UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(TAKE HOME)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	ANALOG ELECTRONICS
COURSE CODE	:	BEV 10503
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JULY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS **OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) *Bipolar junction transistor (BJT) has three separately doped regions and contains two* pn junctions. Differentiate between operation of a BJT as a switching and amplifying device.

(4 marks)

(b) ***Figure Q1(b)** shows a DC biasing circuit for BJT. Establishing the correct operation* point requires the selection of bias resistor (R_B) and collector resistor (R_C) to provide the appropriate input current and output voltage conditions. Given four set of resistor values of 75 kΩ, 150 kΩ, 1 kΩ, and 2 kΩ. Identify the suitable resistor value for R_B and R_C in the BJT circuit to be biased in saturation region by setting V_{CC} = 12 V and $\beta = 100$.

(4 marks)

(c) You are given a task to design a BJT amplifier circuit using a common emitter configuration with an emitter resistance as shown in **Figure Q1(c)**. The BJT amplifier must produce a voltage gain of 3. Set the Q-point parameters to be V_{CEQ} = 6 V, V_{BE} = 0.7 V, I_C = 3 mA and $\beta = 100$.

(i) As the power supply voltage, V_{CC} is not specified, select the value of V_{CC} so that the BJT work as an amplifier device.

(2 marks)

(ii) Given that the voltage gain, $A_v = R_C/R_E$, determine the commercial value of R_C and R_E at the output circuit.

(3 marks)

(iii) If $R_B = 0.1(\beta+1)R_E$ for $R_B << (\beta+1)R_E$, determine the value of V_{BB} at the input circuit.

(3 marks)

(iv) Analyze the commercial values for input resistance of R_1 and R_2.

(4 marks)

Q2 (a) **Figure Q2(a)** shows a Field Effect Transistor (FET) circuit. Assume that V_{TN} = 1 V, K_n = 1.5 mA/V^2 and $\lambda = 0$.

(i) Sketch the output characteristics (I_D versus V_{DS}) for $0 \leq V_{DS} \leq 5$ V. Label and add numerical values on each of the axis.

(2 marks)

(ii) Calculate and indicate the $V_{DS(sat)}$ on the plot. Clearly indicate the saturation and Ohmic regions as well as the saturation currents, $I_{D(sat)}$.

(3 marks)

(b) ***Figure Q2(b)** shows an amplifier circuit using enhancement mode Metal-Oxide-Semiconductor FET (MOSFET). Assume that $V_{TN} = 2$ V, $K_n = 93$ mA/V^2 and $\lambda = 0$.*

(i) Determine the voltage between gate and source, V_{GS}.

(4 marks)

(ii) Determine the drain current, I_D.

(2 marks)

(iii) Calculate the transconductance, g_m.

(2 marks)

(iv) Draw the AC equivalent circuit.

(4 marks)

(v) Determine the midband voltage gain of the circuit.

(3 marks)

Q3 (a) Frequency response of an amplifier refers to the frequency range in which the amplifier will operate with negligible effects from capacitors and device internal capacitance. BJT and FET amplifiers react differently at low and high frequency resulting in different frequency response.

(i) Explain why FET has higher bandwidth than BJT.

(6 marks)

(ii) List all capacitors that affected in low and high frequency responses for both BJT and FET amplifiers using a comparison table.

(6 marks)

(b) The common emitter BJT circuit in **Figure Q3(b)** has the following parameters:

$V_{CC} = 20$ V	$R_S = 1$ kΩ	$R_1 = 40$ kΩ	$R_2 = 10$ kΩ	$R_E = 2$ kΩ
$R_C = 4$ kΩ	$R_L = 2.2$ kΩ	$r_o = \infty$	$\beta = 100$	
$C_S = 10$ μF	$C_E = 20$ μF	$C_C = 1$ μF		
$C_{be} = 36$ pF	$C_{bc} = 4$ pF	$C_{ce} = 1$ pF	$C_{Wi} = 6$ pF	$C_{Wo} = 8$ pF

DC analysis on this circuit shows that $I_E = 1.65$ mA and $r_e = 15.76$ Ω, while AC analysis shows that voltage gain, $A_v = -90$.

(i) Analyze the dominant and lower cut-off frequency, f_L.

(4 marks)

(ii) Determine the high cut-off frequencies, f_{Hi} and f_{Ho}.

(4 marks)

Q4 (a) ***Figure Q4(a)*** *shows a power amplifier circuit with* V_{CC} *= 15 V,* R_L *= 15 Ω and* $V_{CE}(sat) = 0$ V.

