equations using classical method*	*Inverse Z transform with Partial fraction*
	SLO-2	*Even & Odd signals*	*Frequency spectrum.*	*Practice Problems*	*Zero input response , Zero state response, Total response*	*Inverse Z transform with Partial fraction*
S-8	SLO-1	*CT systems and DT systems*	*Fourier transform: Introduction*	*Analysis using Laplace transform*	*Practice problems*	*Residue method*
	SLO-2	*Classification of systems: Static & Dynamic*	*Representation of Continuous time signals*	*ROC and Convergence of Laplace Transform*	*Practice problems*	*Convolution method*
S-9	SLO-1	*Superposition theorem*	*Properties of Continuous time Fourier transform*	*Properties of Laplace transform*	*DFT and IDFT*	*Analysis and characterization of DT system using Z-transform*
	SLO-2	*Linear & Nonlinear system*	*Properties of Continuous time Fourier transform*	*Problems on properties of Laplace transform*	*Properties of DFT*	*Analysis and characterization of DT system using Z-transform*
S-10	SLO-1	*Time-variant & Time-invariant system*	*Parseval's relation for energy signals*	*Inverse Laplace transform*	*Practice problems*	*Practice problems*
	SLO-2	*Time-invariant system*	*Energy density spectrum*	*Problems*	*Convolution sum*	*Practice problems*
S-11	SLO-1	*Causal system*	*Practice problems on Fourier Transform*	*Analysis of LTI system using Laplace transform*	*Convolution properties*	*Realization of Discrete time system- Direct form I, Direct Form II*
	SLO-2	*Noncausal system*	*Practice problems on Fourier Transform*	*Analysis LTI system using Laplace transform-Problems*	*Linear Convolution,-Tabulation method, Matrix method*	*Realization of Discrete time system-Parallel and cascade form*
S-12	SLO-1	*Stable & Unstable,LTI System*	*Practice problems on properties of Fourier Transform*	*Analysis LTI system using Fourier transform*	*Linear convolution-Graphical method*	*Practice problems*
	SLO-2	*Unstable, LTI System*	*Practice problems on properties of Fourier Transform*	*Analysis LTI system using Fourier transform-Problems*	*Circular convolution-concentric circle method, matrix method*	*Practice problems*

Learning Resources	1. *Alan V Oppenheim, Ronald W. Schafer Signals & Systems, 2nd ed., Pearson Education, 2015* 2. *P.Ramakrishna Rao, Shankar Prakriya, Signals & Systems, 2nd ed., McGraw Hill Education, 2015* 3. *Simon Haykin, Barry Van Veen, Signals and Systems, 2nd ed., John Wiley & Sons Inc., 2007*	4. *Lathi B.P, Linear Systems & Signals, 2nd ed., Oxford Press, 2009* 5. *John G. Proakis, Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, 4th ed., Pearson Education, 2007*

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. *Mr. Anuj Kumar, Bombardier* Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor* of ECE, CEG, Anna University, *meena68@annauniv.edu*	*1. Dr. S. Dhanalakshmi , SRM IST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC105T	Course Name	ELECTROMAGNETICS AND TRANSMISSION LINES	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J, 18PYB101J	Co-requisite Courses	Nil	Progressive Courses	18ECC206T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Clark's Table, IS : 456-2000	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Gain knowledge on the basic concepts and insights of Electric field			
CLR-2 :	Gain knowledge on the basic concepts and insights of Magnetic field and Emphasize the significance of Maxwell's equations.			
CLR-3 :	Interpret the wave propagation in guided waveguide.			
CLR-4 :	Acquire the fundamental knowledge on Transmission Line Theory.			
CLR-5 :	Acquire the knowledge on transmission line parameter calculation and impedance matching concepts.			
CLR-6 :	Acquire knowledge on theoretical concepts and analysis techniques to find solutions for problems related to electromagnetic wave propagation and Transmission line Theory.			

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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Apply the concepts and knowledge to solve problems related to electric field.	2	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-2 :	Analyze the concepts of Magnetic field and Maxwell's equations in the real world application.	2	60	60	H	M	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-3 :	Translate the phenomenon of guided wave propagation and its mode of propagation.	1	60	60	H	M	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-4 :	Describe the importance of transmission line theory applicable to low frequency transmission lines.	1	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	Solve transmission line parameter and impedance matching through analytical and graphical methods.	2	60	60	M	H	-	-	-	-	-	-	-	-	-	-	-	-	M
CLO-6 :	Demonstrate how electromagnetic waves are generated using Maxwell's equations and how Transmission lines are used to transfer electromagnetic energy from one point to another with minimum losses over a wideband of frequencies.	2	60	60	M	H	-	-	-	-	-	-	-	-	-	L	-	-	H

Duration (hour)		Electrostatics	Magnetostatics and Maxwells Equations	Electromagnetic Waves and Waveguides	Transmission Line Theory	Transmission Line Calculator and Impedance Matching
		9	9	9	9	9
S-1	SLO-1	Introduction	Energy density in electrostatic field	Introduction	Transmission line parameters	Introduction
	SLO-2	Rectangular co-ordinate	Problem discussion.	Waves in general	Transmission line parameters	Smith chart Introduction
S-2	SLO-1	Cylindrical & Spherical Co-ordinate	Biot savart law-Magnetic field intensity due to Infinite line charge	Plane wave in lossless dielectric	Transmission line equivalent circuit	Reflection coefficient, Standing wave ratio Input impedance calculation in smith chart
	SLO-2	Review of vector calculus	H- due finite and semi finite line charge	Plane wave in free space	Explanation	Practice problems.
S-3	SLO-1	Coulomb's Law and field intensity	Ampere's circuital law& application: Infinite line current	Plane wave in good conductor	Transmission line equation derivation	Single stub matching Introduction
	SLO-2	Problem based on coulomb's law	Infinite Sheet current	Problems based on plane waves in lossless, free space and good conductor	Problem discussion.	Procedure for single stub matching
S-4	SLO-1	Electric field due to continuous charge distribution-.Concept	Infinitely long coaxial Transmission line	Rectangular waveguide	Transmission line characteristics: lossless line	Problems solving in smith chart
	SLO-2	Derivation of E due Infinite Line charge	Problem based on ACL.	Rectangular waveguide-Problems	Distortionless line.	Problems solving in smith chart
S-5	SLO-1	Electric field due to sheet charge	Magnetic flux density	Transverse Electric (TE) mode	Input impedance derivation	Impedance matching using Quarter wave transformer

	SLO-2	*Problem based on sheet charge*	*Problem based on magnetic field and flux.*	*Transverse Electric (TE) mode-problems*	*Problems for input impedance calculation.*	*Problems.*
S-6	SLO-1	*Electric field due to volume charge*	*Maxwell's equation for static field*	*Transverse Electric (TE) mode*	*Standing wave ratio*	*Single stub tuner*
	SLO-2	*Electric flux density*	*Faraday's law*	*Transverse Electric (TE) mode-Problems*	*Calculation of standing wave ratio.*	*Problem discussion*
S-7	SLO-1	*Gauss law application-point charge*	*Transformer EMF*	*Wave propagation in guide*	*Reflection coefficient*	*Slotted Line (Impedance Measurement)*
	SLO-2	*Electric flux due infinite line charge*	*Motional EMF*	*Problem discussion*	*Problem discussion.*	*Problem discussion*
S-8	SLO-1	*Electric flux due sheet charge*	*Displacement current.*	*Power Transmission*	*Shorted line, open circuited line*	*Transmission Lines as circuit Elements*
	SLO-2	*Electric flux due coaxial cable*	*Maxwell's equation in time varying field*	*Calculation of Pavg and Ptotal*	*Matched line*	*Problem discussion*
S-9	SLO-1	*Relation between E&V*	*Time varying potential concepts*	*Power attenuation*	*Power calculations*	*Additional smith chart problem solving.*
	SLO-2	*Electric dipole and flux lines*	*Time varying potential derivation.*	*Calculation of αTE and αTE*	*Problem discussion.*	*Additional smith chart problem solving.*

Learning Resources	1. *Matthew N. O. Sadiku., S. V. Kulkarni, Elements of Electromagnetics, 6th ed., Oxford University Press, 2015* 2. *G. S. N. Raju, Electromagnetic Field Theory and Transmission Lines, Pearson Education, 2006* 3. *Nannapaneni Narayana Rao, Principles of Engineering Electromagnetics,6th ed., Pearson Education, 2016*	4. *William H. Hayt,Jr., John A.Buck., Engineering Electromagnetics, 8th ed., Tata McGraw-Hill 2012* 5. *John D.Ryder, Networks, Lines and Fields, PHI, 2009*

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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC201J	Course Name	ANALOG ELECTRONIC CIRCUITS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ECC102J*	Co-requisite Courses	*18ECC202J*	Progressive Courses	*18ECE201J*
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
CLR-1 :	*Understand the operation and design of BJT amplifier circuits for a given specification*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	*Understand the operation and design of MOSFET amplifier circuits for a given specification*			
CLR-3 :	*Understand the effects of negative feedback on amplifier circuits, and analyze the different RC and LC oscillator circuits to determine the frequency of oscillation*			
CLR-4 :	*Understand the operation and design of various types of power amplifier circuits.*			
CLR-5 :	*Understand how matched transistor characteristics are used in the IC design and to be able to design BJT and MOSFET current sources.*			
CLR-6 :	*Gain hands-on experience to put theoretical concepts learned in the course to practice.*			

