Program :	**Diploma in Electronics/ Electronics and Communication Engineering/ Biomedical Engineering**
Course Code :**4043**	Course Title: **Linear Integrated Circuits**
Semester :**4**	Credits: **4**
Course Category: **Program Core**	
Periods per week: **4(L:3, T:1, P:0)**	Periods per semester:**60**

Course Objectives:

- To provide an insight on the fundamental concepts of operational amplifiers and their applications.
- To give a functional description of various linear integrated circuits and discuss on various circuits which act as the bridge between analog and digital domains.

Course Prerequisites:

Topic	Course code	Course Title	Semester
Semiconductor theory, working of diodes and transistors		Basic Electronics	2
Design and working of Amplifiers and oscillators		Electronic Circuits	3

Course Outcomes:

On completion of the course, the student will be able to:

COn	Description	Duration (Hours)	Cognitive level
CO1	Illustrate the internal structure, working and electrical parameters of operational amplifier.	12	Understanding
CO2	Develop circuits using operational amplifier.	20	Applying
CO3	Implement circuits using timer IC and PLL	12	Applying
CO4	Explain the operation of various fixed and variable voltage regulators, ADC and DAC	14	Understanding
	Series Test	2	

CO-PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2						
CO2	3						
CO3	3						
CO4	2						

3-Strongly mapped, 2-Moderately mapped, 1-Weakly mapped

Course Outline:

Module Outcomes	Description	Duration (Hours)	Cognitive Level
CO1	**Illustrate the internal structure, working and electrical parameters of operational amplifier.**		
M1.01	Illustrate the operation of differential amplifier	4	Understanding
M1.02	Explain the block diagram of operational amplifier	2	Understanding
M1.03	Explain operational amplifier parameters	3	Understanding
M1.04	Illustrate thebasic op-amp feedback circuits	3	Understanding
Contents: **Fundamentals of operational amplifier** **Differential amplifier:** BJT differential amplifier - types -Large and small signal operation- Input resistance - Voltage gain - CMRR - non-ideal characteristics **Operational Amplifier** : Op-amp symbol - package types - block diagram - DC and AC op-amp parameters - equivalent circuit - voltage transfer curve - Open loop op-amp configurations - Op-amp with negative feedback - Properties of practical op-amp - Inverting amplifier - Non-inverting amplifier - Voltage follower			
CO2	**Develop circuits using operational amplifier.**		
M2.01	Develop various amplifiers using op-amp	4	Applying
M2.02	Developwave-shaping circuits using op-amp	4	Applying
M2.03	Develop oscillator circuits using op-amp	4	Applying
M2.04	Illustrate comparator circuits using op-amp	4	Applying
M2.05	Developactive filters using op-amp	4	Applying
	Series Test I	1	

Contents:

Applications of operational amplifier

Summing amplifier - difference amplifier - Scaling and averaging amplifiers - adder - subtractor - Instrumentation amplifier - Voltage to current converter, Current to voltage converter - Integrator - Differentiator - Precision rectifiers - Peak detector - Clipper and Clamper - Log and antilog amplifier - Phase shift and Wien bridge oscillators - Astable and mono stable multi vibrators - Triangular and saw tooth wave generators- Comparators - Zero crossing detector - Schmitt trigger - First order low-pass, high-pass and band-pass Butterworth filters.

CO3	**Implement circuits using timer IC and PLL**		
M3.01	Explain the functional block diagram of 555 timer	3	Understanding
M3.02	Develop circuits using 555 timer IC	3	Applying
M3.03	Explain the functional block diagram of 565 PLL	3	Understanding
M3.04	Illustrate applications ofPLL	3	Understanding

Contents:

Timer & PLL

555 Timer IC- Functional block diagram - features – a stable and mono stable multi vibrator using 555 -

Phase Locked Loop - General block diagram of PLL - Operation - Lock range, capture range and pull-in time - Functional block diagram of PLL IC 565 - Applications of PLL for AM & FM detection and Frequency multiplication, Frequency division, Frequency synthesizing

CO4	**Explain the operation of various fixed and variable voltage regulators, ADC and DAC**		
M4.01	Explain fixed and variable voltage regulators	4	Understanding
M4.02	Compare and contrast various analog to digital converters	5	Understanding
M4.03	Compare and contrast various digital to analog converters	5	Understanding
	Series Test II	1	

Contents:

IC Voltage regulators and Data Converters

Monolithic Voltage Regulators: Fixed voltage regulators, 78XX and 79XX series - Adjustable voltage regulators IC LM723 - Low voltage and high voltage configurations, Current boosting, Current limiting, Short circuit and Fold-backprotection- optocoupler - principle of operation.

Data Converters:D/A converter - Specifications - Weighted resistor type, R-2R Ladder type.

A/D Converters: Specifications - Classification - Flash type - Counter ramp type - Successive approximation type - Dual slope type - Sample-and-hold circuits.

Text / Reference:

T/R	Book Title/Author
T1	Roy D. C. and S. B. Jain, **Linear Integrated Circuits**, New Age International, 3/e, 2010
T2	Sergio Franco, **Design with operational amplifiers and analog integrated circuits**, 3rd Edition, Tata McGraw-Hill, 2008
R1	Gayakwad R. A., **Op-Amps and Linear Integrated Circuits**, Prentice Hall, 4/e, 2010
R2	Botkar K. R., **Integrated Circuits**, 10/e, Khanna Publishers, 2010
R3	SalivahananS. ,V. S. K. Bhaaskaran, **Linear Integrated Circuits**, Tata McGraw Hill, 2008
R4	David A. Bell, **Operational Amplifiers & Linear ICs**, Oxford University Press, 2nd edition,2010

Online resources:

Sl.No	Website Link
1	https://nptel.ac.in/courses/117107094/
2	https://nptel.ac.in/courses/117101106/
3	https://nptel.ac.in/courses/108/108/108108111/
4	https://inst.eecs.berkeley.edu/~ee140/fa19/
5	https://freevideolectures.com/course/2915/linear-integrated-circuits