(i) Sketch the DC load line for the output characteristics. Label and add numerical values on each of the axis.

(3 marks)

(ii) Indicate class of the power amplifier.

(1 mark)

(iii) Identify the I_{CQ} by assuming that the Q-point is at the center of the DC load line.

(2 marks)

(iv) Consider $i_c(t) = I_{CQ} + I_{CP}\sin(\omega t)$ and I_{CP} = 0.5 A, calculate the power driven from the source, P_{CC}.

(2 marks)

(v) Calculate the DC and AC power dissipated over the load, $P_{L(DC)}$ and $P_{L(AC)}$, respectively.

(4 marks)

(vi) Calculate the power dissipated over the transistor, P_T.

(2 marks)

(vii) Calculate the power efficiency, η.

(2 marks)

(b) **Figure Q4(b)** shows a simplified schematic of an IC audio amplifier. Identify **FOUR (4)** compound configurations in the amplifier circuit.

(4 marks)

- END OF QUESTIONS -

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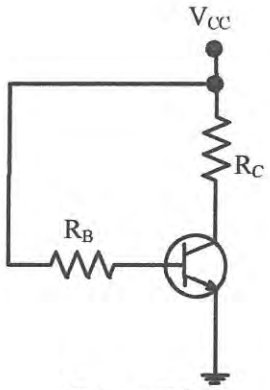

Figure Q1(b)

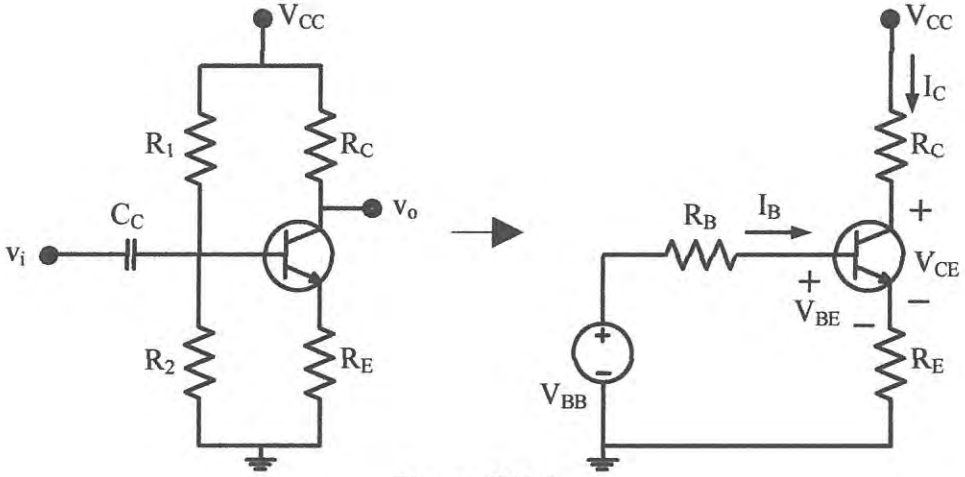

Figure Q1(c)

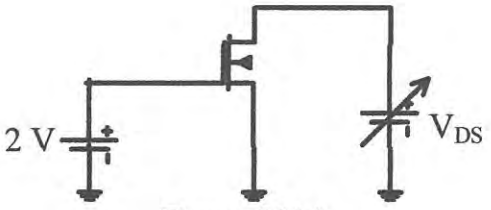

Figure Q2(a)

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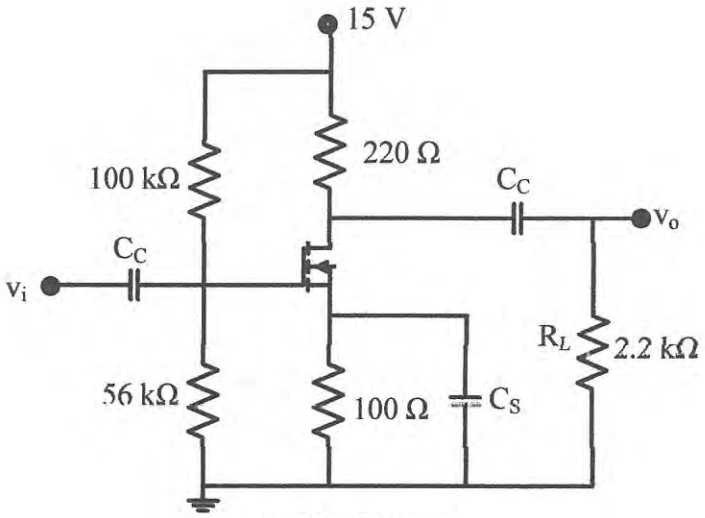