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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Analyze and design bipolar amplifier circuits to meet certain specifications, and to Analyze the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.*	*2,3*	*70*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Analyze and design MOSFET amplifier circuits to meet certain specifications, and to Analyze the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.*	*2,3*	*70*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Understand the characteristics and principles of feedback amplifier circuits and oscillator circuits to analyze and design circuits to meet certain specifications.*	*2,3*	*70*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Analyze three principle classes of power amplifiers, and determine the maximum possible conversion efficiency of each type of power amplifier*	*2,3*	*70*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Design the basic circuit building blocks that are used in the design of IC amplifiers, namely current mirrors and sources*	*2,3*	*70*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Analyze and design analog electronic circuits using discrete components, and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis.*	*3*	*90*	*80*	-	-	*H*	-	*M*	-	-	-	*M*	-	-	*M*	*H*	*L*	-

Duration (hour)		BJT Amplifiers	FET Amplifiers	Feedback amplifies & Oscillators	Oscillators & Power Amplifiers	IC Biasing & Amplifiers with Active Load
		15	15	15	15	15
S-1	SLO-1	*Overview of DC analysis of BJT circuits*	*Overview of FET DC circuit analysis*	*Basic feedback concepts, general feedback structure*	*Crystal Oscillators*	*BJT current sources: Cascode current source, Widlar current source*
	SLO-2	*Overview of BJT models*	*Problem solving*	*Properties of negative feedback*	*Problem solving*	*Multi-transistor current source Problem solving*
S-2	SLO-1	*AC load line analysis*	*Graphical analysis, load lines, and small-signal models*	*Feedback Topologies: Voltage-Series & Current-Series feedback connections*	*Negative-resistance oscillator*	*FET current sources: 2-transistor MOSFET current source*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*
S-3	SLO-1	*AC analysis of Common-Emitter BJT amplifier config. using hybrid-π model*	*AC analysis of Common-Source MOSFET amplifier configuration*	*Feedback Topologies: Voltage-Shunt & Current-Shunt feedback connections*	*Power Amplifiers: Definitions and amplifier types*	*FET current sources: Cascode current mirror and Wilson current mirror*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Q point placement*	*Problem solving*
S 4-5	SLO-1	*Lab 1: Learning to design amplifier and oscillator circuits*	*Lab 4: Design & analyze differential amplifier with resistive load*	*Lab 7: Design and analyze RC oscillators*	*Lab 10: BJT & FET Current Sources*	*Lab 13: Design and analyze differential amplifier with active load*
	SLO-2					
S-6	SLO-1	*AC analysis of Common-Base BJT*	*AC analysis of Common-Gate MOSFET*	*Practical Feedback Amplifier Circuits*	*Maximum dissipation hyperbola*	*Analysis of CE BJT amplifier circuit with*

		amplifier configuration using hybrid-π model	*amplifier configuration*			*active load*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Heat sink*	*Problem solving*
S-7	SLO-1	*AC analysis of Common-Collector BJT amplifier config. using hybrid-π model*	*AC analysis of Common-Drain MOSFET amplifier configuration*	*Oscillators: Principles of Oscillation*	*Class A amplifier*	*Analysis of CS FET amplifier circuit with active load*
	SLO-2	*Problem solving*	*Problem solving*	*Types of Oscillators*	*Problem solving*	*Problem solving*
S-8	SLO-1	*Multi-stage amplifier configurations: CE - CE, CE - CC amplifiers*	*BiFET amplifier configuration*	*Audio Frequency Oscillators: RC Phase-Shift Oscillator*	*Class B and Class AB push-pull amplifiers*	*DC and small-signal analysis of basic BJT differential pairs*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*
S 9-10	SLO-1	*Lab 2: Design and analyze BJT amplifier configurations*	*Lab 5: Design and analyze negative feedback amplifier configurations*	*Lab 8: Design and analyze LC oscillators*	*Lab 11: Design and analyze BJT CE amplifier with active load*	*Lab 14: Model Practical Examination*
	SLO-2					
S-11	SLO-1	*Multi-stage amplifier configurations: CE - CB, and CC - CC amplifiers*	*Low Frequency response analysis of a basic FET CS amplifier*	*Audio Frequency Oscillators: Wein Bridge Oscillator*	*Class C amplifiers*	*DC and small-signal analysis of basic FET differential pairs*
	SLO-2	*Problem solving*	*Problem Solving*	*Problem Solving*	*Problem solving*	*Problem solving*
S-12	SLO-1	*Low Frequency response analysis of a basic BJT CE amplifier*	*High Frequency response analysis of a basic FET CS amplifier*	*Radio Frequency Oscillators: Hartley Oscillator*	*Class D and Class E amplifiers*	*Analysis of BJT differential amplifier with active load*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem solving*	*Amplifier distortions*	*Problem solving*
S-13	SLO-1	*High Frequency response analysis of a basic BJT CE amplifier*	*Design problems in MOSFET amplifier configurations*	*Radio Frequency Oscillators: Colpitts & Clapp Oscillators*	*IC Biasing & Amplifiers with Active Load: BJT current sources: 2- & 3-transistor current sources*	*Analysis of FET differential amplifier with active load*
	SLO-2	*Problem Solving*	*Operational voltage levels*	*Problem solving*	*Problem solving*	*Problem solving*
S 14-15	SLO-1	*Lab 3: Design and analyze multistage amplifier configurations*	*Lab 6: Design and analyze MOSFET amplifier configurations*	*Lab 9: Classes of power amplifier (efficiency calculation)*	*Lab 12: Design and analyze FET CS amplifier with active load*	*Lab 15: End Semester Practical Examination*
	SLO-2					

Learning Resources	1. *David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015* 2. *Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011* 3. *Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010* 4. *Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014*	5. *Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013* 6. *Albert P. Malvino, David J. Bates, Electronic Principles, 8th ed., Tata McGraw Hill, 2015*

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
r. Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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
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Course Code	18ECC202J	Course Name	LINEAR INTEGRATED CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC102J	Co-requisite Courses	18ECC201J	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Study the basic principles, configurations and practical limitations of op-amp			
CLR-2 :	Understand the various linear and non-linear applications of op-amp			
CLR-3 :	Understand the operation and analysis of op-amp oscillators, single chip oscillators and frequency generators			
CLR-4 :	Identify the active filter types, filter response characteristics, filter parameters and IC voltage regulators.			
CLR-5 :	Gain knowledge on data converter terminology, its performance parameters, and various circuit arrangements for A/D and D/A conversions.			
CLR-6 :	Gain hands-on experience to put theoretical concepts learned in the course to practice.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques	3	80	70	H	M	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Elucidate and design the linear and non-linear applications of an opamp and special application ICs	3	85	75	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Explain and compare the working of multivibrators using special application IC 555 and general purpose opamp	3	75	70	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Classify and comprehend the working principle of data converters and active filters	3	85	80	-	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication	3	85	75	-	M	H	-	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Analyze and design electronic circuits and systems using linear ICs, and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis	3	85	75	-	M	H	-	M	-	-	-	M	-	-	-	H	L	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Op-amp symbol, terminals, packages	Basic op-amp circuits: Inverting & Non-inverting voltage amplifiers	Waveform Generators: Sine-wave Generators - Design	Filters: Comparison between Passive and Active Networks	Digital to Analog Conversion: DAC Specifications
	SLO-2	Op-amp-Specifications	Voltage follower	Implementation & Solving problems	Active Network Design	Solving problems
S-2	SLO-1	Block diagram Representation of op-amp	Summing, scaling & averaging amplifiers,	Square Wave generators- Design	Filter Approximations	Weighted Resistor DAC
	SLO-2	Ideal op-amp & practical op-amp - Open loop & closed loop configurations	AC amplifiers	Implementation & Solving problems	Design of LPF & Solving problems	Solving problems
S-3	SLO-1	DC performance characteristics of op-amp	Linear Applications: Instrumentation Amplifiers	Triangle wave generators	Design of HPF & Solving problems	R-2R Ladder DAC
	SLO-2	Solving Problems	Instrumentation Amplifiers, Solving Problems	Saw-tooth Wave generators.	Design of BPF& Solving problems	Solving problems
S 4-5	SLO-1	Lab-1:Basic op-amp circuits	Lab 4: Comparators	Lab 7: Waveform generators: using op-amp & 555 Timer	Lab 10: Design of LPF, HPF, BPF and Band Reject Filters	Lab 13: Flash Type ADC
	SLO-2					
S-6	SLO-1	AC performance characteristics of op-amp	V-to-I Converters	IC 555 Timer: Circuit schematic	Design of Band Reject Filters	Inverted R-2R Ladder DAC
	SLO-2	Solving Problems	I-to-V converters	Operation and its applications	Solving problems	Monolithic DAC
S-7	SLO-1	Frequency response	Differentiators	IC 555 Timer: Monostable operation	State Variable Filters – All Pass Filters,	Analog to Digital conversion: ADC specifications
	SLO-2	Frequency response	Integrators	Applications & Solving problems	Solving problems	Solving problems

S-8	SLO-1	*Frequency compensation*	*Non-linear Applications: Precision Rectifiers*	*IC 555 Timer: Astable operation*	*Switched Capacitor Filters.*	*Ramp Type ADC*
	SLO-2	*Frequency compensation*	*Wave Shaping Circuits (Clipper and Clampers)*	*Applications & Solving problems*	*Solving problems*	*Solving problems*
S 9-10	SLO-1	*Lab 2: Integrators and Differentiators*	*Lab 5: Wave shaping circuits*	*Lab 8: Waveform generators: using op-amp & 555 Timer*	*Lab 11: IC Voltage regulators*	*Lab 14: Simulation experiments using EDA tools*
	SLO-2					
S-11	SLO-1	*Basic op-amp internal schematic*	*Log and Antilog Amplifiers,*	*PLL: Operation of the Basic PLL*	*Voltage Regulators: Basics of Voltage Regulator*	*Successive Approximation ADC*
	SLO-2	*operations of blocks*	*Analog voltage multiplier circuit and its applications,*	*Closed loop analysis of PLL*	*Specifications and characteristic parameters*	*Solving problems*
S-12	SLO-1	*Basic op-amp internal schematic*	*Operational Trans-Conductance Amplifier (OTA)*	*Voltage Controlled Oscillator*	*Linear Voltage Regulators using Op-amp,*	*Dual Slope ADC*
	SLO-2	*operations of blocks*	*Comparators : operation*	*Solving problems*	*IC Regulators (78xx, 79xx, LM 317, LM 337, 723),*	*Flash Type ADC,*
S-13	SLO-1	*Review of data sheet of an op-amp.*	*Comparators applications*	*PLL applications*	*Switching Regulators -operation*	*Solving problems on Flash Type ADC,*
	SLO-2	*Solving Problems*	*Sample and Hold circuit.*	*Solving problems*	*Types*	*Monolithic ADC*
S 14-15	SLO-1	*Lab 3: Rectifiers*	*Lab 6: Waveform generators: using op-amp & 555 Timer*	*Lab 9: Design of LPF, HPF, BPF and Band Reject Filters*	*Lab 12: R-2R ladder DAC*	*Lab 15: Simulation experiments using EDA tools*
	SLO-2					

