B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING
SECOND YEAR SECOND SEMESTER – 2023

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) Describe the functions of the four basic building blocks of Op-Amp. (4)

(b) State the conditions for which we cannot assume virtual short between the two input terminals of the Op-Amp used in the circuit shown in Fig. P1(b). The input V_{in} is an ac sine wave whose frequency can be varied. (4)

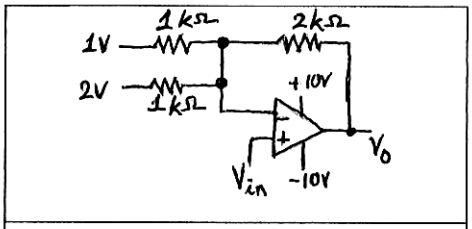

Fig. P1(b)

Module – II (for CO #2) (22 Marks)

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

Q2 (a) Find out the value of the input difference voltage experienced by the Op-Amp used in the circuit shown in Fig. P2(a). (4)

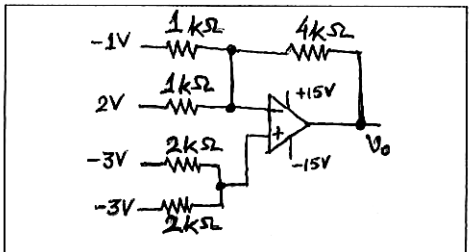

Fig. P2(a)

(b) For the circuit shown in Fig. P2(b), plot the transfer characteristics (V_O Vs. V_I). Assume ideal diode characteristics with zero forward resistance and 0.6V forward voltage drop. 20

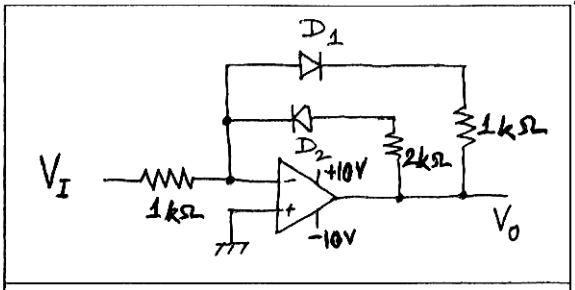

Fig. P2(b)

Q3 (a) For the circuit shown in Fig. P3(a), find out the expression for the input impedance, Z_{in}. What might be the use of this circuit ? (Assume both the Op-Amps to be operating in linear regions) (8+2)

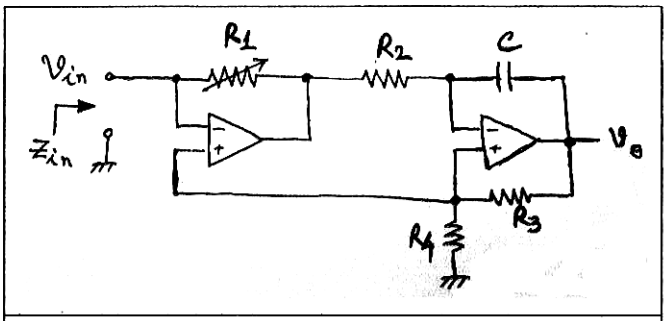

Fig. P3(a)

(b) Find out the differential input impedance of a single Op-Amp based difference amplifier. (3)

Module – III (for CO #3) (40Marks)

[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) For the circuit shown in Fig. P4(a), find out the value of R that gives a hysteresis width of 0.5V. (6)

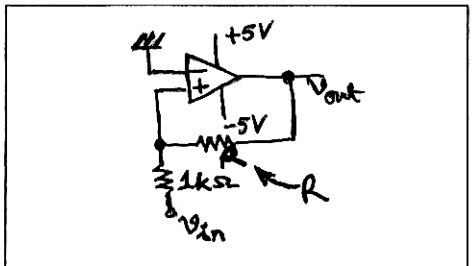

Fig. P4(a)

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

$$f(x,y,z) = \frac{4}{5}x^2y^{\frac{2}{3}} + x\sqrt{z/y}$$

Assume that the inputs x, y and z are available as positive voltage sources. (14)

Q5. Explain the operation of an Op-Amp based astable multivibrator. Draw necessary circuit diagrams and waveforms. Hence design a square-wave generator giving a square wave of frequency 50 Hz and 40% Duty Cycle. (15 + 5)

Q6. Realize the 6th order Butterworth polynomial in normalized s-domain. Use this polynomial to realize a 6th order Butterworth low-pass filter having 50Hz cutoff frequency and pass band gain 10. 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 variable duty cycle square wave generator generating a square wave frequency 100 Hz. Draw necessary circuit diagrams and waveforms. (20)

Q8 With the help of necessary circuit diagram and waveform, explain the operation of a single slope ADC. (10)

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