

<b>22EE330</b>	<b>LINEAR INTEGRATED CIRCUITS</b>
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Category	L	T	P	Credit
PCC	3	-	-	3

### Preamble

A linear integrated circuit is a solid-state analog device characterized by a theoretically infinite number of possible operating states. It operates over a continuous range of input levels. Linear ICs are employed in audio amplifiers, Analog to Digital converters, averaging amplifiers, differentiators, DC amplifiers, integrators, multivibrators, oscillators, audio filters, and sweep generators. Some devices contain several amplifiers within a single housing.

### Prerequisite

22EE260 - Electronics Circuits and devices

22EE280- Electronics Circuits and devices Lab

### Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Explain the Linear Integrated Circuits fabrication techniques	TPS2	70	70
CO2	Explain the working of operation amplifier and its characteristics.	TPS2	70	70
CO3	Design linear circuits using operational amplifiers for the given specifications	TPS3	70	70
CO4	Design Multivibrator circuits using 555 timer IC	TPS3	70	70
CO5	Design voltage regulators, Analog to digital converters and Digital to Analog converters for the given specifications	TPS3	70	70
CO6	Explain the operation of Phase Locked Loop	TPS2	70	70

### Mapping with Programme Outcomes and Programme Specific Outcomes

Cos	PO 1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L						M		M				M
CO2	M	L						M		M				M
CO3	S	M	L	L				M		M				S
CO4	S	M	L	L				M		M				S
CO5	S	M	L	L				M		M				S
CO6	M	L						M		M				M

S- Strong; M-Medium; L-Low

**Assessment Pattern: Cognitive Domain**

CO	CAT 1			CAT 2			ASSIGNMENT 1				ASSIGNMENT 2				TERMINAL			
TPS SCALE	1	2	3	1	2	3	3	4	5	6	3	4	5	6	1	2	3	4
CO1	8	16													4	8		
CO2	6	8	20				50								4	8	10	
CO3	6	16	20				50								2		10	
CO4				8	16										4	8		
CO5				6	8	20					50				4	8	10	
CO6				6	16	20					50				2	8	10	
	20	40	40	20	40	40									20	40	40	

**Syllabus**

**Introduction:** Integrated circuits – Classification, Thin and thick film techniques, SMT(Surface Mount Technology) Monolithic technique - wafer preparation, Epitaxial growth, Oxidation, Photolithography, Diffusion, Ion Implantation, Isolation, Metallization and Packaging, Fabrication of Integrated resistors, capacitors and inductors - Bipolar and MOSFET devices fabrication techniques.

**Operational amplifier:** Basic concepts - differential amplifiers - block diagram-ideal op-amp parameters - Basic op-amp applications Scale changer, Inverting and non-inverting amplifiers, summer and subtractor, Log and antilog amplifiers - multiplier, Divider, differentiator, Integrator. Instrumentation amplifier

**Op-amp circuits:** V to I and I to V converters- Precision rectifier- Clipper and clamper- Sample and hold circuits - Active filters: first order and second order LPF and HPF- Comparators - Regenerative comparator (Schmitt Trigger)- Square wave and Triangular wave generators- Sine wave generators: RC Phase shift and Wein bridge oscillators.

**Other Linear ICs:** IC voltage regulators – Fixed and Variable voltage regulators-78XX and 79XX series regulators, LM317 voltage regulator -Switching Regulator- 555 timer IC: Astable and Monostable modes - Phase locked loop and its applications- D/A converters: weighted resistor and R-2R ladder- A/D converters: Successive approximation, Counter type, Flash type and Delta-sigma.

**Text Book**

1. Roy choudhury and shall B.Jain, Linear Integrated circuits, Wiley Eastern Ltd, 5<sup>th</sup> edition, 2018.

**Reference Books & Web Resources**

1. Ramakant A. Gayakwad, Op-amps and Linear Integrated Circuits, Pearson Education; Fourth edition, 2015
2. K.R.Botkar, Integrated Circuits, Hanna Publishers, 2008
3. Jacob Millman & Christos C.Halkias- Integrated electronics, McGraw Hill Education; 2 edition ,2017.
4. Fred F. Driscoll and Robert F. Coughlin , Operational Amplifiers and Linear Integrated Circuits, Pearson; 4 edition 1997.
5. NPTEL courses web:<http://nptel.ac.in/courses/108106068/>
6. MOOCs course link: <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/>

### Course Contents and Lecture Schedule

Module No.	Topics	No. of Periods
1	<b>Introduction</b>	
1.1	Integrated circuits – Classification	1
1.2	Thin and thick film techniques, SMT(Surface Mount Technology)	1
1.3	Monolithic technique - wafer preparation, Epitaxial growth, Oxidation	1
1.4	Photolithography, Diffusion, Ion Implantation, Isolation, Metallization and Packaging	1
1.5	Fabrication of Integrated resistors	1
1.6	Fabrication of Integrated capacitors and inductors	1
1.7	Bipolar and MOSFET devices fabrication techniques	1
2	<b>Operational amplifier</b>	
2.1	Basic concepts - differential amplifiers - block diagram-	2
2.2	ideal op-amp parameters	1
2.3	Basic op-amp applications Scale changer, Inverting and non-inverting amplifiers, summer and subtractor	1
2.4	Log and antilog amplifiers	1
2.5	multiplier, Divider,	1
2.6	differentiator, Integrator	2
2.7	Instrumentation amplifier	1
3	<b>Op-amp circuits</b>	
3.1	V to I and I to V converters	1
3.2	Precision rectifier	1
3.3	Clipper and clamper, Sample and hold circuits	1
3.4	Active filters: first order and second order LPF and HPF	2
3.5	Comparators - Regenerative comparator(Schmitt Trigger)-	1
3.6	Square wave and Triangular wave generators-	2
3.7	Sine wave generators: RC Phase shift and Wein bridge oscillators.	1
4	<b>Other Linear ICs</b>	
4.1	IC voltage regulators – Fixed and Variable voltage regulators- 78XX and 79XX series regulators,	1

4.2	LM317 voltage regulator -Switching Regulator-	2
4.3	555 timer IC - Astable and Monostable modes	2
5	<b>Applications</b>	
5.1	Phase locked loop and its applications	2
5.2	D/A converters: weighted resistor and R-2R ladder-	2
5.3	A/D converters: Successive approximation, Counter type, Flash type and Delta-sigma	2
	Total	36

**Course Designers:**

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