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 / 18ECC211J	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:*
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 Outcomes (CO):	*At the end of this course, learners will be able to:*	**Learning**
CO-1 :	Analyze the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques	4
CO-2 :	Demonstrate the linear and non-linear applications of an opamp and special application ICs	4
CO-3 :	Illustrate the working of multivibrators using special application IC 555 and general purpose opamp	4
CO-4 :	Describe the working principle of data converters and active filters	6
CO-5 :	Summarize the function of application specific ICs such as Voltage regulators, PLL and its application in communication	6

	Program Outcomes (PO)												**Program Specific Outcomes (PSO)**		
Blooms level (1-6)	1	2	3	4	5	6	7	8	9	10	11	12			
Level of Thinking (Bloom)	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
4	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
4	-	2	3	-	-	-	-	-	-	-	-	-	-	-	2
4	-	2	3	-	-	-	-	-	-	-	-	-	1	-	-
6	-	2	3	-	-	-	-	-	-	-	-	-	2	-	-
6	-	2	3	-	-	-	-	-	-	-	-	-	-	-	3

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	Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4th ed., Prentice Hall, 2000 David A. Bell, Operational Amplifiers and Linear ICs, 3rd ed., OUP, 2013 Roy Choudhury, Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014 Robert F. Coughlin, Frederick F. Driscoll, Operational-Amplifiers and Linear Integrated Circuits, 6th ed., Prentice Hall, 2001 Sergio Franco, Design with operational amplifier and analog integrated circuits, McGraw Hill, 1997	LABORATORY MANUAL, Department of ECE, SRM University David A Bell, Laboratory Manual for Operational Amplifiers & Linear ICs, 2nd ed., D.A. Bell, 2001 David La Lond, Experiments in Principles of Electronic Devices and Circuits, Delmar Publishers, 1993 Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004 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
Remember	15%	15%	15%	15%	5%	5%	10%	5%	5%	5%
Understand	15%	15%	15%	15%	5%	5%	10%	5%	10%	10%
Apply	10%	10%	10%	10%	10%	10%	10%	10%	15%	15%
Analyze	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Evaluate					10%	10%	5%	10%	5%	5%
Create					10%	10%	5%	10%	5%	5%
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