Learning Resources	1. *Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4th ed., Prentice Hall, 2000* 2. *David A. Bell, Operational Amplifiers and Linear ICs, 3rd ed., OUP, 2013* 3. *Roy Choudhury, Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014* 4. *Robert F. Coughlin, Frederick F. Driscoll, Operational-Amplifiers and Linear Integrated Circuits, 6th ed., Prentice Hall, 2001* 5. *Sergio Franco, Design with operational amplifier and analog integrated circuits, McGraw Hill, 1997*	6. *LABORATORY MANUAL, Department of ECE, SRM University* 7. *David A Bell, Laboratory Manual for Operational Amplifiers & Linear ICs, 2nd ed., D.A. Bell, 2001* 8. *David La Lond, Experiments in Principles of Electronic Devices and Circuits, Delmar Publishers, 1993* 9. *Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004* 10. *L. K. Maheshwari, M. M. S. Anand, Laboratory Experiments and PSPICE Simulations in Analog Electronics, PHI, 2006*

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Mr. Manikandan AVM, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. M. Sangeetha, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

ELECTRONICS AND COMMUNICATION 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	18EC C203J	Course Name	MICROPROCESSOR, MICROCONTROLLER AND INTERFACING TECHNIQUES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ECC103J*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECE204J, 18ECE205J*
Course Offering Department	*Electronics and Communication Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	*2*	*3*
CLR-1 :	*Understand basic architecture of Intel 8086 microprocessor and Intel 8051 Microcontroller*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	*Familiarize the students with the programming and interfacing of microprocessors and microcontrollers with memory and peripheral chips*			
CLR-3 :	*Interface a microprocessor / microcontroller to external I/O devices and perform I/O device programming in assembly*			
CLR-4 :	*Use the computer to write and assemble ALPs and also run them by downloading them to the target microprocessor*			
CLR-5 :	*Understand the hardware / software interrupts and their applications, and as well the serial port programming*			
CLR-6 :	*Provide strong foundation for designing real world applications using microprocessors and microcontrollers.*			

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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Apply a basic concept of digital fundamentals to Microprocessor based personal computer system*	*1*	*60*	*70*	-	*H*	-	-	*L*	-	-	-	-	-	-		-	-	-
CLO-2 :	*Solve basic binary math operations using the microprocessor. / microcontroller*	*2*	*60*	*70*	*M*	-	-	-		-	-	-	-	-	-	*M*	-	-	-
CLO-3 :	*Demonstrate programming proficiency using the various addressing modes of the target microprocessor / microcontroller*	*3*	*60*	*70*	-	*M*	*H*	-	*H*	-	-	-	-	-	-		-	-	*L*
CLO-4 :	*Distinguish and analyze the properties of Microprocessors & Microcontrollers.*	*1*	*60*	*70*	-	*M*	-	-		-	-	-	-	-	-	*H*	-	-	-
CLO-5 :	*Illustrate their practical knowledge through laboratory experiments.*	*3*	*60*	*70*	-	*M*	*M*	-	*H*	-	-	-	-	*H*	-		-	-	*H*
CLO-6 :	*Design, interface and program memory chips and various peripheral chips with microprocessor / microcontroller*	*3*	*60*	*70*	-	-	*M*	-	*H*	-	-	-	-		-	*H*	*L*	-	*M*

Duration (hour)		Intel 8086 – Architecture, Signals and Features	Programming with Intel 8086	8086 Interfacing with Memory and Programmable Devices	Intel 8051 – Architecture and Programming	Interfacing of 8051
		15	15	15	15	15
S-1	SLO-1	*Introduction: History of computers, Block diagram of a microcomputer*	*Addressing modes of 8086*	*Semiconductor memory interfacing*	*Introduction: Differences between microprocessor and microcontroller*	*8051 parallel ports, and*
	SLO-2	*Intel 80x86 evolutions*		*Dynamic RAM interfacing*	*Intel's family of 8-bit microcontrollers, and feature of 8051 microcontroller*	*its programming*
S-2	SLO-1	*Features of 8086 microprocessor*	*Instruction Set of 8086: Data Transfer Instructions*	*Programmable Peripheral Interface 8255*	*Architecture of 8051*	*8051 timers, and*
	SLO-2	*Register organization of 8086*	*Example programs*	*Interfacing 8255 with 8086 and programming*		*its programming*
S-3	SLO-1	*Architecture of 8086*	*Data Conversion Instructions, Arithmetic Instructions*	*Interfacing ADC with 8086 and programming*	*Signal descriptions of 8051*	*8051 interrupts, and*
	SLO-2		*Example programs*	*Interfacing DAC with 8086 and programming*		*its programming*
S-4,5	SLO-1	*Lab-1: (a) Learning to Program with 8086 processor kit; Learning the hardware features of the 8086 processor kit*	*Lab-4: General Purpose Programming in 8086*	*Lab-7: Interfacing DAC / ADC with 8086 / 8051*	*Lab-10: Programming timer / counter in 8086 / 8051*	*Lab-13: Simulation of 8051 using Keil Software*
	SLO-2					

S-6	SLO-1	*Instruction queue and pipelining*	*Logical instructions and Processor control instructions*	*Stepper Motor interfacing*	*Register set of 8051*	*8051 serial port, and*
	SLO-2	*Segmentation of memory used with 8086*	*Example programs*		*Operational features of 8051*	*its programming*
S-7	SLO-1	*Methods of generating physical address in 8086*	*String instructions*	*Programmable Interval Timer 8254*	*Memory and I/O addressing by 8051*	*Interfacing program memory with 8086*
	SLO-2	*Pin signals of 8086: Common signals*	*Example programs*	*Interfacing 8254 with 8086 and programming*	*Interrupts and Stack of 8051*	*Interfacing data memory with 8086*
S-8	SLO-1	*Minimum mode signals*	*Branch Instructions*	*Programmable Interrupt Controller 8259*	*Addressing modes of 8051*	*Interfacing input devices: push-button / matrix keypad*
	SLO-2	*Maximum mode signals*	*Example programs*	*Interfacing 8259 with 8086 and programming*		*Example programs*
S-9,10	SLO-1	*Lab-2: General Purpose Programing in 8086*	*Lab-5: Simulation of 8086 using MASM Software / 8086 Emulator*	*Lab-8: Interfacing DC motor / stepper motor / servo motor with 8086 / 8051*	*Lab-11: Programming interrupts in 8086 / 8051*	*Lab-14: Model Practical Exam*
	SLO-2					
S-11	SLO-1	*Minimum mode 8086 system, and*	*Assembly Language Programming of 8086*	*Programmable Keyboard / Display Controller 8279*	*8051 Instruction Set: Arithmetic and Logical Instructions*	*Interfacing display devices: LED / 7-segment / LCD displays*
	SLO-2	*Timings*	*Assembly Language Programming of 8086*	*Interfacing 8279 with 8086 and programming*	*Example Programs*	*Example programs*
S-12	SLO-1	*Maximum mode 8086 system, and*	*Stack structure, and*	*Programmable Communication Interface 8251 USART*	*Data Transfer Instructions*	*Interfacing DAC*
	SLO-2	*Timings*	*related programming*	*Interfacing 8251 with 8086 and programming*	*Example Programs*	*Interfacing ADC*
S-13	SLO-1	*Intel 8088 Microprocessor: Pins signals and Architecture*	*Interrupt structure, and*	*DMA Controller 8257*	*Boolean Variable Instructions and Branch Instructions*	*Interfacing DC motor / stepper motor / servo motor*
	SLO-2	*Differences between 8086 & 8088 microprocessors*	*related programming*	*Interfacing 8257 with 8086 and programming*	*Example Programs*	*Example programs*
S-14,15	SLO-1	*Lab-3: General Purpose Programing in 8086*	*Lab-6: Interfacing 8255 with 8086 / 8051*	*Lab-9: General Purpose Programming in 8051*	*Lab-10: Programming serial communication in 8086 / 8051*	*Lab-15: End-Semester Exam*
	SLO-2					

Learning Resources	1. *K. M. Bhurchandi and A. K. Ray, "Advanced Microprocessors and Peripherals-with ARM and an Introduction to Microcontrollers and Interfacing ", Tata McGraw Hill, 3rd edition 2015* 2. *Muhammad Ali Mazidi and Janice GillispieMazidi, "The 8051 - Microcontroller and Embedded systems", 7th Edition, Pearson Education, 2011.* 3. *Doughlas.V.Hall, "Microprocessor and Interfacing : Programming and Hardware", 3rd edition, McGraw Hill, 2015*	4. *Kenneth.J.Ayala, "8051 Microcontroller Architecture, Programming and Applications", 3rd edition, Thomson, 2007* 5. *Subrataghoshal " 8051 Microcontroller Internals Instructions ,Programming And Interfacing",2nd edition Pearson 2010* 6. *Yu-cheng Liu, Glenn A.Gibson, "Microcomputer systems: The 8086/8088 family-Architecture,programming and design",2nd edition, Prentice Hall of India,2007*

