**Note:** **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

## DISCIPLINE SPECIFIC CORE COURSE – 8: Operational Amplifiers and Applications (INDSC3B)

**Credit distribution, Eligibility and Pre-requisites of the Course**

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| Operational Amplifiers and Applications (INDSC3B) | 04 | 03 | 0 | 01 | Course admission eligibility | Basics of Analog Electronics- BJT circuits |

### Learning Objectives

The Learning Objectives of this course are as follows:

- To provide understanding of DC and AC characteristics of operational amplifiers (op-amp)
- Design various filters and oscillators circuits using op-amps
- Study linear and non-linear applications of op-amp
- Design multivibrators and other circuits using op-amp.

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the DC and AC characteristics of operational amplifiers (op-amp) and its effect on output, significance of op-amp parameters, and compensation techniques
- Elucidate and design circuits to study linear and non-linear applications of op-amps and special application ICs
- Explain the working of signal generators using op-amp
- Explain and compare the working of multivibrators using general purpose op-amp

### SYLLABUS OF DSC- 8

**UNIT – I** **(11 hours)**

**Basic Operational Amplifier:** Concept of differential amplifiers (Dual input balanced and unbalanced output, Single input balanced and unbalanced output), constant current bias, current mirror, cascaded differential amplifier stages with concept of level translator, block diagram of an operational amplifier (IC 741).

**UNIT – II** **(12 hours)**

**Op-Amp parameters:** input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio.

**Op-Amp Circuits:** Open and closed loop configuration, Limitations of open loop, characteristics of ideal op-amp, frequency response of op-amp in open loop and closed loop. Non-Inverting & Inverting amplifiers, Summing & Difference amplifiers, Log & antilog amplifiers, Instrumentation Amplifier, Integrator & Differentiator circuit, Voltage to current converter, Current to voltage converter.

**UNIT – III** **(11 hours)**

**Comparators:** Basic comparator, Level detector, Schmitt Trigger. Voltage limiters, Signal **Generators:** Phase shift oscillator, Wein bridge oscillator, square wave generator, triangle wave generator, saw tooth wave generator, and Multivibrators using opamp.

**UNIT – IV** **(11 hours)**

**Signal conditioning circuits:** Sample and hold systems, Active filters: Low pass and high pass Butterworth filter (first and second order), Band pass filter, Band reject filter, and All pass filter.

**Practical component:** **(30 hours)**

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op-amp.
3. Designing of analog adder and subtractor circuit.
4. Designing of an integrator using op-amp for a given specification and study its frequency response.
5. Designing of a differentiator using op-amp for a given specification and study its frequency response.
6. Designing of a first order low-pass filter using op-amp and study its frequency response.
7. Designing of a first order high-pass filter using op-amp and study its frequency response.
8. Designing of a RC phase shift oscillator using op-amp.
9. Design an astable multivibrator using opamp.
10. Design a schmitt trigger circuit using op-amp and study its hysteresis loop.

**Essential/recommended readings**


1. R. A. Gayakwad, Op-Amps and Linear Integrated circuits, Pearson Education, 4th Edition, May 2015.
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, 6th Edition, Aug 2000, Pearson,
3. Pearson Education (2001).J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw-Hill, (2001).