204187 Integrated Circuits

Teaching Scheme:
Lectures: 3 Hrs/ Week
Practical : 2 Hrs/Week

Examination Scheme:
Theory Online : 50 Marks
Theory Paper : 50 Marks
Practical: 50 Marks

Course Objectives and Outcomes:

Operational amplifier is one of the most important building blocks of any electronic system. It has been in use for many years, and it is used in wide range of application such as linear, non linear, mathematical interfacing, communication and control system. The main objective of this course is to introduce the characteristics, analysis, working principle and applications of Operational Amplifiers.

Having successfully completed this course, the student will be able to:

1. Understand the characteristics of IC and Op-Amp and identify the internal structure.
2. Understand and identify various manufacturing techniques.
3. Derive and determine various performances based parameters and their significance for Op-Amp.
4. Comply and verify parameters after exciting IC by any stated method.
5. Analyze and identify the closed loop stability considerations and I/O limitations.
6. Analyze and identify linear and nonlinear applications of Op-Amp.
7. Understand and verify results (levels of V & I) with hardware implementation.
8. Implement hardwired circuit to test performance and application for what it is being designed.
9. Understand and apply the functionalities of PLL to Frequency synthesizer, multiplier, FM, and AM demodulators

Unit I : OP-AMP Basics **6L**

Block diagram of OP-AMP, Explanations of each block, Differential Amplifier configurations, Differential amplifier analysis for dual-input balanced-output configurations using ‘r’ parameters, Need and types of level shifter, ideal parameters and practical parameters of OP-AMP and their comparison, current mirror circuits.

Unit II : OP-AMP IC Technology **6L**

Different manufacturing technology, features of each technology, types, symbol and ideal equivalent circuit of OP-AMP, frequency response, transient response, stability of OP-AMP, frequency compensation, Effect of temperature on parameters, Noise, Noise model of OP-AMP.

Unit III : Linear Applications of OP-AMP **6L**

Inverting and Non-inverting amplifier, voltage follower, voltage scaling, difference amplifier, Ideal integrator, errors in ideal integrator, practical integrator, frequency response of practical integrator, applications of integrator, Ideal differentiator, errors in ideal differentiator, practical differentiator, frequency response of practical differentiator, applications of differentiator, Requirements of Instrumentation amplifier, 3 OP-AMP Instrumentation amplifier, Instrumentation amplifier applications.

Unit IV : Non-linear Applications of OP-AMP **6L**

Comparator, characteristics of comparator, applications of comparator, Schmitt trigger (symmetrical/asymmetrical), Square wave generator, triangular wave generator, Problems in basic rectifier, Need of precision rectifier, Half wave , Full wave precision rectifiers, peak detectors, sample and hold circuits.

Unit V : Converters using OP-AMP **6L**

V-F and F-V converter, I-V and V-I converter, Current amplifier, DAC, types of DAC, characteristics, specifications, advantages and disadvantages of each type of DAC, ADC, types of ADC, characteristics, specifications, advantages and disadvantages of each type of ADC.

Unit VI : Special Purpose ICs **6L**

PLL types block diagram of PLL, function and types of each block, characteristics/parameters of PLL, and different applications of PLL.

Voltage Regulator: Block diagram of adjustable three terminal positive and negative regulators (317,337). Typical connection diagram, current boosting. Low drop out voltage regulators.

Text Books :

1. Ramakant A. Gaikwad, “Op Amps and Linear Integrated Circuits”, Pearson Education
2. Salivahanan and Kanchanabhaskaran, “Linear Integrated Circuits”, TMH

Reference Books :

1. George Clayton and Steve Winder, “Operational Amplifiers”, Newnes
2. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, TMH
3. Bali,”Linear Integrated Circuits”, Mc Graw Hill
4. Gray, Hurst, Lewise, Meyer, “Analysis & Design of Analog Integrated Circuits, Wiley Publications.

List of Experiments:

1 Measure op-amp parameters and compare with the specifications.

- Measure input bias current, input offset current and input offset voltage.
- Measure slew rate (LM/UA741C and LF356)
- Measure CMRR
- Compare the result with datasheet of corresponding Op Amp.

2 Design, build and test integrator (LF356).

- Design Integrator for given f_a.
- Verify practical and theoretical frequencies f_a and f_b.
- Observe output waveform at f_a and f_b for Sine and Square wave input.
- Plot frequency response for integrator.

3 Design, build and test differentiator (LF356).

- Design differentiator for given f_a.
- Verify practical and theoretical frequencies f_a and f_b.
- Observe output waveform at f_a and f_b for Sine and Square wave input.

- Plot frequency response for differentiator.

4 Design, build and test three Op-amp instrumentation amplifier for typical application (Ex: temperature measurement)

- Implement Wheatstone bridge and balance for null condition.
- Calibrate bridge for 0ºC and room temperature.
- Set gain of IA amplifier to calibrate circuit for variation in temperature.

Note: Any similar application using IA.

5 Design, build and test precision half & full wave rectifier.

- To understand the concept of super diode.
- To implement inverting and non-inverting half wave rectifier.
- To implement inverting and non-inverting full wave rectifier.
- Plot input and output waveforms.

6 Design, build and test Comparator and Schmitt trigger.

- Design of Schmitt trigger circuit for given specifications.
- Implementations of Schmitt trigger using Op-Amp (LF356).
- Without external reference voltage.
- With external reference voltage source.
- With clamped output.(using Zener diodes; without external reference voltage)
- Verification of effect of V_{ref} on output waveforms and hysteresis.
- Observe voltage waveforms and hysteresis.

Calculate UTP, LTP and hysteresis theoretically and practically.

7 Design, build and test Sample and hold circuit

- Design sample and hold circuit for given specifications.
- Implementation S &H using Op-amp(Any one 741,356 or LF 398)
- Plot original signal, S&H signal, and Capacitor droop.
- Observe the effect of increase in input frequency on sampled output.

8 Design, build and test PLL and any one application.

- Study PLL IC 565.

- Find the free running frequency.
- Find lock range and capture range.

9 2 bit DAC and 2 bit ADC.

A) Design and implement 2bit R-2R ladder DAC.
  - Measure and verify output voltage practically and theoretically.
  - Calculate resolution, step size and few more specification.

B) Design and implement 2bit flash type ADC.
  - Verify operation of comparators and priority encoder individually.
  - Calculate no.of comparator, resolution, full scale voltage range etc.

10 Design, build and test square & triangular wave generator.
- Design of Square wave generator for given specifications.
- Implementation of circuit using Op-Amp for different duty cycles (LF356).
- Verification of effect of slew rate on output waveforms.
- Observe voltage waveforms of output and timing capacitor.
- Calculate frequency of output waveform theoretically and practically.

Optional Experiments

1 Verify and understand **practically** virtual ground and virtual short concept in inverting and non inverting configuration.

2 Design and implement Wien bridge oscillator using Op-Amp.

3 Plot DC transfer characteristics of emitter coupled differential amplifier.

4 Study effect of emitter resistance and constant current source on figure of merit (CMRR) of emitter coupled differential amplifier.

5 Design and implement V-I converter.

6 Any experiment based on application of Op-Amp

Note:
- First 10 experiments are compulsory.
- Any additional experiment from optional list.