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Mr. Manikandan AVM, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC204J	Course Name	DIGITAL SIGNAL PROCESSING	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ECC104T*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECE243J, 18ECE244J, 18ECE245T*
Course Offering Department	*Electronics and Communication 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
		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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLR-1 :	*Understand the operations involved in digital conversion of analog signals.*																		
CLR-2 :	*Realize a digital filter in direct, cascade and parallel forms. Perform efficient computation of DFT using radix 2 FFT*																		
CLR-3 :	*Design digital FIR filter using windowing technique and frequency sampling methods.*																		
CLR-4 :	*Design IIR filters using both direct method and method involving conversion of analog filter to digital filter*																		
CLR-5 :	*Understand sampling rate conversion and apply it for applications like QMF, sub band coding.*																		
CLR-6 :	*Utilize the techniques for digital conversions, filter designs and multi rate signal processing to solve real time problems*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	*Determine the knowledge of sampling and quantization and understand the errors that arise due to quantization.*	*1*	*80*	*70*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Understand the concept of DFT and its efficient computation by using FFT algorithm.*	*1*	*75*	*70*	-	*M*	-	-	-	-	-	-	-	-	-	-	-	-	
CLO-3 :	*Design FIR filters using several methods*	*3*	*75*	*70*	-	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	*H*
CLO-4 :	*Design IIR filters using several methods*	*3*	*75*	*70*	-		*H*	-	-	-	-	-	-	-	-	-	-	-	*H*
CLO-5 :	*Discuss the basics of multirate DSP and its applications.*	*1*	*70*	*70*	-	*M*	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Apply the concepts of digital filter designs and multi rate signal processing for real time signals*	*2*	*70*	*70*	-	*M*	-	-	-	-	-	-	-	-	-	-	*M*	-	-

Duration (hour)		Signals and Waveforms	Frequency Transformations	FIR Filters	IIR Filters	Multirate signal Processing
		15	15	15	15	15
S-1	SLO-1	*Basic Elements of DSP*	*Realization of digital filters Direct form of realization*	*Design of Linear Phase FIR filters General consideration*	*Design of digital IIR filters Comparison of FIR and IIR filters*	*Introduction to Multirate signal processing*
	SLO-2	*Advantages and applications of DSP*	*Cascade form of realization*	*Causality, its implication Characteristics of practical frequency selective filters*	*Analog IIR filter design*	*Decimation*
S-2	SLO-1	*Continuous Time vs Discrete time signals*	*Parallel form of realization*	*Frequency response of symmetric FIR filter*	*Properties of Butterworth filters*	*Interpolation*
	SLO-2	*Continuous valued vs discrete valued signals*	*Introduction to DFT*	*N is odd*	*Properties of chebyshev filters Comparison of Butterworth and chebyshev filters*	*Spectrum of interpolated signal*
S-3	SLO-1	*Concepts of frequency in analog signals*	*Computation of DFT*	*Frequency response of symmetric FIR filter*	*Analog IIR filter design*	*Sampling rate conversion by a rational factor I/D*
	SLO-2	*Continuous and discrete time sinusoidal signals*	*Properties of DFT Periodicity, linearity and symmetry properties*	*N is even*	*Design of low pass Butterworth filter*	*Anti-aliasing and anti-imaging filters*
S-4	SLO-1	*Lab 1 :Generation of basic signals*	*Lab 7: Linear convolution*	*Lab 13: Design of digital FIR Low Pass, High Pass filter using rectangular window*	*Lab 19: Design of analog Butterworth filter*	*Lab 25: Interpolation*
	SLO-2					
S-5	SLO-1	*Lab 2: Unit step, ramp and impulse*	*Lab 8: Circular convolution*	*Lab14: Design of digital FIR Band Pass, Band Stop filter using rectangular window*	*Lab 20: Design of analog Chebyshev filter*	*Lab 26: Effect of interpolation in frequency domain*
	SLO-2					

Duration (hour)		Signals and Waveforms	Frequency Transformations	FIR Filters	IIR Filters	Multirate signal Processing
		15	15	15	15	15
S-6	SLO-1	*Sampling of analog signals Sampling theorem*	*Circular convolution*	*Frequency response of anti-symmetric FIR filter*	*Analog IIR filter design*	*Polyphase structure of decimator Polyphase decimation using z transform*
	SLO-2	*Aliasing Quantization of continuous amplitude signals*	*Matrix method and concentric circle method*	*N is odd and N is even*	*Design of low pass Chebyshev filter*	*Polyphase structure of interpolator Polyphase interpolation using z transform*
S-7	SLO-1	*Analog to digital conversion Sample and hold,*	*Efficient Computation of the DFT*	*Design of FIR filters Fourier series method*	*Design of digital filters Impulse invariance method*	*Advantages of multirate DSP*
	SLO-2	*Quantization and coding*	*Divide and Conquer Approach to Computation of the DFT Using FFT*	*Need for filter design using window Comparison of various windowing techniques*	*Design of digital filters Bilinear transformation*	*Applications of multirate DSP*
S-8	SLO-1	*Oversampling A/D converters*	*N Point DFT Decimation-in-Time FFT Radix-2 FFT Algorithm*	*Filter Design using windowing technique*	*Design of digital filters Impulse invariance method*	*Practical Applications of multirate DSP*
	SLO-2	*Digital to analog conversion Sample and hold*	*N Point DFT Decimation-in-Frequency FFT*	*Rectangular window*	*Design of digital filters Bilinear transformation*	*interfacing of digital systems with different sampling rates*
S-9	SLO-1	*Lab 3: Generation of waveforms*	*Lab9: Autocorrelation and cross correlation*	*Lab 15: Design of digital FIR Low Pass and High Pass filter using Hanning and Hamming window*	*Lab 21: Design of digital Butterworth filter using impulse invariance method*	*Lab 27: Decimation*
	SLO-2					
S-10	SLO-1	*Lab 4: Continuous and discrete time*	*Lab10: Spectrum analysis using DFT*	*Lab 16: Design of digital FIR Band Pass and Band Stop filter using Hanning and Hamming window*	*Lab 22: Design of digital Butterworth filter using bilinear transformation*	*Lab 28: Effect of decimation in frequency domain*
	SLO-2					
S-11	SLO-1	*Oversampling D/A converters*	*Radix-2 FFT Algorithm Implementation of FFT Using DIT*	*Filter Design using windowing technique Hanning window*	*Design of digital Chebyshev filters*	*Practical Applications of multirate DSP Sub band coding of speech signals*
	SLO-2	*Quantization noise*	*Implementation of FFT Using DIF*	*Filter Design using windowing technique Hamming window*	*Impulse invariance method*	*Filter banks Analysis filter bank*
S-12	SLO-1	*Errors due to truncation*	*IDFT*	*Filter Design using windowing technique*	*Design of digital Chebyshev filters*	*Synthesis filter bank*
	SLO-2	*Probability of error*	*Using DIT FFT*	*Black mann window*	*Bilinear transformation*	*Subband coding filterbank*
S-13	SLO-1	*Errors due to rounding*	*IDFT*	*Design of FIR filters*	*Frequency transformation in analog domain*	*Quadrature Mirror Filter*
	SLO-2	*Probability of error*	*Using DIF FFT*	*Frequency sampling method*	*Frequency transformation in digital domain*	*Alias free filter bank*
S-14	SLO-1	*Lab 5: Study of sampling theorem*	*Lab 11: Efficient computation of DFT using FFT*	*Lab 17: Design of digital FIR Low Pass, High Pass, Band pass and band stop filter using Black mann window*	*Lab 23: Design of digital Cheby shev filter using impulse invariance method*	*Lab 29: Design of anti-aliasing filter*
	SLO-2					
S-15	SLO-1	*Lab 6: Aliasing effects*	*Lab12: Computation of IDFT*	*Lab 18: Design of digital FIR filter using frequency sampling method*	*Lab 24: Design of digital Cheby shev filter using bilinear transformation*	*Lab 30: Design of anti-imaging filter*
	SLO-2					

Learning Resources	1. *John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Pearson Education, 4th edition, 2014* 2. *Alan V. Oppenheim, Ronald W. Schafer, "Discrete-Time Signal Processing", Pearson Education, 1st edition, 2015*	3. *Sanjit Mitra, "Digital Signal Processing –A Computer Based Approach", McGraw Hill, India, 4th Edition, 2013.* 4. *Fredric J. Harris, "Multirate Signal Processing for Communication Systems",1st edition, Pearson Education, 2007*

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*Dr. M.S. Vasanthi,,SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC205J	Course Name	ANALOG AND DIGITAL COMMUNICATION	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18MAB203T*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECC301T, 18ECC302J, 18ECE221T & 18ECE223T*
Course Offering Department	ECE	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
CLR-1 :	*Introduce and Understand the need for modulation, various Amplitude modulators/demodulators, frequency modulators and demodulators*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	*Comprehend the radio transmitters and receivers using the modulators and demodulators and to analyze the noise performance*			
CLR-3 :	*Introduce basics of Digital modulation and detection techniques*			
CLR-4 :	*Analyze the pass band data transmission techniques in terms of probability of error*			
CLR-5 :	*Introduce basics of spread spectrum techniques and information theory concepts*			
CLR-6 :	*Gain hands-on experience to put theoretical concepts learned in the course to practice.*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*			
CLO-1 :	Understand the concepts of analog modulation and demodulation techniques	*2*	*80*	*70*
CLO-2 :	Learn the function of radio transmitters and receivers and familiarize with noise performance of various receivers	*2*	*85*	*75*
CLO-3 :	*Understand various digital modulation schemes and matched filter receiver*	*2*	*75*	*70*
CLO-4 :	*Understand and analyze various digital pass band data transmission schemes*	*2*	*85*	*80*
CLO-5 :	*Understanding data transmission using spread spectrum and error coding techniques*	*2*	*85*	*75*
CLO-6 :	*Analyze the operation of analog and digital communication systems and take measurement of various communication systems to compare experimental results in the laboratory with theoretical analysis*	*2*	*85*	*75*