Figure Q2(b)

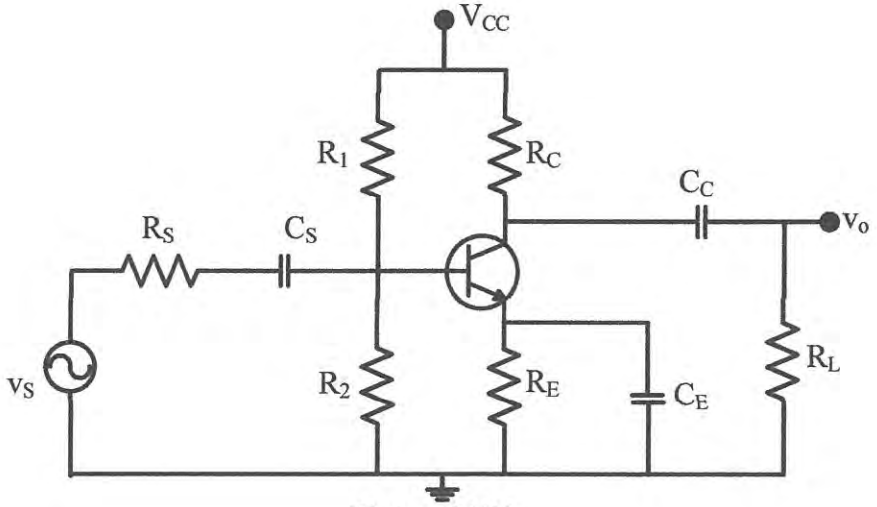

Figure Q3(b)

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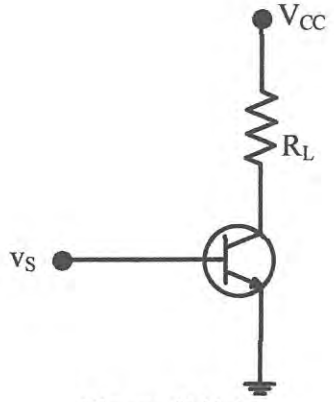

Figure Q4(a)

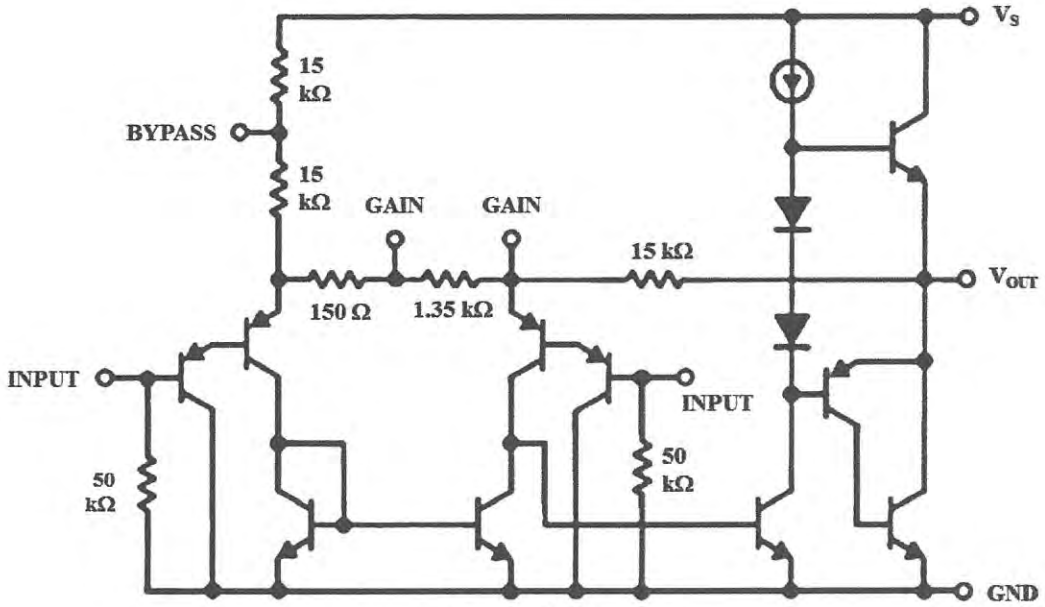

Figure Q4(b)