

<b>University of Mumbai</b>			
<b>CLASS: T.E. (Electronics Engineering)</b>		<b>Semester - V</b>	
<b>SUBJECT: Linear Integrated Circuit and Design</b>			
Periods per week (each of 60 min.)	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical examination	3	25
	Oral Examination	-	-
		Term Work	25
		Total	150

<b>Objective</b>	To teach the basic concepts in the design of electronic circuits using linear integrated circuits and their applications in the processing of analog signals. Also to introduce a few special function integrated circuits such as Regulator ICS, Waveform generator etc.	
<b>Pre-requisite</b>	Passive circuit analysis and transistor behavior. single or two stage amplifier, Diff-Amp and Current Mirror concepts	
<b>Module</b>	<b>Contents</b>	<b>Hours</b>
1	<b>Operational Amplifier Fundamentals</b> <ul style="list-style-type: none"> <li>• Basic Op Amp Configurations,</li> <li>• Ideal Op Amp Circuits Analysis,</li> <li>• Simplified Op Amp Circuits Diagram,</li> <li>• Input Bias and Offset Currents,</li> <li>• Low-Input-Bias-Current Op Amps,</li> <li>• Input Offset Voltage,</li> <li>• Low-Input-Offset-Voltage Op Amps,</li> <li>• Input Offset-Error Compensation,</li> <li>• Maximum Ratings.</li> <li>• Open-Loop Response,</li> <li>• Closed-Loop Response</li> <li>• Input and Output Impedances</li> <li>• Transient Response</li> <li>• Effect of Finite GBP on Integrator Circuits</li> <li>• Effect of Finite GBP on Filters</li> <li>• Current-Feedback Amplifiers</li> </ul>	08

	<ul style="list-style-type: none"> <li>• The Stability Problem,</li> <li>• Stability in Constant-GBP Op Amps Circuits,</li> <li>• Internal Frequency Compensation</li> <li>• External Frequency Compensation</li> <li>• Stability in CFA Circuits</li> <li>• Composite Amplifiers</li> <li>• Op Amp Powering.</li> <li>• Slew rate and methods of improving slew rate.</li> </ul>	
2	<p><b>Linear Applications of OP-AMP</b></p> <ul style="list-style-type: none"> <li>• Current shunt feedback (Inverting Amplifier)</li> <li>• Current Series feedback (Non-Inverting Amplifier)</li> <li>• Summing Amplifier, Averaging Amplifier</li> <li>• Difference Amplifier,</li> <li>• Instrumentation Applications,</li> <li>• Integrator/Differentiator using OP-AMP</li> <li>• Current-to-Voltage Converters,</li> <li>• Voltage-to-Currents Converters,</li> <li>• Grounded load V/I Converter</li> <li>• V-F and F-V Converters.</li> <li>• Sample-and-Hold Amplifiers</li> </ul>	08
3	<p><b>Active Filter</b></p> <ul style="list-style-type: none"> <li>• The Transfer function,</li> <li>• First-Order Active Filters,</li> <li>• Audio Filter Applications,</li> <li>• Standard Second- Order Responses, KRC Filters,</li> <li>• Multiple-Feedback Filters,</li> <li>• State-Variable and Biquad Filters,</li> <li>• Sensitivity, Filter approximations,</li> <li>• Cascade design,</li> <li>• Generalized impedance converters,</li> <li>• Direct design,</li> <li>• Switched capacitor filters.</li> </ul>	08