Program Learning Outcomes (PLO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*M*	-	-	-	-	-	-	-	-	*H*	-	-	*H*	-	-
CLO-2 :	-	*M*	*H*	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-3 :	*M*	-	-	-	-	-	-	-	-	-	-	-	-	*M*	*H*
CLO-4 :	-	-	-	*M*	-	-	-	-	-	-	-	-	-	*M*	-
CLO-5 :	-	*H*	-	-	-	-	-	-	-	-	-	-	*M*	-	*H*
CLO-6 :	-	-	*H*	-	*H*	-	-	-	*H*	-	-	*M*	-	*M*	*H*

Duration (hour)		Analog Modulation	Radio Transmitters and Receivers	Digital Modulation System and Baseband Detection	Passband Data Transmission	Spread Spectrum Techniques and Information theory Concepts
		15	15	15	15	15
S-1	SLO-1	*Modulation, Need for Modulation,*	*AM transmitter : Low Level,*	*Pulse modulation systems, Overview of PAM,PWM,PPM*	*Overview of ASK, FSK, PSK*	*Spread spectrum Communications, Frequency Hopping Spread Spectrum (FHSS)*
	SLO-2	*Amplitude Modulation, Types of Amplitude Modulation*	*AM transmitter : High Level Transmitter*	*Pulse modulation systems, Overview of PAM,PWM,PPM*	*Overview of ASK, FSK, PSK*	*Spread spectrum Communications, Frequency Hopping Spread Spectrum (FHSS)*
S-2	SLO-1	*Double sideband Full carrier*	*FM transmitter: Direct Method*	*Pulse modulation systems, Sampling and quantization*	*Generation, Signal Space Diagram and detection of FSK*	*Direct Sequence Spread Spectrum (DSSS)*
	SLO-2	*Double sideband Full carrier*	*FM transmitter: Direct Method*	*Pulse modulation systems, Sampling and quantization*	*Generation, Signal Space Diagram and detection of FSK*	*Direct Sequence Spread Spectrum (DSSS)*
S-3	SLO-1	*Double sideband Suppressed carrier*	*FM transmitter: Indirect Method*	*PCM systems*	*Probability of Error for FSK*	*Direct Sequence Spread Spectrum (DSSS)*
	SLO-2	*Single sideband Suppressed carrier, VSB*	*FM transmitter: Indirect Method*	*Bandwidth of PCM, PCM TDM signal multiplexing, Limitations of PCM system*	*Probability of Error for FSK*	*Code Division Multiple Access of DSSS*
S 4-5	SLO-1	*Lab-1: AM modulator and Demodulator*	*Lab-4: Pre emphasis and De-emphasis*	*Lab-7: DPCM and its Demodulation*	*Lab-10: QPSK Modulation and Demodulation*	*Lab-13: Mini Project*
	SLO-2					

Duration (hour)		Analog Modulation	Radio Transmitters and Receivers	Digital Modulation System and Baseband Detection	Passband Data Transmission	Spread Spectrum Techniques and Information theory Concepts
		15	15	15	15	15
S-6	SLO-1	*Generation of AM waves: Linear method-Collector modulator*	*Classification of radio receiver, Functions and Characteristics of radio receiver*	*Data formatting*	*Generation, Detection, Signal Space Diagram of PSK*	*Code Division Multiple Access of DSSS*
	SLO-2	*Generation of AM waves: Linear method- Collector modulator*	*Tuned Radio Frequency receiver*	*Data formatting*	*Generation, Detection, Signal Space Diagram of PSK*	*OFDM Communication*
S-7	SLO-1	*Non-linear Modulation-Balanced Modulator*	*Super-heterodyne receiver- AM*	*Differential PCM (DPCM)*	*Probability of Error for PSK*	*OFDM Communication*
	SLO-2	*Non-linear Modulation-Balanced Modulator*	*Super-heterodyne receiver- AM*	*Differential PCM (DPCM)*	*Probability of Error for PSK*	*OFDM Communication*
S-8	SLO-1	*Demodulation of AM waves : Linear diode detector*	*Super-heterodyne receiver- FM*	*Delta modulation (DM)*	*Generation, signal space diagram and detection of QPSK*	*Measures of Information*
	SLO-2	*Demodulation of AM waves : Linear diode detector*	*Super-heterodyne receiver- FM*	*Delta modulation (DM), Noise in DM*	*Generation, signal space diagram and detection of QPSK*	*Measures of Information*
S 9-10	SLO-1	*Lab-2: DSB-SC modulator and demodulator*	*Lab-5: PAM,PPM,PWM modulation and demodulation*	*Lab-8: DM and its Demodulation*	*Lab-11: DPSK Modulation and Demodulation*	*Lab-14: Model Practical Exam*
	SLO-2					
S-11	SLO-1	*Frequency modulation, Types of FM*	*Sources of Noise*	*Demodulation and detection process*	*Probability of Error for QPSK*	*Source encoding, Shannon's Channel capacity theorem*
	SLO-2	*Narrow Band FM, Wide Band FM, Phase modulation*	*Sources of Noise*	*Demodulation and detection process*	*Probability of Error for QPSK*	*Shannon's Channel capacity theorem*
S-12	SLO-1	*Generation of Narrowband FM*	*Noise in AM (Envelope Detection),*	*Maximum likelihood receiver structure, Matched filter receiver*	*Generation, signal space diagram and detection of π/4 QPSK*	*Linear block codes*
	SLO-2	*Generation of Narrowband FM*	*Noise in AM (Envelope Detection),*	*Maximum likelihood receiver structure, Matched filter receiver*	*Generation, signal space diagram and detection of π/4 QPSK*	*Linear block codes*
S-13	SLO-1	*Demodulation of FM : Foster seely discriminator*	*Noise in FM*	*Probability error of the Matched filter, Inter symbol interference, Eye pattern*	*Generation, signal space diagram and detection of QAM*	*Cyclic codes*
	SLO-2	*Demodulation of FM : Foster seely discriminator*	*Threshold effect, Pre-emphasis and De-emphasis*	*Probability error of the Matched filter, Inter symbol interference, Eye pattern*	*Generation, signal space diagram and detection of QAM*	*Cyclic codes*
S 14-15	SLO-1	*Lab-3: FM Modulator and Demodulator*	*Lab-6: Pulse Code Modulation and Demodulation*	*Lab-9: PSK Modulation and Demodulation*	*Lab-12: BER performance analysis of various Modulation Schemes*	*Lab-15: University Practical Exam*
	SLO-2					

Learning Resources	
	1. *Simon Haykin and Michael Moher, "Communication Systems," 5th edition, John Wiley & Sons, 2013*
	2. *Singh. R. P & Sapre. S. D, "Communication Systems: Analog & Digital," 3rd edition, McGrawHill Education, Seventh Reprint, 2016.*
	3. *Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 20008.*
	4. *Bernard Sklar, "Digital Communication, Fundamentals and Application", Pearson Education Asia, 2nd Edition, 2001*
	5. *Taub & Schilling, "Principle of Communication Systems", McGraw Hill Inc, 2nd Edition, 2003.*
	6. *John G. Proakis, "Digital Communication", McGraw Hill Inc, 5th Edition, 2008.*
	7. *B.P. Lathi, "Modern Digital and Analog Communication System", Oxford University Press, 3rd Edition, 2005.*
	8. *Shu Lin, Daniel Costello, "Error control coding – Fundamentals and Applications", Prentice Hall, Upper Saddle River, NJ, 2nd Edition, 2004.*
	9. *Lab Manual*

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*Mrs. S. Vasanthadev Suryakala, SRMIST*
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Course Code	18ECC206J	Course Name	VLSI DESIGN	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC103J	Co-requisite Courses	Nil	Progressive Courses	18ECE301J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
CLR-1 :	Use Verilog HDL as a design-entry language for FPGA in electronic design automation of digital circuits			
CLR-2 :	Design, construct and simulate VLSI adders and multipliers.			
CLR-3 :	Understand MOSFET operation			
CLR-4 :	Implement a given logic function using appropriate logic styles for improved performance			
CLR-5 :	Understand the basic processes in IC fabrication, steps in the fabrication of MOS ICs, and as well the layout design rules.			
CLR-6 :	Use modern engineering tools such as HSPICE / Modelsim / Xilinx to carry out design experiments and gain experience with the design and analysis of MOS circuits and systems.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Design and implement digital circuits using Verilog HDL to simulate and verify the designs.	3	85	75	-	H	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Design general VLSI system components, adder cells and multipliers to address the design of datapath subsystem.	3	85	75	-	H	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Examine the characteristics of MOS transistors	2	80	70	H	M	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze CMOS inverter and other complex logic gates designed using different logic styles	2	80	70	-	L	L	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Explain how the transistors are built, and understand the physical implementation of circuits.	2	80	70	-	L	L	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Use HSPICE computer analysis program and Verilog HDL for simulation and analysis of MOS circuits and building blocks	3	85	75	-	M	M	-	H	-	-	-	H	M	L	M	-	-	M

