B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING
SECOND YEAR SECOND SEMESTER – 2025

ANALOG INTEGRATED CIRCUITS

Time : Three hours **Full Marks : 100**

ALL MODULES ARE COMPULSORY.

Module – I (for CO #1) (8 Marks)

[CO1 : describe the salient features of analog integrated circuits and the fundamentals of Operational Amplifier.]

Q1(a) State the important functionalities of the four basic building blocks of an Op-Amp (4)

(b) The Op-Amp used in Fig. P1(b) has slew rate of 0.5V/μs. The input V_i is an ac sine wave of frequency 100 Hz. Find out the value of the maximum allowable input amplitude for which there will be no distortion in the output wave shape. (4)

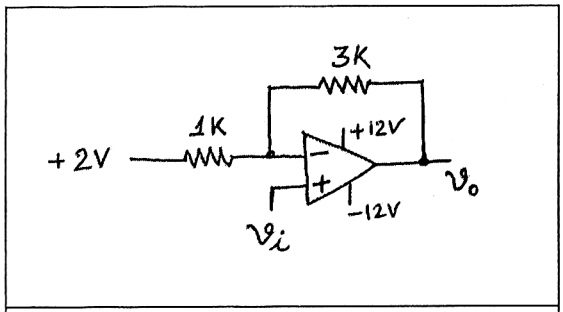

Fig. P1(b)

Module – II (for CO #2) (26 Marks)

[CO2 : construct and **analyze** various linear analog circuits, e.g. amplifiers, adder, instrumentation amplifiers, integrators, differentiators, etc.]

Q2 (a) For the circuit shown in Fig. P2(a), R = 1 kΩ, R_f = 5 kΩ and C = 0.1 μF. What is the dc gain of the circuit ? What will be the 3 dB cut-off frequency ? (2 +3)

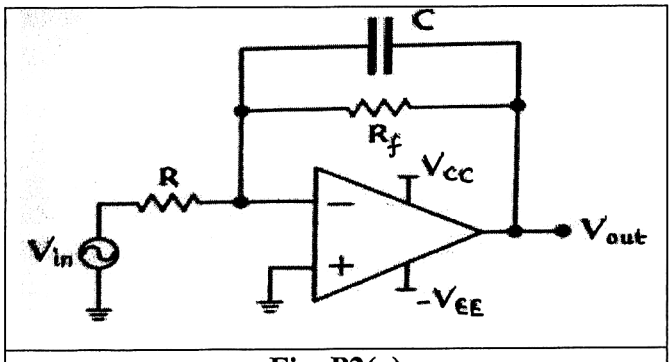

Fig. P2(a)

(b) For the circuit shown in Fig. P2(b), assume the Op-Amp is ideal. Find out the ratio V_{in}/I_{in}. (5)

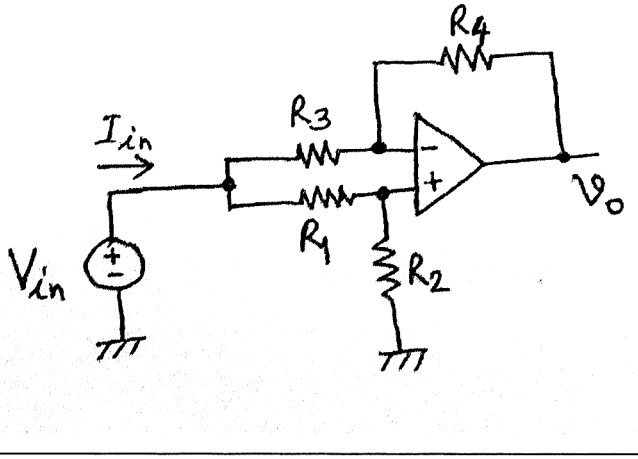

Fig. P2(b)

Q3. (a) What is GIC ? Explain how it can be used to realize an inductor ? (6 + 2)

(b) Find out the expression of the output voltage V_O for the circuit shown in Fig. P3(b). (8)

