B.Sc. in CSE, 3rd Semester — December 23, 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Semester Final Examination — Winter Semester, A. Y. 2022-2023
Course No.: EEE 4383 — Time: 3 Hours
Course Title: Electronic Devices and Circuits — Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Explain the purpose of incorporating negative feedback in op-amp designs. **05 (CO1, PO1)**

   b) Using the ideal op-amp, design a circuit that will take $V_1$, $V_2$ & $V_3$ as inputs and will produce the following output: **08 (CO3, PO3)**

$$V_{out} = V_1 - 6\,dV_2/dt + 9\int V_3\,dt$$

   c) Determine $V_o$ in the op-amp circuit of Fig. 1(c) **12 (CO3, PO3)**

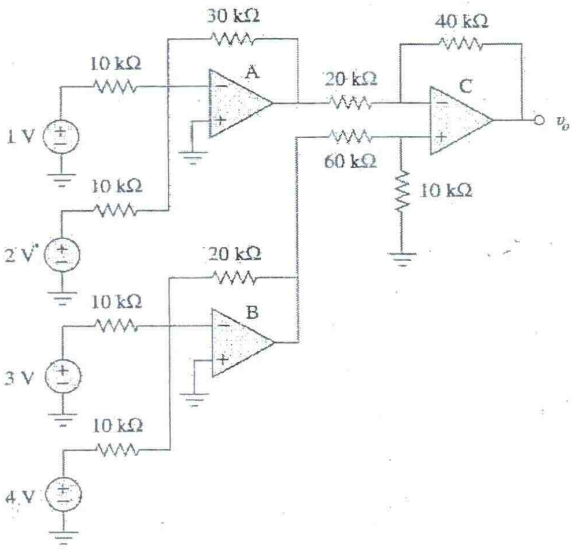


Fig. 1(c)

2. a) Write down the three most important characteristics of an ideal operational amplifier. **03 (CO1, PO1)**

   b) Determine $V_o$ in the op-amp circuit of Fig. 2(b) **07 (CO3, PO3)**

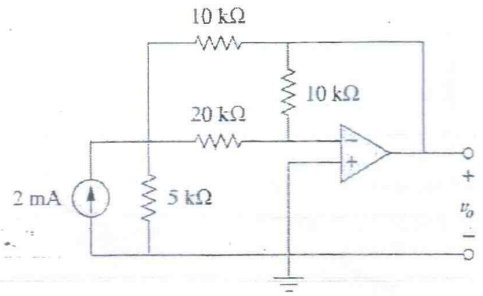


Fig. 2(b)

c) An op-amp integrator with R= 4 MΩ and C = 1 μF has the input waveform shown in fig. 2(c). Sketch the output waveform. (Show necessary calculation) **15 (CO3, PO3)**

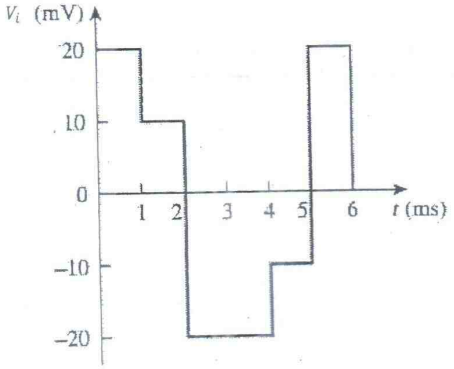


Fig. 2(c)

3. a) Write down at least five major differences between the Bipolar junction transistor (BJT) and Field effect transistor (FET). **05 (CO1, PO1)**

b) Sketch a CMOS inverter using a P-channel MOSFET and an N-channel MOSFET and explain how CMOS works as an inverter. **10 (CO3, PO3)**

c) Illustrate the basic construction of an N-channel JFET. For $V_{GS}$= 0V, briefly describe the working principle of N-channel JFET. Apply the proper biasing between drain and source and sketch the drain characteristics curve for different values of $V_{GS}$. **10 (CO1, PO1)**

