

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

Semester Final Examination
Course No.: EEE 4383
Course Title: Electronic Devices and Circuits

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
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.

1. a) Write down the three most important characteristics of an ideal operational amplifier. 06
(CO1, PO1)
- b) Calculate V_0 and i_0 in the Op-amp circuit of fig. 1(b). 10
(CO3, PO3)

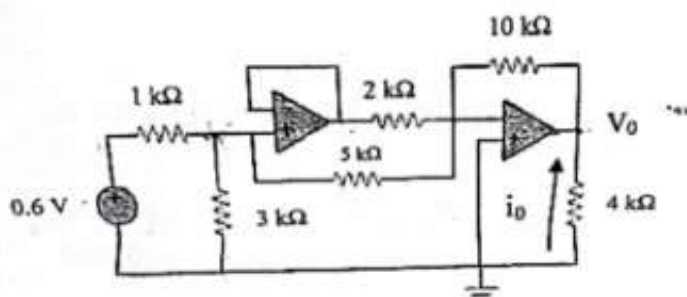


Fig. 1(b)

- c) 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: 09
(CO3, PO3)
- $$V_{out} = 5V_1 - 10 \frac{dV_2}{dt} + 2 \int V_3 dt$$
2. a) Write down the significant difference between the construction of an enhancement type MOSFET and a depletion type MOSFET. 04
(CO1, PO1)
- b) 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. 15
(CO1, PO1)
- c) Sketch the transfer characteristics for an n-channel depletion-type MOSFET with $I_{DSS} = 10$ mA and $V_P = -4$ V. 06
(CO1, PO1)
3. a) Write down at least five applications of UJT. 05
(CO1, PO1)
- b) Sketch UJT static emitter characteristic curve with proper labeling and explain its three operating regions. 12
(CO1, PO1)

08
(CO3,
PO3)

- c) For a unijunction transistor with $V_{BB} = 20V$, $\eta = 0.65$, $R_{B1} = 2k\Omega$ ($I_E = 0$), and $V_D = 0.7V$, determine:

- R_{B2}
- R_{BB}
- V_{RB1}
- V_P

4. a) Write down at least five major differences between the Bipolar junction transistor (BJT) and Field effect transistor (FET).

05
(CO1,
PO1)

- b) Design 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 a P-channel JFET. For $V_{GS} = 0V$, briefly describe the working principle of P-channel JFET. Apply the proper biasing between drain and source and sketch the drain characteristics curve for different values of V_{GS} .

10
(CO2,
PO2)

5. a) Sketch the effect of an increasing level of R_c on the load line and the Q point in the output characteristics curve of BJT.

05
(CO1,
PO1)

- b) Explain three types of equivalent circuits of a diode and sketch their corresponding characteristics.

06
(CO1,
PO1)

- c) Analyze the circuit using small signal r_e model of fig. 5(c) and find the following parameters.

14
(CO2,
PO2)

- Calculate I_B , I_C , and r_e .
- Determine Z_i and Z_o .
- Calculate A_v .
- Determine the effect of $r_o = 30k\Omega$ on A_v .

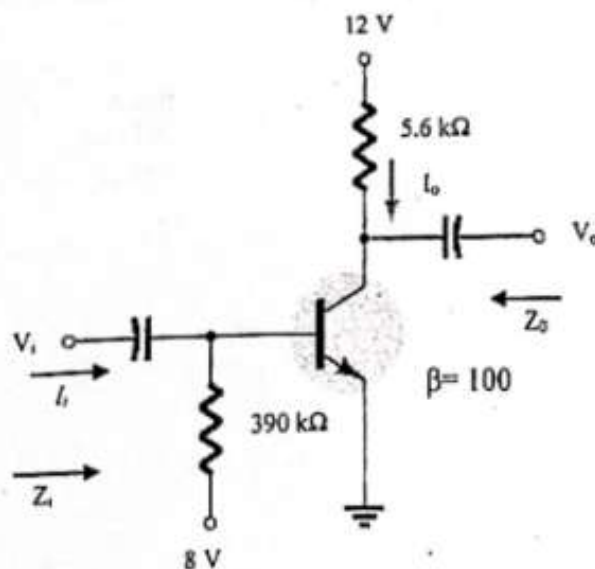


Fig. 5(c)

6. a) Sketch the output voltage wave shape (V_o) of fig. 6(a) and show the necessary calculation.