Duration (hour)		Introduction to Verilog HDL & Coding	Subsystem Design	MOS Transistor	CMOS Inverter and Circuit Design Styles	Microelectronic Materials
		15	15	15	15	15
S-1	SLO-1	Introduction to HDL & Verilog HDL	General VLSI System Components: Multiplexers	Generic overview of the MOS device: MOS transistor symbols	CMOS Inverter Characteristics: Operation and properties of static CMOS inverter	Properties of basic materials used in microelectronics: Silicon, Silicon dioxide
	SLO-2	Introduction to Verilog HDL, modules and ports	Decoders	MOS structure: accumulation, depletion, inversion; nMOS transistor: cutoff, linear, saturation regions of operation	VTC of static CMOS inverter	Polysilicon and Silicon Nitride
S-2	SLO-1	Lexical Conventions: White Space and Comments, Operators	Comparators	MOS Transistor under Static Conditions: The threshold voltage	DC Inverter Calculations	IC Fabrication: Wafer Formation, Photolithography,Well,Channel Formation
	SLO-2	Numbers, Strings, Identifiers, System Names, and Keywords	priority encoder	Resistive operation	Symmetrical Inverter	Silicon Dioxide (SiO_2), Isolation, Gate Oxide
S-3	SLO-1	Verilog Data Types: Nets, Register Variables, Constants	shift and rotate operations	Saturation region	Inverter switching characteristics	Gate, Source/Drain Formations, Contacts and Metallization, Passivation, Metrology
	SLO-2	Referencing Arrays of Nets or Regs	Adders: Standard adder cells	Current-voltage characteristics	Output capacitance	Recurring Process: Diffusion, Ion Implantation, Deposition, Etching, Planarization
S-4, 5	SLO-1		Lab-3: Design using FSM and ASM charts	Lab-6: Realization of VLSI multipliers - I		

Duration (hour)		Introduction to Verilog HDL & Coding	Subsystem Design	MOS Transistor	CMOS Inverter and Circuit Design Styles	Microelectronic Materials
		15	15	15	15	15
	SLO-2	*Lab-0: Verilog Operators: Arithmetic, Bitwise, Reduction, Logical, Relational, Shift, Conditional, Concatenation, Expressions and Operands, Operator Precedence*			*Lab-9: Design and Analysis of CMOS Inverter using HSPICE*	*Lab-12: Design and Analysis of 4-input Dynamic NAND gate using HSPICE*
S-6	SLO-1	*Verilog modelling: Gate-level modelling*	*Ripple Carry Adder (RCA)*	*Dynamic behavior: MOSFET Capacitances, MOS structure capacitances*	*Secondary Parasitic Effects: Leakage Currents, Parasitic Resistances*	*Simplified CMOS Process flow*
	SLO-2	*Realization of Combinational and sequential circuits*	*Carry Look-Ahead Adder (CLA)*	*Channel capacitance and Junction (or, depletion) capacitances*	*Inverter layout*	
S-7	SLO-1	*Compilation and simulation of Verilog code*	*Carry Select Adder (CSL)*	*Parasitic Resistances, viz., Drain and Source Resistance, Contact Resistance*	*Power-Delay Product: Static Power Consumption*	*Layout design rules: Well rules, transistor rules*
	SLO-2	*Test bench*	*Carry Save Adder (CSA)*	*Non-ideal I-V effects: Mobility Degradation, Velocity Saturation*	*Dynamic Power Consumption, Total Power Consumption, PDP*	*Contact rules, metal rules, via rules and other rules*
S-8	SLO-1	*Dataflow modelling*	*Carry Skip Adder (CSK)*	*Channel Length Modulation, Threshold Voltage Effects*	*CMOS Circuit Design Styles: Static CMOS logic styles*	*Gate Layouts*
	SLO-2	*Realization of Combinational and sequential circuits*	*Carry Bypass Adder (CBA)*	*Leakage, Temperature Dependence, Geometry Dependence, Subthreshold Current*	*CMOS circuits, pseudo-nMOS, tristate circuits, clocked CMOS circuits*	*Stick diagrams*
S-9, 10	SLO-1	*Lab-1: Realization of combinational and sequential circuits using gate-level and dataflow modeling*	*Lab-4: Realization of VLSI adders - I*	*Lab-7: Realization of VLSI multipliers - II*	*Lab-10: (a) Design, Analysis of complex CMOS gate using HSPICE (b) Design, Analysis of Pseudo-NMOS gates using HSPICE*	*Lab-13: Model Practical Examination*
	SLO-2					
S-11	SLO-1	*Behavioral modelling*	*Multipliers: Multiplication (unsigned, shift/add multiplication algorithms, multiplication of signed numbers, types of multiplier architectures)*	*Short-channel MOSFETS: Hot carriers, Lightly-Doped Drain (LDD)*	*Differential Cascade Voltage Switch Logic (DCVSL), Pass Transistor Logic (PTL)*	*CMOS Process Enhancements: Transistors (Multiple Threshold Voltages and Oxide Thicknesses, Silicon-on-Insulator, High-k Gate Dielectrics, Higher Mobility, Plastic Transistors,)*
	SLO-2	*Realization of Combinational and sequential circuits*	*Braun multiplier*	*MOSFET scaling*	*Dynamic CMOS logic styles: Basic dynamic logic*	
S-12	SLO-1	*Switch-level modelling*	*Baugh-Wooley multiplier*	*Short-channel effects: Negative Bias Temperature Instability, oxide breakdown*	*Signal integrity issues in dynamic design*	*Interconnects*
	SLO-2	*Realization of MoS circuits*	*Wallace Tree multiplier*	*Drain-Induced Barrier Lowering (DIBL), Gate-Induced Drain Leakage (GIDL), Gate Tunnel Current*	*Signal integrity issues in dynamic design*	*Circuit elements*
S-13	SLO-1	*Design using FSM*	*Booth multiplier*	*Tutorials*	*Domino Logic Circuits: Differential Domino logic, multiple-output domino*	*Beyond conventional CMOS*
	SLO-2	*Realization of sequential circuits*	*Booth multiplier*	*Tutorials*	*Compound domino, NORA, TSPC*	*Tutorials*
S-14, 15	SLO-1	*Lab-2: (a) Realization of digital circuits using behavioral modeling (b) Realization of MOS circuits using switch-level mdeling*	*Lab-5: Realization of VLSI adders - II*	*Lab-8: Realization of RAM & ROM*	*Lab-11:(a)Design,Analysis of AND/NAND gate in DCVSL using SPICE (b) Design, Analysis of Pass-Transistor gates and CPL gates using HSPICE*	*Lab-14: End-Semester Practical Examination*
	SLO-2					

Learning Resources	1. *Jan Rabaey, Anantha Chandrakasan, B Nikolic, "Digital Integrated Circuits: A Design Perspective". Second Edition, Feb 2003, Prentice Hall of India.* 2. *Weste, Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 4th ed., Addision-Wesley, 2011.* 3. *Wayne Wolf, "Modern VLSI Design: IP-based Design", 4th edition, PHI, 2009.*	4. *R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", Wiley, (3/e), 2010.* 5. *John P. Uyemura, "CMOS Logic Circuit Design", Kluwer, 2001.* 6. *S. Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003* 7. *Paul. R.Gray, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley, (4/e), 2001.* 8. *M.D.Ciletti , Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, 1999*

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. J. Manjula, SRMIST*

Course Code	18ECC301T	Course Name	WIRELESS COMMUNICATION	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*18ECC205J, 18ECC105T*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECE220T*
Course Offering Department	*Electronics and Communication Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Understand the elements of Wireless Communication and mobile communications*			
CLR-2 :	*Understand the Mobile Radio Wave Propagation - Large Scale Fading*			
CLR-3 :	*Analyze how to apply Mobile Radio Wave Propagation - Small Scale Fading*			
CLR-4 :	*Study the Capacity and Diversity concepts in wireless communications*			
CLR-5 :	*Acquire the knowledge of Wireless System and Standards*			
CLR-6 :	*Understand and design various wireless systems*			

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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Acquire the knowledge of Wireless communication and basic cellular concepts*	*2*	*75*	*60*	*H*	-	-	-	-	-	-	-	-	-	-	*M*	*M*	-	*L*
CLO-2 :	*Understand` the essential Radio wave propagation and mobile channel models*	*2*	*75*	*60*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	-	*M*	*M*	-	*H*
CLO-3 :	*Familiarize about Various performance analysis of mobile communication system.*	*2*	*75*	*60*	*H*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	*H*
CLO-4 :	*Attain the knowledge of Diversity and capacity concepts*	*2*	*75*	*60*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	-	-	*H*
CLO-5 :	*Be familiar with the various standards of Mobile Communication Systems*	*2*	*75*	*60*	*H*	-	-	-	-	-	-	-	-	-	-	*M*	*M*	-	*L*
CLO-6 :	*Explore the various concepts of wireless communication, its design with respect to fading and link performance*	*2*	*75*	*60*	*H*	*H*	*H*	*H*	*M*	-	-	-	-	*M*	-	*M*	*M*	-	*H*

Duration (hour)		Wireless communication: Mobile communications	Large Scale Fading	Small Scale Fading	Improvement on Link performance	Wireless systems and standards
		12	12	12	12	12
S-1	SLO-1	*Introduction to wireless communication and mobile radio communication*	*Introduction to Radio wave Propagation*	*Introduction Small scale multipath propagation*	*Introduction to diversity, equalization and capacity*	*AMPS Voice modulation Process*
	SLO-2	*Classification of wireless communications - simplex, half duplex, dull duplex*	*Large scale and small scale fading*	*Impulse response model of multipath channel*		
S-2	SLO-1	*Paging and Cordless systems*	*Friis transmission equation- Free space propagation model - pathloss model*	*Impulse response model of multipath channel*	*Space diversity*	*GSM system architecture and its interfaces*
	SLO-2	*Cellular telephone systems*		*Small scale multipath measurements - Direct Pulse measurement*	*Scanning diversity*	
S-3	SLO-1	*Timing diagram - landline to mobile*	*Two Ray model*	*Small scale multipath measurements - Sliding correlator measurement*	*Maximal ratio combiner*	*GSM frame structure*
	SLO-2	*Timing diagram - mobile to mobile*		*Small scale multipath measurements - Swept frequency measurement*	*Equal gain diversity*	
S-4	SLO-1	*Basic antenna parameters, Far field and near field*	*Simplified pathloss model*	*Parameters of mobile multipath channels - Time dispersion and Coherent bandwidth*	*Rake Receiver*	*GSM speech operations input - output*
	SLO-2	*Frequency reuse, sectored and omni-directional antennas*	*Emperical model - Okumara*			
S-5	SLO-1	*Channel assignment strategies*	*Emperical model - Hata model*		*Capacity in AWGN*	*Forward CDMA process*