4. a) Sketch an n-channel enhancement-type MOSFET with the proper biasing applied ($V_{DS}$>0 V, $V_{GS}$> $V_T$) and indicate the channel, the direction of electron flow, and the resulting depletion region. Briefly describe the basic operation of an enhancement-type MOSFET. **13 (CO1, PO1)**

b) Using the data provided in fig 4(b) and an average threshold voltage of $V_{GS(TH)}$= 3V, **12 (CO1, PO1)**

i. Determine the resulting value of *k* for the N-channel enhancement type MOSFET.

ii. Sketch the transfer characteristic curve. (Show necessary calculation)

| Characteristics | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Gate Threshold Voltage ($V_{DS}$ = 10 V, $I_D$ = 10 μA) | $V_{GS(TH)}$ | 1.0 | 5.0 | $V_{dc}$ |
| Drain-Source On-Voltage ($I_D$ = 2.0 mA, $V_{GS}$ = 10 V) | $V_{DS(on)}$ | - | 1.0 | V |
| On-State Drain Current ($V_{GS}$ = 10 V, $V_{DS}$ = 10 V) | $I_{D(on)}$ | 3.0 | - | mAdc |

Fig. 4(b)

5. a) Illustrate the effect of lower values of $V_{CC}$ on the load line and the Q point in output characteristics curve of BJT. **05 (CO1, PO1)**

b) Analyze the circuit using small signal $r_e$ model for the common emitter configuration given in Fig. 5(b) and find the following parameters. **20 (CO2, PO2)**

i. Determine $r_e$

ii. Calculate $Z_i$ and $Z_o$.

iii. Find $A_v$.

iv. Repeat parts (ii) and (iii) with $r_o = 25\ k\Omega$.

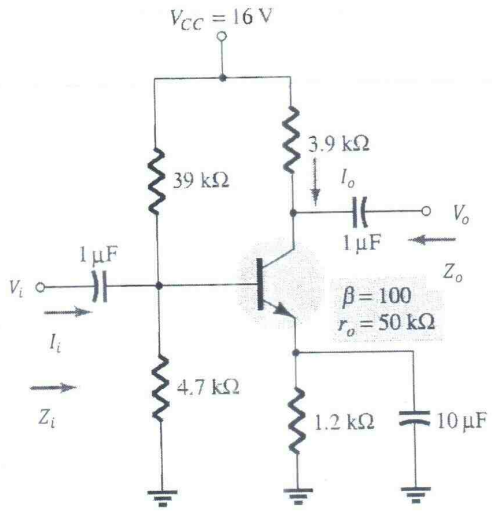


Fig. 5(b)

6. a) Sketch Output Voltage ($V_o$) for the given network shown in figure 6(a). Also, show the necessary calculation. **12 (CO2, PO2)**

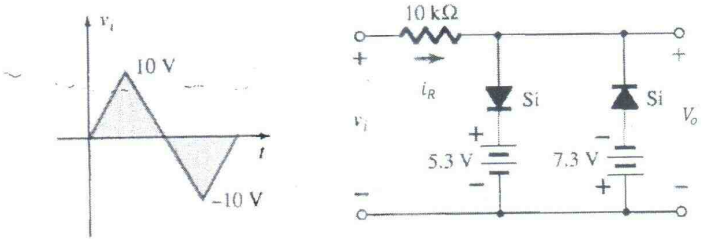


Fig. 6(a)

b) For the network of Fig. 6(b2): **13 (CO2, PO2)**

i. Calculate 5τ

ii. Compare 5τ to half the period of the signal

iii. Sketch $V_o$ (show necessary calculation)

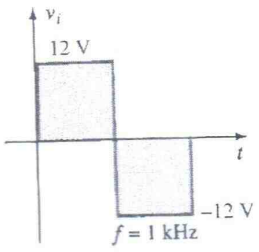


Fig. 6(b1)

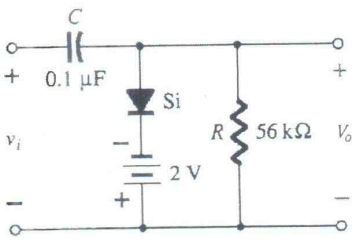


Fig. 6(b2)