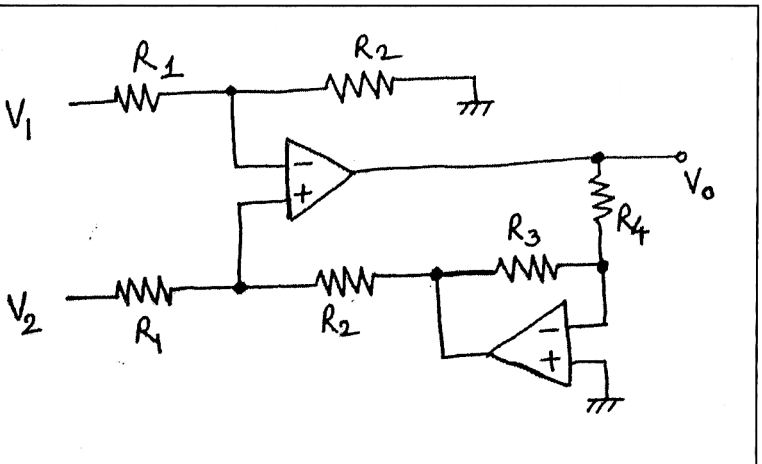

Fig. P3(b)

Module – III (for CO #3) (36 Marks)

[Answer Question No. 4 and ANY ONE from 5 and 6]

[CO3 : construct and analyze various nonlinear analog circuits, e.g. comparators with positive feedback, multivibrators, oscillators, other waveform generators, active filters, precision rectifiers, etc.]

Q4. (a) Using analog multipliers and operational amplifiers realize the following function.

$$f(x, y, z) = 4(x^2 y^{\frac{1}{3}})/z^2$$

Assume that the inputs x, y and z are available as positive voltage sources. (10)

(b) Explain how multipliers are helpful in amplitude modulation and demodulation. (6)

Q5. With the help of necessary circuit diagram and waveforms, explain the operation of a precision full wave rectifier. (20)

Q6. Realize the 4th order Butterworth polynomial in normalized s-domain. Use this polynomial to realize a 4th order Butterworth low-pass filter having 100Hz cutoff frequency and pass band gain 20. Show the final circuit diagram for the filter with all component values. Give the analysis of any assumed circuit block. (5 + 15)

Module – IV (for CO #4) (30 Marks)

[CO4 : describe the critical aspects of the limitations of practical Operational Amplifiers, study the timer circuits and DAC – ADC modules.]

Q7. With the help of the relevant portion of the internal block diagram of IC-555, explain the operation of a 555-timer based square wave generator. Use it to generate a square wave of frequency 200 Hz with 50%duty ratio. Draw necessary circuit diagrams and waveforms. (15)

Q8. (a) With the help of necessary block diagram, briefly explain the operation of a dual slope ADC. (10)

8. (b) A 4-bit weighted-resistor DAC with inputs b_3, b_2, b_1, and b_0 (MSB to LSB) is designed using an ideal opamp, as shown in Fig. P8(b). The switches are closed when the corresponding input bits are logic '1' and open otherwise. When the input $b_3b_2b_1b_0$ changes from 1110 to 1000, what will be the change in magnitude of the output voltage V_O ? (5)

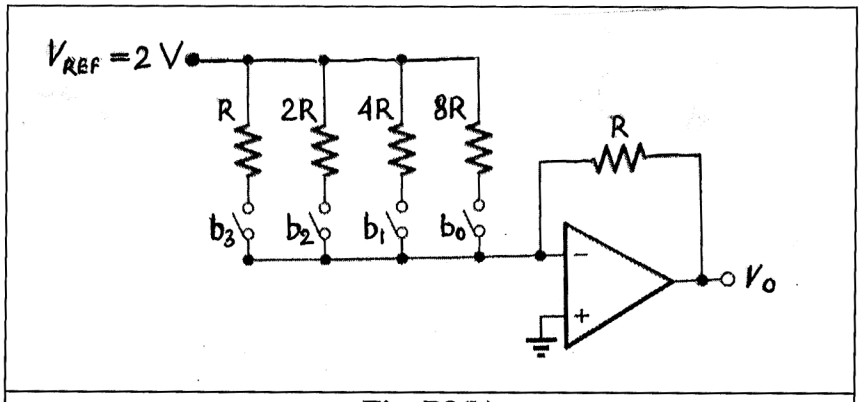

Fig. P8(b)