UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	ANALOG ELECTRONICS
COURSE CODE	:	BEL 10203
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) **Figure Q1(a)** shows a schematic of a silicon BJT, where i_E, i_C, and i_B are emitter current, collector current, and base current respectively, with the arrows showing the current directions. The three regions A, B, and C in the schematics have different dopant concentrations.

(i) Name the type of carrier represented by carrier 1 in the diagram.
(2 marks)

(ii) From part **Q1(a)(i)**, state the dopant type (donor or acceptor) with the material for region B.
(3 marks)

(iii) Is it an NPN or PNP transistor? Explain your answer.
(3 marks)

(iv) State what the dashed arrow in the diagram indicates?
(2 marks)

(v) If the silicon in region B is replaced with another semiconductor with a larger bandgap (e.g., gallium arsenide), and the emitter current is held constant, what do you expect to happen to i_B?
(3 marks)

(vi) What is the difference between a semiconductor, an insulator, and a metal? Discuss the energy band diagram when describing the difference.
(5 marks)

(vii) State **TWO (2)** basis how you can differentiate a semiconductor from other solids?
(2 marks)

(viii) Explain whether the following conditions can be achieved for intrinsic semiconductor. Justify your answers.
1) Number of holes > number of electrons
2) Number of holes < number of electrons.
(5 marks)

Q2 (a) **Figure Q2(a)** shows an output-stage of an amplifier. The BJT has $\beta = \alpha$ and $V_{BE} = 0.7$ V when it is **ON**.

(i) Identify the architecture of the circuit, whether common emitter or common collector or common base.

(2 marks)

(ii) Calculate R_L so that its dissipated power is 0.3 W.

(5 marks)

(iii) Identify its class of operation whether class A or class AB or class C.

(5 marks)

(iv) Determine V_{out} and i_E. Redraw and plot the graphs as in **Figure Q2(b).**

(8 marks)

(v) What is the efficiency of the output stage under these conditions?

(5 marks)

Q3 (a) Sketch the transfer characteristics curve of a JFET, D – MOSFET and E – MOSFET and describe the differences between them.

(6 marks)

(b) FET transistor circuit has the parameters: V_{DD} = 20 V, $R_{G1(UPPER)}$ = 10 MΩ, $R_{G2(LOWER)}$ = 4.7 MΩ, R_D = 200Ω, RR_L = 500Ω, C_g= 1μF, C_d= 10μF and C_l = 22 μF. The FET transistor has V_{TH} = 4 V and $I_{D(on)}$ = 14 mA at V_{GS} = 6 V.

(i) Determine the I_{DQ} and V_{GSQ}.

(4 marks)

(ii) Draw the small-signal equivalent circuit of the circuit from the answer in **Q3(b)(i)**.

(3 marks)

(iii) Calculate the input impedance, Z_{in}, the voltage gain, A_V, the current gain, A_I and the power gain, A_P of the circuit.

(10 marks)

(iv) Deduce the effect to the voltage gain, A_V if an additional resistor is connected between source terminal and ground.

(2 marks)

Q4 (a) **Figure Q4(a)** is an amplifier circuit that only amplifies the signals of specified frequencies. Assume that BJT transistor has an infinite value of AC collector resistance, r_o (or r_c);

(i) Calculate the mid-band gain of this amplifier?
(5 marks)

(ii) Draw the low frequency AC equivalent circuit.
(2 marks)

(iii) Determine the dominant low cut-off frequency.
(7 marks)

(iv) Draw the high frequency AC equivalent circuit.
(2 marks)

(v) Determine the dominant high cut-off frequency.
(6 marks)

(vi) Sketch the normalized magnitude response of this filter. Clearly indicate the break frequencies and bandwidth in the diagram.
(3 marks)

Q5 (a) Name two parameters of an E-MOSFET that are not specified for D-MOSFET
(2 marks)

(b) For the multistage amplifier shown in **Figure Q5(b),** assume infinite ac resistance for r_d and r_o.

(i) Determine the dc bias voltage and current for each stage. Assume V_{BE}=0.7V.
(9 marks)

(ii) Draw the midband AC equivalent circuit and determine the voltage gain for each stage.
(10 marks)

(iii) Determine the overall midband voltage gain of the amplifier.
(2 marks)

(iv) Describe the purpose of coupling capacitor in the circuit.
(2 marks)

-END OF QUESTIONS -

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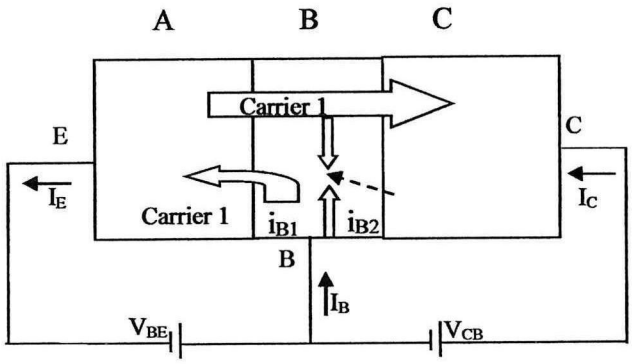

Figure Q1(a)