05
(CO1,
PO1)

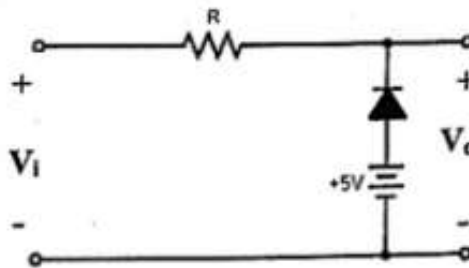
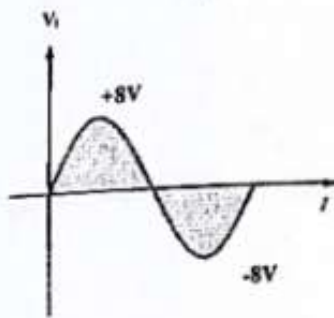


Fig. 6(a)

- b) Write down the different modes of operation of BJT and the working principle of BJT for common emitter configuration.

10
(CO1,
PO1)

- c) For the emitter-bias network of fig. 6(c), determine

10
(CO2,
PO2)

- i. I_B
- ii. I_C
- iii. V_{CE}
- iv. V_C
- v. V_E
- vi. V_B
- vii. V_{BC}

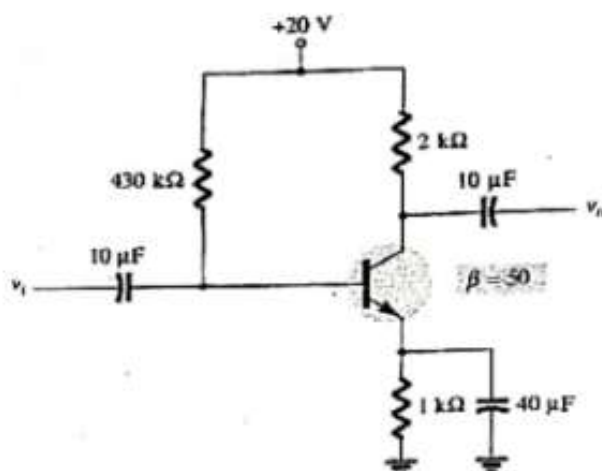


Fig. 6(c)

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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.

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)
- $$V_{out} = V_1 - 6 \frac{dV_2}{dt} + 9 \int V_3 dt$$
- c) Determine V_o in the op-amp circuit of Fig. 1(c) 12
(CO3, PO3)

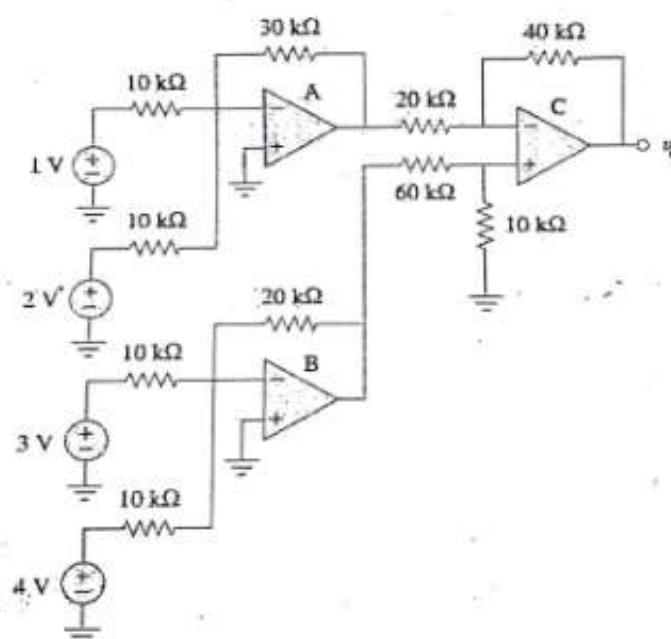


Fig. 1(c)

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)

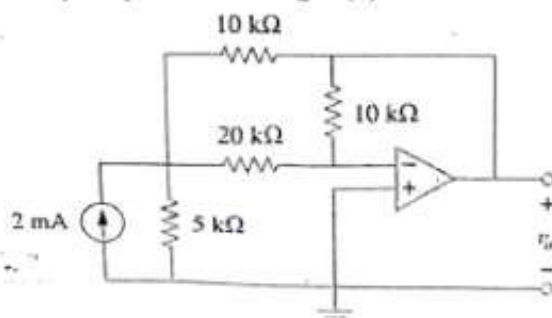


Fig. 2(b)

- c) An op-amp integrator with $R = 4 \text{ M}\Omega$ and $C = 1 \mu\text{F}$ has the input waveform shown in fig. 2(c). Sketch the output waveform. (Show necessary calculation)

15
(CO3,
PO3)

