Department of Physics and Astronomy, National Institute of Technology Rourkela

End-semester Examination, Autumn 2023-2024

PH5006: Analog and Digital Electronics

Total marks: 50 **Time: 3 hours**

Note: Answer all questions

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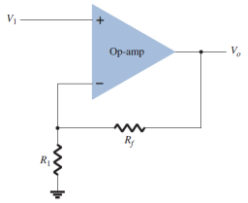
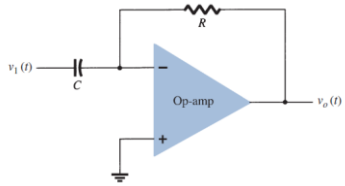
1. **(A)** Derive an expression for the voltage gain of the non-inverting amplifier. **[3]**

(B) Explain the virtual ground of an operational amplifier. **[2]**

(C) For the following circuit, calculate the input voltage, V_1 for V_0 = 12 V, R_1 = 100kΩ, Rf = 500 kΩ. **[2]**



(D) For the following differentiator circuit, calculate $v_o(t)$ for $v_1(t)$= 5Sin(ωt), R = 500 kΩ and C = 10μF. **[2]**

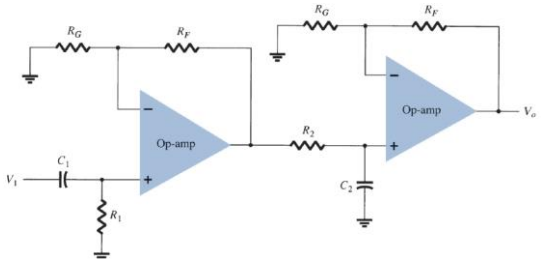


(E) Draw a circuit diagram for a voltage buffer amplifier. **[1]**

2. **(A)** Show the connection of three op-amp stages using an LM348 IC to provide outputs that are 10, 20, and 50 times larger than the input, use a feedback resistor of R_f = 500 kΩ in all stages. **[3]**

(B) Define the cut-off frequency of an active filter. Draw the circuit diagram and derive an expression for the cut-off frequency of low pass and high pass filter. **[1+4]**

(C) Calculate the cutoff frequencies of the band pass filter circuit as shown below with R_1 = 10 kΩ, R_2 = 15 kΩ, C_1 = 0.1μF, and C_2 = 0.002 μF. **[2]**



3. **(A)** Discuss the differences between the ordinary amplifier and the power amplifier. **[2]**

(B) Derive an expression for the efficiency of the transformer coupled class A power amplifier. How does it different from the direct coupled class A amplifier and the push-pull class B amplifier. **[4+2]**

(C) A transformer coupled class A amplifier supplies 3-Watt power to the speaker. If the supply voltage is 30 V and I_{CQ} is 200 mA, then find the efficiency of this amplifier. **[2]**

4. **(A)** How does the closed loop gain depend on the temperature of negative feedback amplifier. **[2]**

(B) For a negative feedback amplifier, if the gain of the amplifier is 500 and transfer function of feedback network is 0.6, then calculate the amount of feedback. **[2]**

(C) For negative feedback amplifier, the following parameters are given: open loop gain = 100, minimum and maximum frequency are 80 Hz and 60kHz respectively. If 2% of the output is returned to the input in opposition, then find the modified value of gain and the cut-off frequency. **[2]**

(D) Derive an expression of the closed loop gain of a series-shunt feedback amplifier. **[2]**

(E) What are the Barkhausen criteria for the oscillator? Draw the circuit diagram of a RC phase shift oscillator using BJT. **[2]**

5. **(A)** Convert the followings to the Octal and decimal number system

$(14.3)_{10}$ and $(13AB.D)_{16}$ **[2+2]**

(B) What is a truth table for NOR gates? Show a switching circuit using NOR gate. **[2]**

(C) Design the Ex-OR and Ex-NOR gates using NAND gate. **[2]**

(D) What are the differences between half adder and full adder? **[2]**