Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	SEMICONDUCTOR
COURSE CODE	:	BWC 30203
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	2 HOUR 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Sketch related band diagrams to differentiate between conductor, semiconductor and insulator.

(7 marks)

(b) (i) Define the epitaxial growth of semiconductor crystal?

(2 marks)

(ii) By using a simple diagram with labels, explain the gallium nitride (GaN) semiconductor growth via hydride vapor phase epitaxy (HVPE) method.

(11 marks)

Q2 (a) There are two collision or scattering mechanisms that dominate in a semiconductor and affect the carrier mobility which are phonon scattering and ionized impurity scattering.

(i) Explain the phonon scattering mechanism.

(6 marks)

(ii) Explain the ionized impurity scattering mechanism.

(6 marks)

(b) (i) Sketch a simple diagram of the distribution of surface states within the forbidden bandgap.

(3 marks)

(ii) By considering the boundary conditions of a semiconductor and the adjacent medium, justify the existence of surface states.

(5 marks)

Q3 (a) (i) Sketch the band diagram of a silicon p-n junction by indicating the valence band, the conduction band, the Fermi energy, and the built-in potential, V_{bi}. Assume that no voltage is applied across the junction.

(6 marks)

(ii) In the diagram sketched in the **Q3(a)(i)**, indicate the area of depletion region.

(2 marks)

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(b) Explain what the diffusion current is and which way it is flowing for forward bias and reverse bias.

(6 marks)

(c) The doping concentration for Si is $N_d = 1 \times 10^{16}$ cm^{-3} and $N_a = 3 \times 10^{16}$ cm^{-3}, for donor and acceptor respectively. At 300 K, calculate the concentration of holes on the p-side and the concentration of holes (minority carriers) on the n-side.
(For silicon, $n_i = 1.5 \times 10^{10}$ cm^{-3})

(6 marks)

Q4 (a) **Figure Q4(a)** shows an n-p-n transistor. Determine the direction of the biased current for the

(i) the emitter, and
(ii) the collector.

(4 marks)

(b) With the help of a circuit diagram, explain the action of an n-p-n transistor.

(6 marks)

(c) In a transistor, when the base current, I_B is changed by 30 μA, this will result in a change of 0.03 V in base to emitter voltage, V_{BE} and a change of 3 mA in the collector current, I_C. Calculate

(i) current gain, β_{ac}

(3 marks)

(ii) transconductance, g_m,

(2 marks)

(iii) If this transistor is used as an amplifier with the load resistance, R_L of 7.5 kΩ, calculate the voltage gain of the amplifier.

(5 marks)

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Q5 (a) Consider a metal-semiconductor junction, draw the band-diagram of the Schottky diode with no bias applied for

(i) n-type semiconductor.
(ii) p-type semiconductor.

(6 marks)

(iii) Explain how work function of metal and semiconductor affect the formation of Schottky diode.

(4 marks)

(iv) Sketch the I-V characteristics of the Schottky Diode in forward biased and reverse biased condition.

(4 marks)

(b) (i) Define Ohmic contact.

(2 marks)

(ii) List out the methods to make ohmic contacts.

(4 marks)

- END OF QUESTIONS –

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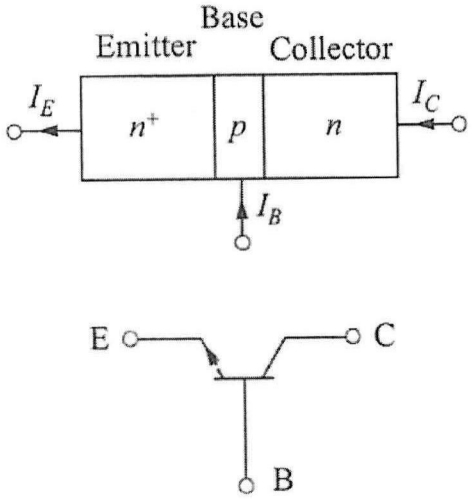

Figure Q4(a)

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