4	<p><b>Non Linear Applications of OP-AMP</b></p> <ul style="list-style-type: none"> <li>• Voltage Comparators</li> <li>• Comparator Application</li> <li>• Schmitt Triggers,</li> <li>• Precision Rectifier</li> <li>• Peak Detectors</li> <li>• Mono-shot Multi-vibrator</li> <li>• Astable Multi-vibrator</li> <li>• Triangular /saw-tooth waveform Generator</li> </ul>	08
5	<p><b>Data Converters and Regulators</b></p> <ul style="list-style-type: none"> <li>• Analog Switches</li> <li>• A-D Conversion Techniques</li> <li>• D-A Conversion Techniques</li> <li>• Integrated ICs employing above techniques and their applications</li> <li>• Functional block diagram of Voltage Regulators</li> <li>• Fixed voltage Regulators(78XX and 79XX)</li> <li>• Variable Voltage Regulators (LM317 and CA723)</li> </ul>	10
6	<p><b>6.Waveform Generators and synthesizers</b></p> <ul style="list-style-type: none"> <li>• Oscillators using OP-AMP (RC –Phase shift and Wien Bridge oscillators)</li> <li>• Monolithic Timer – NE555</li> <li>• Phase-Locked Loops, Monolithic PLLs</li> </ul>	6

**Text Books:**

1. Sergio Franco, Design with operational amplifiers and analog integrated circuits, Third edition, McGraw Hill International edition, 2002.
2. Ramakant A.Gayakwad, 'OP-AMP and Linear IC's', Prentice Hall / Pearson Education, 1994.
3. Robert Coughlin and F Driscoll, Operational Amplifiers and Linear Integrated circuits, sixth edition, Pearson Education Asia, 2001
4. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.

**Additional Reading:**

1. Donald A. Neamen, Electronic Circuit Analysis and Design, Second edition, McGraw Hill International edition 2001

2. James M. Fiore, Op Amps and Linear Integrated circuits, First reprint, Thomson Asia Pte. Ltd., 2001
3. K.R.Botkar, 'Integrated Circuits'. Khanna Publishers, 1996.

### Suggested Practical list

Sr. No.	Topic	Experiments
1	Operational Amplifier Fundamentals	Determination of Slew Rate, CMRR and Frequency and offset voltage for IC 741 Op-amp.
2	Linear Applications of OP-AMP	Design and implementation of linear equation for op-amp i.e. $V_o = V_1 + V_2 - V_3$ using IC 741
3		Frequency response of Integrator/ differentiator using simulation Program on SPICE
4	Active Filter	Frequency Response of 2 <sup>nd</sup> order HPF filter on SPICE
5		Frequency Response of 2 <sup>nd</sup> order LPF using SPICE
6	Non Linear Applications of OP-AMP	Design of Schmitt Trigger using IC 741 for designed value of UTP and LTP
7		Design of mono-stable Multi-vibrator for required pulse width using IC 741
8		Design of Astable multi-vibrator for required frequency and Duty cycle using IC 741
9		Design of triangular/ Saw-tooth wave form generator using IC 741
10	Data Converters and Regulators	Design of R/2R ladder 4-bit D/A Converter using IC 741
11		Design FLASH TYPE 2-bit A/D converter using LM 324
12		Design of LOW / HIGH Voltage Regulator using IC 723
13	Waveform Generators and synthesizers	Design RC oscillators for required frequency and verify it using SPICE code
14		Design of mono-stable Multi-vibrator for required pulse width using IC 555
15		Design of Astable multi-vibrator for required frequency and Duty cycle using IC 555
16		Verify IC 565 as Frequency Demodulator
17		Verify working of waveform generator ICL 8038

**Practical/ Oral Examination:**

Practical Examination will be based on experiments performed from the list of experiment given in the syllabus and the evaluation based on the same experiment.

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

**Termwork:**

The term-work shall consist of at least six laboratory experiments covering the whole of syllabus, duly recorded and graded as well as at least four computer simulations using EDA tools like PSPICE duly recorded and graded. This will carry a weightage of Ten marks. A test shall be conducted and will carry a weightage of ten marks.

The distribution of marks for term work shall be as follows

Laboratory work (Experiments and Journal)	: 10 marks.
Test (at least one)	: 10 marks.
Attendance (Practical and Theory)	: 05 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

**Theory Examination:**

1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and will cover all modules.
4. Remaining questions will be from the same module or mixed in nature. (e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In the question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from pre-requisite module