Duration (hour)		Wireless communication: Mobile communications	Large Scale Fading	Small Scale Fading	Improvement on Link performance	Wireless systems and standards
		12	12	12	12	12
	SLO-2	*Handoff and its types*	*Emperical model - Walfish and bertoni model*	*Parameters of mobile multipath channels - Doppler spread and Coherent time*		
S-6	SLO-1	*Interference and system capacity*	*Piecewise linear model - log normal model*	*Types of fading: Flat and Frequency selective fading*	*Capacity of flat fading channels*	*Reverse CDMA Process*
	SLO-2					
S-7	SLO-1	*Trunking and Grade of Service*	*Shadowing*	*Types of fading: Flat and Frequency selective fading*	*Equalizer and its mode*	*Multicarrier modulation*
	SLO-2		*Combined pathloss and shadowing*			
S-8	SLO-1	*Cell splitting*	*Outage Probabilty*	*Types of fading: Fast and Slow fading*	*Adaptive equalizer block diagram*	*OFDM Transmitter Block diagram*
	SLO-2					
S-9	SLO-1	*Sectoring*	*Cell Coverage Area*	*Types of fading: Fast and Slow fading*	*Types of Equalizers - elementary level only*	*OFDM Receiver Block diagram*
	SLO-2					
S-10	SLO-1	*Microcell zone concepts*	*Solving problems – Brewster angle*	*Ricean distribution*	*Introduction to MIMO antennas*	*Importance of Cyclic Prefix*
	SLO-2					
S-11	SLO-1	*Umbrella cells*	*Solving problems –empirical model*	*Rayleigh distribution*	*Introduction to MIMO antennas*	*Case study - Modern antennas*
	SLO-2					
S-12	SLO-1	*Solving Problems*	*Solving problems – friis transmission formula*	*Solving problems – Doppler effect*	*Case study :Recent trends in Diversity and MIMO antennas*	*Case study - Modern antennas*
	SLO-2					

Learning Resources	1. *Rappaport.T.S., "Wireless Communications: Principles and Practice", 2nd Edition, Pearson, 2011.* 2. *John D Kraus , Ronald J Marhefka, Ahmed S Khan "Antenna and Wave Propagation", 4th Edition, Tata McGraw Hill, 2010* 3. *Constantine Balanis. A, "Antenna Theory: Analysis and Design", 3rd Edition, John Wiley, 2012.* 4. *Andreas.F.Molisch., "Wireless Communications", Wiley, 2nd Edition-2005, Reprint-2014*	5. *Andrea Goldsmith, " Wireless Communications", Cambridge University Press, Aug 2005* 6. *Schiller, "Mobile Communications", Pearson Education Asia Ltd., Reprint 2012* 7. *Lee W.C.Y., " Mobile Communications Engineering: Theory and Applications", McGraw Hill, New York, 2nd Edition, 1998*

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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. Sandeep Kumar P, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. T. Ramarao, SRMIST*

Course Code	18ECC302J	Course Name	MICROWAVE & OPTICAL COMMUNICATIONS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ECC205J*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECE226T & 18ECE323T*
Course Offering Department	*Electronics and Communication Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify Microwave active devices and Microwave generators*
CLR-2 :	*Analyze Microwave passive devices*
CLR-3 :	*Explore Microwave Measurements*
CLR-4 :	*Analyze Optical Fibers Optical Sources, Amplifier and Transmitter Optical Detectors , Receiver and Performance Measurements*
CLR-5 :	*Explore Optical Communication System Design and Concepts*
CLR-6 :	*Analyze Microwave and optical components*

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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Acquire knowledge on the theory of microwave transmission, microwave generators and associated components.*	*2*	80	*70*	*H*	-	-	*L*	-	-	-	-	-	-	-	-	-	-	*L*
CLO-2 :	*Analyse microwave passive devices and components.*	*2*	80	*70*	*H*	*M*	*H*	*H*	-	-	-	-	-	-	-	-	*L*	-	*M*
CLO-3 :	*Understand microwave measurements and associated techniques with equipment*	*2*	80	*70*	*H*	*M*	*H*	*M*	-	-	-	-	-	-	-	-	*M*	-	*H*
CLO-4 :	*Familiarize with the fundamentals of light transmission through fiber*	*2*	80	*70*	*H*	*H*	-	*M*	-	-	-	-	-	-	-	-	*L*	-	*L*
CLO-5 :	*Design a basic optical communication system.*	*2*	80	*70*	*H*	*H*	-	*H*	-	-	-	-	-	-	-	-	*M*	-	*M*
CLO-6:	*Understand the working principle of microwave components , Microwave measurements, optical sources, detector and fibers*	*2*	80	*70*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	-	-	*M*	-	*H*

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to microwaves and optical communications*	*High frequency parameters: S parameters, S matrix analysis for N-port microwave device*	*Impedance matching.*	*Elements of Optical fiber communication*	*Point-to-Point link –Analog system design considerations and design steps*
	SLO-2					
S-2	SLO-1	*History of Microwave Engineering, Microwave transmission and Applications; Maxwell Equations*	*Directional coupler*	*VSWR and Impedance measurement*	*Functional block diagram of a Transmitter and receiver module*	*Point-to-Point link – Digital system design considerations and design steps*
	SLO-2					
S-3	SLO-1	*Microwave Tubes*	*E and H plane Tee*	*Measurement of Power*	*Optical fiber structure, Light Propagation in Optical fibers: Ray theory , Total Internal reflection, Skew rays*	*Digital Link Design: Link power budget*
	SLO-2	*Klystron amplifier*				
S-4-5	SLO-1	*Lab- 1 Characteristics of Reflex Klystron*	*Lab- 4 Gain and radiation pattern of Horn antenna*	*Lab- 7 Practice session*	*Lab- 10 Measurement of Numerical Aperture, propagation and bending losses of optical fiber*	*Lab- 13 Design of basic Optical Communication system using computational tool*
	SLO-2					
S-6	SLO-1	*Reflex Klystron oscillators*	*Magic Tee*	*Measurement of Frequency and Q factor*	*Optical Sources: Light source materials, LED Structures*	*Rise time budget*
	SLO-2					
S-7	SLO-1	*Magnetron oscillators*	*Microwave Circulators, Isolators*	*Insertion loss measurements*	*LED Characteristics*	*Overview of Analog links: Radio over Fiber;*
	SLO-2					

Duration (hour)		15	15	15	15	15
S-8	SLO-1	*Microwave Bipolar Transistors Field effect transistor*	*Attenuators and Phase Shifters*	*Attenuation measurements*	*Semiconductor Laser Diode, Laser Characteristics*	*Key link parameters*
	SLO-2					
S-9-10	SLO-1	*Lab- 2 Study of power distribution in Directional coupler, E plane, H plane and Magic Tee*	*Lab- 5 Characteristics of filters, Microstrip patch antenna and parallel line coupler*	*Lab- 8 DC characteristics of LED and Laser diode*	*Lab- 11 Analysis of Analog optical link*	*Lab- 14 Practice Session*
	SLO-2					
S-11	SLO-1	*IMPATT, TRAPATT and Tunnel diode*	*Rectangular Waveguides*	*Measurement of Scattering parameters*	*Optical Detectors: PIN and APD photo detector*	*Multichannel System: Need for multiplexing Operational principles of WDM, DWDM*
	SLO-2					
S-12	SLO-1	*Gunn diode*	*Rectangular Waveguides*	*Measurement of Scattering parameters*	*Responsivity and efficiency of APD*	*WDM Components: Coupler/Splitter, Fabry Perot Filter*
	SLO-2					
S-13	SLO-1	*Gunn Oscillation modes*	*Power Dividers*	*Functioning details of Vector Network Analyzer; Signal Analyzer; Spectrum analyzers*	*Fiber attenuation and dispersion*	*WDM Components: Optical MEMS switches*
	SLO-2					
S-14-15	SLO-1	*Lab- 3 Impedance measurement by slotted line method*	*Lab- 6 Design of RF Filters and Amplifier using computational tool*	*Lab- 9 DC characteristics of PIN and APD photo-diode*	*Lab- 12 Analysis of Digital optical link*	*Lab- 15 Study experiment - Gunn Diode (Microwave) and Optical WDMA (Optical)*
	SLO-2					

Learning Resources	
	1. *David M. Pozar, "Microwave Engineering", 4th Edition, John Wiley & Sons, 2012.*
	2. *David M. Pozar, "Microwave & RF Design of Wireless Systems", John Wiley & Sons, 2001.*
	3. *Samuel Y. Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson Education, 2013.*
	4. *Robert. E. Collin, "Foundations for Microwave Engineering", 2nd edition, Wiley, Reprint 2014.*
	5. *Annapurna Das, Sisir K. Das, "Microwave Engineering", 3rd Ed., McGraw Hill, 2015.*
	6. *I. Hunter, "Theory and design of microwave filters", The Institution of Engineering &Technology, 2001.*
	7. *Keiser G, "Optical Fiber Communication Systems", 5th Edition, 6th Reprint, McGraw Hill Education (India), 2015.*
	8. *Vivekanand Mishra, Sunita P. Ugale, "Fiber Optic Communication: Systems and Components", Wiley-India, 1st edition, 2013*
	9. *Djafar.K. Mynbaev and Lowell and Scheiner, "Fiber Optic Communication Technology", Pearson Education Asia, 9th impression, 2013*
	10. *John M. Senior, " Optical fiber Communications: Principles and Practice", Pearson Education, 3rd Edition, 2009*
	11. *R.P. Khare, "Fiber Optics and Optoelectronics", Oxford University Press, 2007.*
	12. *Rajiv Ramaswami, Kumar N. Sivaranjan, Galen H.Sasaki "Optical Networks A practical perspective", 3nd edition, 2013*

