



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04000051

Subject Name: Linear Integrated Circuits

WEF Academic Year :	2025-26
Semester :	4
Category of the Course :	PCC-04

Course Outcome :

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Describe the internal structure, types, and characteristics of operational amplifiers and interpret manufacturer datasheets.	RM and UN
02	Explain the behavior of ideal and practical op-amps in various configurations including open-loop and negative feedback systems.	UN
03	Analyze and evaluate the effects of input offset voltage, bias current, slew rate, and temperature variations on practical op-amp performance.	AN
04	Design and implement linear and non linear applications of op-amps.	CR
05	Utilize specialized ICs (555 Timer, PLL, LM317, LM380, XR2206) and operational transconductance amplifiers and monolithic ICs in various applications.	AP

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Course Scheme:

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/ CA (I)	TW/S L (I)	ESE (V)	
45	0	30	45	120	4	70	30	20	30	50	200



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Course Content :

Sr. No.	Course Content	Total Hours	% Weightage
1	Introduction to Operational Amplifiers: Introduction, Block diagram representation of a typical op-amp, its equivalent circuit, types of ICs, Manufacturers' designations and package types for ICs, Power supplies for ICs	4	8
2	Interpretation of Data Sheets and Characteristics of an op-amp: Interpreting datasheet, Ideal op-amp, Equivalent circuit of an op-amp, Ideal voltage transfer curve, Open-loop op-amp configurations	4	8
3	An Op-amp with Negative Feedback: Voltage-series feedback amplifier, Voltage-shunt feedback amplifier, Differential amplifier	5	13
4	The Practical op-amp: Introduction, Input offset voltage, Input bias current, Input offset current, Total output offset voltage, Thermal drift, Effect of variation in power supply voltage on offset voltage, Change in input offset voltage and input offset current with time, Other op-amp parameters which changes with change in temperature and supply voltage, noise, Common-mode configuration and common-mode rejection ratio, Slew rate and it equations, Effect of slew rate in applications, Difference between bandwidth, Transient response and slew rate	8	17
5	General Linear Applications: DC and AC amplifiers, AC amplifiers with single supply voltage, Peaking amplifier, Summing, Scaling and Averaging amplifier, Instrumentation amplifier - its block diagram along with applications, Differential input and differential output amplifier, Voltage-to-current converter with floating load (low-voltage DC voltmeter, low-voltage AC voltmeter, Diode match finder, Zener diode tester, Light-emitting diode tester), Current-to-voltage converter, Very high-input impedance circuit, Integrator, Differentiator.	8	17



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6	Comparators and Converters: Comparator, Zero Crossing Detector, Schmitt Trigger, Voltage limiters, Clipper and clampers, Absolute value output circuit, Peak detector, Sample and hold Circuit, Precision rectifier – Half/Full Wave, Square, Triangular and Saw tooth Wave Generator, Log/ Antilog Amplifier	8	17
7	Specialized IC Applications: a. 555 Timer and its Applications: Block Diagram, Monostable and Astable Multivibrator, Applications as Frequency Divider, Square Wave Generator. b. Free-Running Ramp Generator c. Phase Locked Loop and Its Applications: Block Diagram and Operation, Applications as Frequency Multiplier, Frequency Shift Keying. d. 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), Basic Switching Regulator and its characteristics. e. Power Amplifiers: Monolithic Power Amplifiers (LM380) f. Function Generator: IC XR 2206	6	15
8	Operational Trans-conductance Amplifier: Introduction, Internal diagram, Analysis, Active Filter	2	5

Reference Book :

1. Op-amps and Linear Integrated Circuits, by Ramakant A. Gayakwad.
2. Design with Operational Amplifiers and Analog Integrated Circuits, by Sergio Franco, Tata Mcgraw-hill 2009 Edition.
3. Linear Integrated Circuits, by D. Roy Choudhury and Shail B. Jain, New Age International Publishers, 3rd Edition.
4. Design of Analog Filters, by R. Schaumann, and Mac E. Van Valkenburg.

Suggested Course Practical List :

1. Measurement of input and output offset voltage of 741 ICs.
2. To configure op-amp in voltage follower mode and to measure its slew rate.



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3. To configure op-amp in inverting and non-inverting amplifier mode and measure their gain and bandwidth.
4. To prepare precision rectifier using op-amp and verify its operation using measurements.
5. To prepare full-wave rectifier using op-amp and verify its operation using measurements.
6. To measure PSRR and CMRR of given op-amp.
7. To design Schmitt trigger circuit using op-amp and take measurements.
8. To design, build astable and monostable multi-vibrators using 741 IC and verify their operation using measurements by observing waveforms.
9. To design, build and obtain the frequency responses of First order Low-Pass and Band-Pass Active Filters.
10. To design triangular wave generator using op-amp and verify its operations with measurements.
11. To design and build second order Low-pass, Band-pass, High-pass, All pass and Band Elimination filters using BIQUAD Circuit.
12. To design Butterworth low-pass filter (Sallen-key circuit), construct the same circuit on breadboard and take necessary measurements
13. To design Friend Deliyannis band-pass filter, construct the same circuit on breadboard and take necessary measurements.
14. To design monostable and astable multi-vibrators using 555 timer IC and verify their operation using measurements.
15. To design, build and test Linear Voltage Regulators.

List of Laboratory/Learning Resources Required:

- i. Function Generator
- ii. Oscilloscope
- iii. Digital Multi-meter
- iv. DC Power Supply (0-30 V)
- v. Multisim, SCILAB, PSpice, NGSpice (Open-Source Software)

Activities suggested under Problem Based Learning:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.



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2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions



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12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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