FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **BACHELOR OF TECHNOLOGY (Electronics and Communication)**

Semester: **V**

Course Code: **202060504**

Course Title: **Linear Integrated Circuits**

Course Group: **Professional Core Course**

Course Objectives: This course introduces the basic building blocks of linear integrated circuits, and the linear and non-linear applications of operational amplifiers. It is also aimed to develop better insight among the students regarding the theory and applications of special functions ICs. Further it explores the IC fabrication technology.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50/18	50/17	25/9	25/9	150/53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hour s
1	**Basics of Operational Amplifiers:** Basic information about op-amps – Ideal Operational Amplifier - General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, Analysis of data sheets of an Op-amp, Open and closed loop configurations – FET Operational Amplifiers.	9
2	**Applications of Operational Amplifiers:** Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.	9

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3	**Analog to Digital And Digital to Analog Converters:** Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R - 2R Ladder types - switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type - A/D Converter using Voltage-to-Time Conversion - Over-sampling A/D Converters, Sigma – Delta converters.	**9**
4	**Waveform Generators and Special Function ICs**: Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, **IC 555 Timer and its applications -** Block diagram, Monostable and Astable multivibrator, Applications as Frequency divider, Square wave generator; **IC 565 Phase Locked Loops and its Applications -** Block diagram and operation, Applications as Frequency Multiplier, Frequency Shift Keying; **Design of Power Supply -** Simple op-amp voltage regulator, Three terminal voltage regulators, Fixed and adjustable voltage regulators (78XX, LM317), Heat sink, Dual power supply (LM320, LM317), Monolithic switching regulator, Frequency to Voltage and Voltage to Frequency converters.	**9**
5	**Integrated Circuit Fabrication:** Introduction, classification, IC Chip size and circuit complexity, Fundamentals of monolithic IC technology, Basic Planar Processes, Fabrication of a circuit, active and passive components of IC's, Fabrication of FET, Thin and Thick Film Technology, Technology Trends.	**9**
		45

List of Practicals / Tutorials:

1	a) Measurement of input and output offset voltage of 741 ICs. b) To configure op-amp in voltage follower mode and to measure its slew rate.
2	To measure PSRR and CMRR of given op-amp.
3	To configure op-amp in inverting and non-inverting amplifier mode and measure their gain and bandwidth.
4	Design and test the integrator and differentiator for a given time constant.
5	Design an Instrumentation amplifier Using IC 741.
6	Design an Active low-pass, High-pass and band-pass filters using Op-amp.
7	R-2R Ladder Type D- A Converter using Op-amp
8	Astable and Monostable multivibrators using NE555 Timer.
9	PLL characteristics and its use as Frequency Multiplier, Clock synchronization
10	To design Schmitt trigger circuit using op-amp and take measurements.
11	DC power supply using LM317.

Reference Books:

1	D. Roy Choudhry and Shail Jain, **Linear Integrated Circuits**, 5th Edition, New Age International Pvt. Ltd., 2018.
2	Ramakant A. Gayakwad, **OP-AMP and Linear ICs**, 4th Edition, Prentice Hall/Pearson Education, 2015.
3	Sergio Franco, **Design with Operational Amplifiers and Analog Integrated Circuits**, 4th Edition, Tata Mc Graw-Hill, 2016.

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4	S. Salivahanan and V. S. Kanchana Bhaskaran, **Linear Integrated Circuits**, 2nd Edition, TMH, 2016.
5	Gray and Meyer, **Analysis and Design of Analog Integrated Circuits**, 5th Edition, Wiley International, 2009.

Supplementary learning Material:	
1	NPTEL Integrated Circuits MOSFETs OP-Amps https://onlinecourses.nptel.ac.in/noc20_ee13/preview and their applications
2	Coursera Video lectures.

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

Internal Evaluation:

The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
15	40	10	15	10	10	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Design linear and nonlinear applications of OP – AMPS	**25**
CO-2	Design applications using analog multiplier and PLL.	**25**
CO-3	Design ADC and DAC using OP – AMPS	**25**
CO-4	Generate waveforms using OP – AMP Circuits; Analyze special function ICs.	**25**

Curriculum Revision:	
Version:	2.0
Drafted on (Month-Year):	June -2022
Last Reviewed on (Month-Year):	-

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Next Review on (Month-Year):	June-2025

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