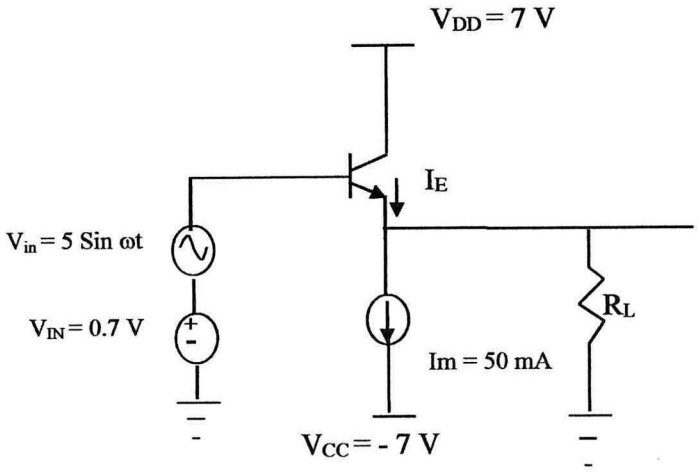

Figure Q2(a)

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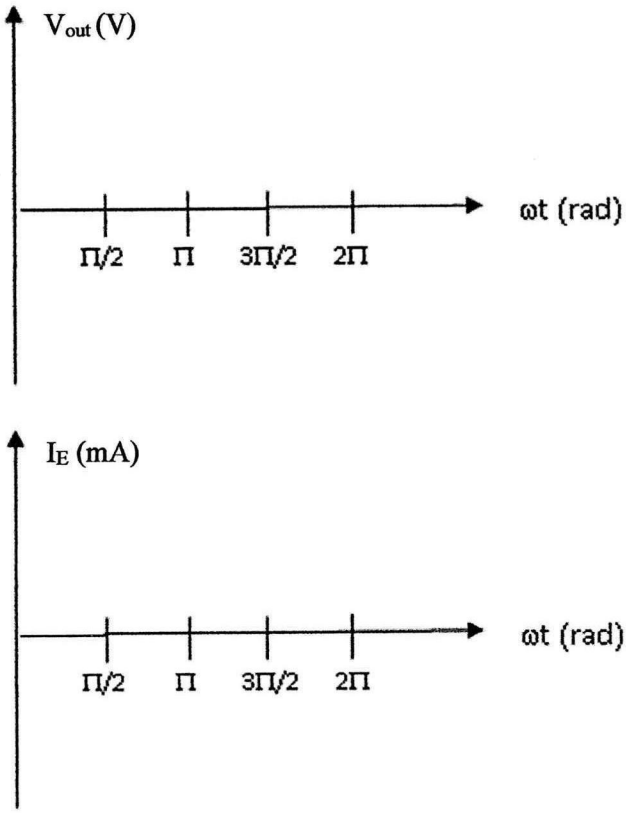

Figure Q2(b)

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C_{wi} = 8 pF C_{bc} = 5 pF
C_{wo} = 13 pF C_{be} = 22 pF
C_{ce} = 12 pF

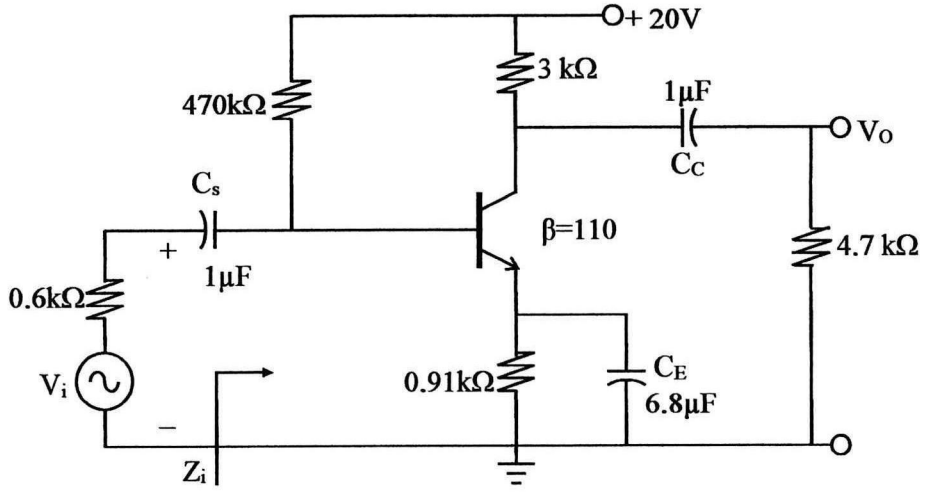

Figure Q4(a)

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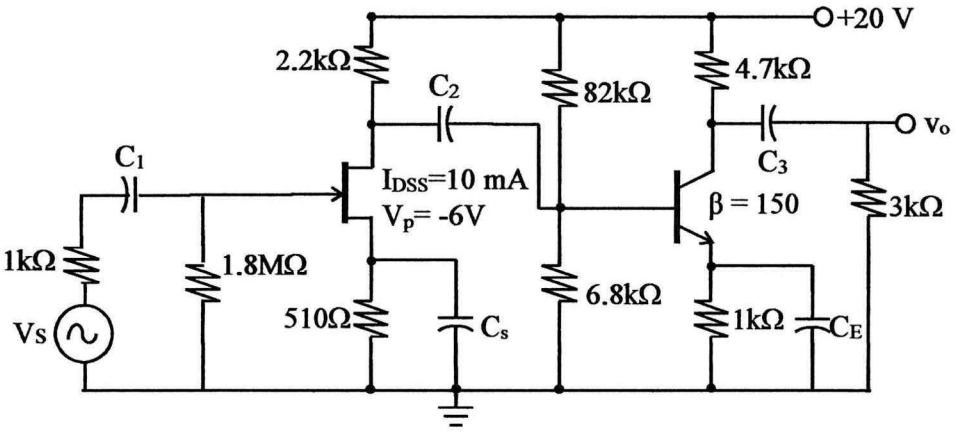

Figure Q5(b)