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. P. Sandeep Kumar, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. T. Ramarao, SRMIST*

Course Code	18ECC303J	Course Name	COMPUTER COMMUNICATION NETWORKS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18CSS101J*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECE320T*
Course Offering Department	*Electronics and Communication 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
		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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLR-1 :	*Introduce the basic concepts in the field of computer networks.*																		
CLR-2 :	*Understand the functional aspects of OSI model architecture.*																		
CLR-3 :	*Acquire knowledge of the Network Layer protocols*																		
CLR-4 :	*Analyze the various issues and challenges of Transport Layer.*																		
CLR-5 :	*Familiarize the various Application Layer Protocols.*																		
CLR-6:	*Utilize the networking concepts to analyze the performance of Routing protocols.*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	*Express the basic services and concepts related to internetworking.*	*1*	*60*	*65*	-	-	-	-	-	-	*H*	-	-	-	-	*M*	-	-	-
CLO-2 :	*Explain the basic OSI model architecture and its lower layer functions.*	*1*	*60*	*65*	-	-	*M*	-	-	-	*L*	-	-	-	-	-	-	-	*H*
CLO-3 :	*Illustrate the various Network Layer concepts, mechanisms and protocols.*	*2*	*65*	*65*	-	-	*H*	-	-	*L*	*M*	-	-	-	-	-	-	-	-
CLO-4 :	*Describe the services and techniques of Transport Layer.*	*1*	*60*	*65*	-	-	-	-	-	-	*M*	-	-	-	-	-	-	-	*H*
CLO-5 :	*Discuss the various services and protocols in Application Layer.*	*1*	*60*	*65*	-	-	*M*	-	-	-	-	-	-	-	-	-	-	-	*H*
CLO-6 :	*Analyze the various Networking concepts and Routing protocols.*	*2*	*60*	*65*	-	-	-	-	*L*	-	-	-	-	-	-	*M*	-	-	*H*

Duration (hour)		Data Communication & Networking Basics	Osi Lower Layers	Network Layer	Transport Layer	Application Layer
		15	15	15	15	15
S-1	SLO-1	*Introduction to Data Communication and Networking*	*Network models*	*Introduction to Network Layer*	*Introduction to Transport Layer*	*Introduction to Application Layer*
	SLO-2	*Data transfer modes-Serial and Parallel transmission*	*OSI layer architecture*	*Need for Internetworking*	*TCP/IP Model*	*Application Layer Paradigms*
S-2	SLO-1	*Protocols & Standards*	*Data Link Layer-Introduction*	*Addressing-Classful*	*User Datagram Protocol(UDP)*	*Client Server Interaction*
	SLO-2	*Layered Architecture*	*Link Layer Addressing*	*Addressing-Classful*	*User Datagram Protocol(UDP)*	*Client Server Interaction*
S-3	SLO-1	*Principles of Layering & Description*	*Error Detection*	*Addressing-Classless*	*Transmission Control Protocol(TCP)*	*SIP*
	SLO-2	*Brief description of concepts in OSI & TCP/IP model*	*Error Detection*	*Addressing-Classless*	*Transmission Control Protocol(TCP)*	*SIP*
S 4-5	SLO-1	*Lab 1: To build and configure a simple network of four nodes connected with point-to-point links.*	*Lab 4: To simulate token ring protocol and to study its performance.*	*Lab 7:To simulate CSMA/CA protocol and to study its performance*	*Lab 10: Implementation and study of Selective Repeat protocol.*	*Lab 13: Create a Socket (TCP&UDP) between two computers and enable file transfer between them.*
	SLO-2					
S-6	SLO-1	*Switching Types- Circuit- & Packet switching*	*Error Correction*	*Network Layer Protocol-IPV4*	*TCP Services & Features*	*Compression Techniques*
	SLO-2	*Switching Types- Message switching, Comparison of switching types*	*Error Correction*	*Internet Protocol(IP)-IPV4*	*TCP Services & Features*	*Compression Techniques*

Duration (hour)		Data Communication & Networking Basics	Osi Lower Layers	Network Layer	Transport Layer	Application Layer
		15	15	15	15	15
S-7	SLO-1	*LAN, MAN & WAN*	*Data link control-LLC*	*Internet Protocol(IP)-IPV6*	*Congestion Control*	*Introduction to Cryptography*
	SLO-2	*LAN, MAN & WAN*	*Data link control-LLC*	*Internet Protocol(IP)-IPV6*	*Congestion Control*	*Types, Attacks and Services*
S-8	SLO-1	*Network topologies-Types*	*Data link control-MAC*	*Routing Protocols- Distance Vector& Link State*	*Congestion Control*	*DES*
	SLO-2	*Comparison of topologies*	*Data link control-MAC*	*Routing Issues-Delivery, Forwarding and Routing*	*Congestion Control*	*DES*
S 9-10	SLO-1	*Lab 2: To simulate star and bus network topologies.*	*Lab 5: Implementation of Error detection and Correction scheme.*	*Lab 8: Implementation and study of stop and wait protocols*	*Lab 11: To configure a network using Link State Routing protocol.*	*Lab 14: Implementation of Data Encryption and Decryption.*
	SLO-2					
S-11	SLO-1	*IEEE standards for LAN-Ethernet*	*Flow & Error Control Protocol*	*Routing Information Protocol-RIP*	*QOS-Quality of Service*	*RSA*
	SLO-2	*Types of Ethernet*	*Flow & Error Control Protocol*	*Routing Information Protocol-RIP*	*QOS-Quality of Service*	*RSA*
S-12	SLO-1	*Token Bus*	*ARQ Schemes*	*Open Shortest Path First-OSPF*	*Techniques to improve QOS*	*Email*
	SLO-2	*Token Ring*	*ARQ Schemes*	*Open Shortest Path First-OSPF*	*Techniques to improve QOS*	*FTP*
S-13	SLO-1	*FDDI*	*HDLC*	*Border Gateway Protocol-BGP*	*Techniques to improve QOS*	*HTTP*
	SLO-2	*FDDI*	*HDLC*	*Border Gateway Protocol-BGP*	*Techniques to improve QOS*	*SNMP*
S 14-15	SLO-1	*Lab 3: To simulate token bus protocol and to study its performance.*	*Lab 6:To simulate CSMA/CD protocol and to study its performance*	*Lab 9: Implementation and study of Go back N protocol.*	*Lab 12: To configure a network using Distance Vector Routing protocol.*	*Lab 15: Mini Project*
	SLO-2					

Learning Resources	1. *Behrouz A.Fehrouzan, "Data communication & Networking", Mc-Graw Hill, 5th Edition Reprint, 2014.* 2. *Andrew S.Tanenbaum, "Computer Networks", Pearson Education India, 5th Edition, 2013.* 3. *William Stallings, "Data & Computer Communication", Pearson Education India, 10th Edition, 2014* 4. *James F. Kurose, Keith W. Ross, "Computer Networking: A Top–Down Approach Featuring the Internet", Pearson Education,6th Edition, 2013.* 5. *"Lab Manual" , Department of ECE, SRM Institute of Science and Technology*

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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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Course Code	18ECC350T	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	*Electronics and Communication 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
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLR-1 :	*Acquire skills to solve real world problems in Analog and Digital Electronics (Discrete & IC)*																		
CLR-2 :	*Acquire skills to solve real world problems in Analog and Digital Communication*																		
CLR-3 :	*Acquire skills to solve real world problems in Signals & Systems, and DSP*																		
CLR-4 :	*Acquire skills to solve real world problems in Microprocessors & Microcontrollers, and VLSI Design*																		
CLR-5 :	*Acquire skills to solve real world problems in Electromagnetics and Transmission Lines*																		
CLR-6 :	*Acquire skills to solve real world problems in Microwave and Optical Communications*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	*Practice and gain confidence and competence to solve problems in Analog and Digital Electronics (Discrete & IC)*	*3*	*85*	*80*	*H*	*H*	*H*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-2 :	*Practice and gain confidence and competence to solve problems in Analog and Digital Communication*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*
CLO-3 :	*Practice and gain confidence and competence to solve problems in Signals & Systems, and DSP*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-4 :	*Practice and gain confidence and competence to solve problems in Microprocessors & Microcontrollers, and VLSI Design*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*
CLO-5 :	*Practice and gain confidence and competence to solve problems in Electromagnetics and Transmission Lines*	*3*	*85*	*80*	*H*	*H*	*H*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-6 :	*Practice and gain confidence and competence to solve problems in Microwave and Optical Communications*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*

Duration (hour)		3	3	3	3	3
S-1	SLO-1	*Tutorial on Analog Electronics (Discrete & IC)*	*Tutorial on Digital Communication*	*Tutorial on Microprocessors & Interfacing*	*Tutorial on Transmission Lines*	*Tutorial on Optical Communication*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-2	SLO-1	*Tutorial on Digital Electronics*	*Tutorial on Signals and Systems*	*Tutorial on Microcontrollers & Interfacing*	*Tutorial on VLSI Design*	*Model Test*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Model Test*
S-3	SLO-1	*Tutorial on Analog Communication*	*Tutorial on Digital Signal Processing*	*Tutorial on Electromagnetics*	*Tutorial on Microwave Communication*	*Final Test*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Final Test*

Learning Resources	*1. R.S.Khurmi, J.K.Gupta, Mechanical Engineering: Conventional and Objective Types, S.Chand & Co., 2018*	*2. R.K.Jain, Conventional & Objective Type Question & Answers on Mechanical Engineering for Competitions, Khanna Publishers, 2014*

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	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
	Create										
	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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