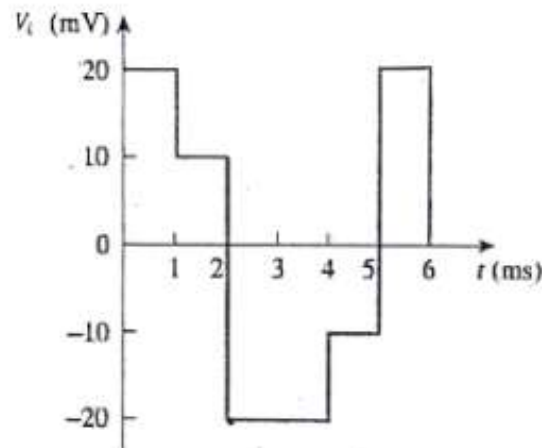


Fig. 2(c)

3. a) Write down at least five major differences between the Bipolar junction transistor (BJT) and Field effect transistor (FET).
b) Sketch a CMOS inverter using a P-channel MOSFET and an N-channel MOSFET and explain how CMOS works as an inverter.
c) Illustrate the basic construction of an N-channel JFET. For $V_{GS} = 0\text{V}$, 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} .
4. a) Sketch an n-channel enhancement-type MOSFET with the proper biasing applied ($V_{DS} > 0\text{ V}$, $V_{GS} > V_T$) and indicate the channel, the direction of electron flow, and the resulting depletion region. Briefly describe the basic operation of an enhancement-type MOSFET.
b) Using the data provided in fig 4(b) and an average threshold voltage of $V_{GS(TH)} = 3\text{ V}$,
- Determine the resulting value of k for the N-channel enhancement type MOSFET.
 - Sketch the transfer characteristic curve. (Show necessary calculation)

05
(CO1,
PO1)
10
(CO3,
PO3)
10
(CO1,
PO1)
13
(CO1,
PO1)
12
(CO1,
PO1)

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

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.
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.
- Determine r_e
 - Calculate Z_i and Z_o .

05
(CO1,
PO1)
20
(CO2,
PO2)

- iii. Find A_v .
- iv. Repeat parts (ii) and (iii) with $r_o = 25 \text{ k}\Omega$.

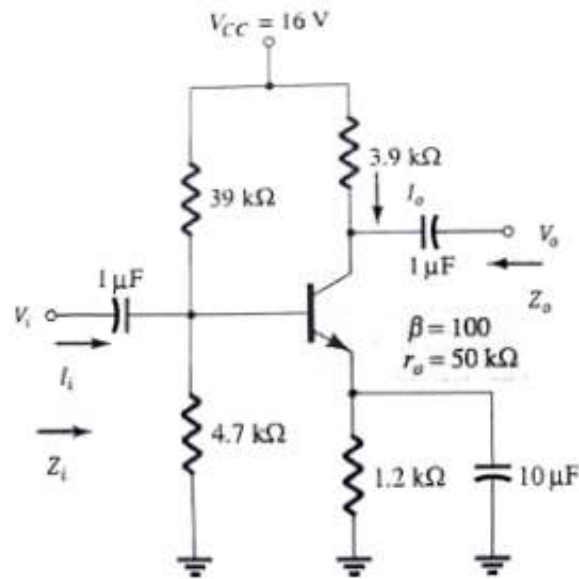


Fig. 5(b)

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

12
(CO2,
PO2)

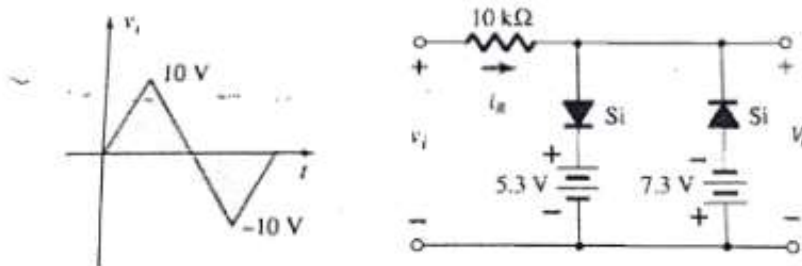


Fig. 6(a)

- b) For the network of Fig. 6(b2):
- i. Calculate 5τ
 - ii. Compare 5τ to half the period of the signal
 - iii. Sketch V_o (show necessary calculation)

13
(CO2,
PO2)

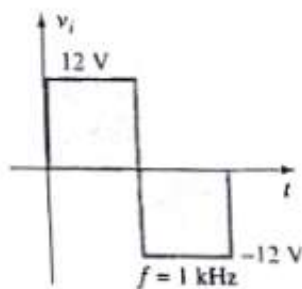


Fig. 6(b1)

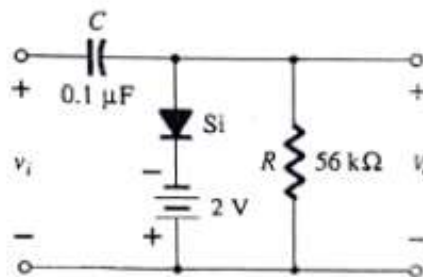


Fig. 6(b2)