<table>
<tr><td colspan="5">Devi Ahilya Vishwavidhyalaya, Indore, India<br>Institute of Engineering & Technology</td><td colspan="2">II Year B.Tech. (Electronics and Instrumentation Engineering)</td></tr>
<tr><td>Course Code & Name</td><td colspan="6">Instructions Hours per Semester and Credits</td></tr>
<tr><td rowspan="2">4REPC3<br><br>LINEAR DEVICES AND APPLICATION</td><td colspan="2">Classroom Instruction (CI)</td><td>Lab Instruction (LI)</td><td>Term Work (TW) and Self Learning (SL)</td><td>Total no. of Hours Per semester</td><td>Total Credits (Total Hours/30)</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>TW+SL</td><td rowspan="2">120</td><td rowspan="2">4</td></tr>
<tr><td>20</td><td>10</td><td>20</td><td>70</td></tr>
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**Course Learning Objective:**

1. Understand the fundamentals, characteristics, and parameters of operational amplifiers and linear ICs.
2. Analyze and apply op-amp configurations for amplification and arithmetic operations.
3. Design and evaluate op-amp based application circuits for measurement and signal processing.
4. Analyze and design active filters and oscillator circuits using operational amplifiers.
5. Implement timing and control applications using IC 555 and Phase Locked Loop (PLL).

**Prerequisites:**

Basic knowledge of Circuit analysis, basic electronics, Semiconductor physics.

## COURSE CONTENTS

**Unit-I**

**Fundamentals of operational amplifier:**

Operational Amplifier, Equivalent Circuit, Circuit symbols and Terminals. Op-Amp IC 741 pin diagram and pin function, Op-Amp parameters Input offset voltage, Input Offset current, Input bias current, Differential input resistance, Input capacitance, input voltage range ,offset voltage adjustment range, Common Mode Rejection Ratio (CMRR), Supply Voltage Rejection Ratio (SVRR), Slew Rate, Large Signal Voltage Gain, Supply voltage, Supply Current, Output voltage Swing, Gain Bandwidth Product, Output Short Circuit Current, Transfer Characteristic- Ideal and Practical Voltage Transfer Curve, Op-Amp Configuration: Open Loop and Closed loop, Virtual Ground Concept, Features, pin diagram and pin function of dual Op Amp IC 747.

**Unit-II**

**Basic OP-Amp Circuits:**

Closed Loop configuration, modes of operations: Inverting and Non- Inverting modes, Differential amplifier, Unity Gain Amplifier (voltage follower), Arithmetic operations: Addition, multiplication, Scaling, Averaging, Subtraction, Integrator, Differentiator, Concept of frequency compensation of Op-Amp and offset nulling

**Unit-III**

**OP-Amp Applications:**
Op-Amp as an Instrumentation amplifier: Working, Derivation of output voltage, IC LM 324-Pin Configuration, specification and application, Voltage to Current converter with Floating and Grounded load, Current to Voltage converter, Sample and Hold Circuit, Logarithmic and Antilogarithmic amplifier using diodes, Analog Divider and analog multiplier, Comparators: IC LM710, Zero Crossing Detector, Schmitt Trigger, Window Detector, Phase Detector Active Peak Detector, Peak to Peak Detector.

**Unit-IV**
**Filters and Oscillators:**
Filter and its classification, Merits and demerits of active filters over passive filters, Filter characteristic terms: order of filter, cut off frequency. Pass band. Stop band, Centre frequency, Q factor, Filter types and its Frequency Response: Low pass (First Order and second order). high Pass (First Order and second order). Band pass (Wide and Narrow), Band Reject (Wide and Narrow), All Pass Filter, Oscillator types using IC 741: Phase shift oscillator, Wein Bridge oscillator, Colpitts oscillator, Hartley oscillator.

**Unit-V**
**IC 555 and other Linear IC IC 555:**
Block Diagram of Timer, Pin diagram and functions, Astable, Monostable, Bistable multivibrator. Schmitt trigger and Voltage Control Oscillator, Phase Lock Loop (PLL): Block diagram and its operation, lock range and capture range, Applications of PLL: PLL as Multiplier, FM Demodulator, IC 565: Pin diagram and function.

**Course Outcome:**

| CO No. | CO |
|---|---|
| CO1 | Identify and analyze the internal structure, parameters, and transfer characteristics of operational amplifiers including IC 741 and IC 747. |
| CO2 | Apply operational amplifiers in inverting, non-inverting, differential, and arithmetic circuit configurations. |
| CO3 | Analyze and design op-amp based applications such as instrumentation amplifiers, converters, and comparators. |
| CO4 | Design and analyze active filters and oscillator circuits using operational amplifiers. |
| CO5 | Implement circuits using IC 555 timer and Phase Locked Loop (PLL) systems. |

**BOOKS RECOMMENDED:**

[1] Millman & Halkias - Integrated Electronics, Tata McGraw Hill.
[2] Franco-Design with Operational Amplifiers & Analog Integrated Circuits, TMH
[3] Schilling & Belove-Electronic Circuit, Discrete & Integrated , TMH
[4] Gayakwad R.A- Op-Amps and Linear IC's, Pearson .
[5] Coughlin and Driscoll – Operational Amplifier and Linear Integrated Circuits – Pearson Education Asia

**CO-PO-PSO Relationship**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **4REPC3.CO1** | 3 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | 1 |

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| **4REPC3.CO2** | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | 3 | 3 | 2 |
| **4REPC3.CO3** | 2 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 3 | 3 | 3 |
| **4REPC3.CO4** | 2 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 3 |
| **4REPC3.CO5** | 2 | 2 | 2 | - | 1 | - | - | - | - | - | - | 2 | 2 | 3 |

**List of Practical Assignments:**

During the learning of course, students need to carryout following assignments:

1) To measure the gain of inverting & non-inverting amplifier.
2) To analyze the voltage transfer characteristics of op-amp.
3) To study the inverting adder & subtractor configuration of op-amp.
4) To study the non- inverting adder & subtractor configuration of op-amp.
5) To study the differentiator configuration of op-amp.
6) To study the integrator configuration of op-amp.
7) To study the low pass & high pass filter.
8) To study the band pass & band reject filter.
9) To study the zero crossing detector.
10) To analyze the performance of comparator**.**