UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	SEMICONDUCTOR MATERIAL ANALYSIS
COURSE CODE	:	BED 40702
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JUNE/JULY 2018
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER THREE (3) QUESTIONS ONLY

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

Q1 a) Using the concept of band diagram, explain the difference between metals, semiconductors and insulators.

(10 marks)

b) Give **TWO (2)** kinds of excitation mechanism that can cause an electron to make a transition from the top of valence band to the bottom of conduction band.

(3 marks)

c) A Ge bar 0.1 cm long and 100 μm^2 in cross sectional area is doped with 10^{17} cm^{-3} antimony. Find the current at 300 K with 10 V applied between the two ends. (mobility of electrons in Ge = 3 x 10^3 cm^2 $V^{-1}s^{-1}$).

(7 marks)

Q2 (a) Determine the amount (in grams) of boron (B) that, substitutionally incorporated into 1 kg of germanium (Ge), will establish a charge carrier density of 3.091 x $10^{17}/cm^3$.

(6 marks)

(b) Draw a schematic energy band diagram for this material, and label all critical features.

(4 marks)

(c) For an intrinsic semiconductor, the electron and hole concentrations are equal and the intrinsic concentration is

$$n_i = (N_c N_v)^{1/2} e^{-Eg/2kT}$$

where E_g is energy gap, N_c and N_v are the effective density of states in the conduction and valence band respectively. With reference to the graph in **Figure Q2 (c)** calculate the band gap of Si.
(Boltzman Constant k = 8.62 x 10^{-5} eV/K)

(Hint : the slope cannot be measured directly from the plot; take values from two points on the plot and take the natural log for the solution).

(10 marks)

Q3 (a) Using the free electron theory, derive the relation showing Ohm's law, that is

$$j \alpha \sigma$$

(where j is the current density and σ is the conductivity). Hence show the relation between σ and mobility μ.

(8 marks)

(b) A megawatt generator is needed to power a magnetic cyclotron system. It requires a current of 2000 A through a copper cable, 150 m long and 1 cm in diameter. If the electron density and resistivity ρ, of copper is 8.45×10^{22} cm^{-3} and 1.7×10^{-6} Ωcm respectively, find the following:

(i) the current density j that flows in the wire

(3 marks)

(ii) the mobility μ of the conduction electrons

(3 marks)

(iii) the drift velocity of the electrons

(3 marks)

(iv) the power loss in the cable

(3 marks)

Q4 (a) Explain the reason why Si appears black and shiny GaP appears yellow.

(4 marks)

(b) Explain the meaning of photoconductivity in a semiconductor.

(3 marks)

(c) **Figure Q4** shows the absorption coefficients of a few typical semiconductors as a function of photon energy. Taking the graph for x-Si and GaAs, determine which curve belong to the direct and which one belong to the indirect semiconductor. Explain your answer.

(6 marks)

(d) From **Figure Q4**, determine at what wavelength does the absorption edge start for both of the semiconductor materials.

(4 marks)

(e) List **THREE (3)** things that is experienced by the photon during absorption process in the semiconductor.

(3 marks)

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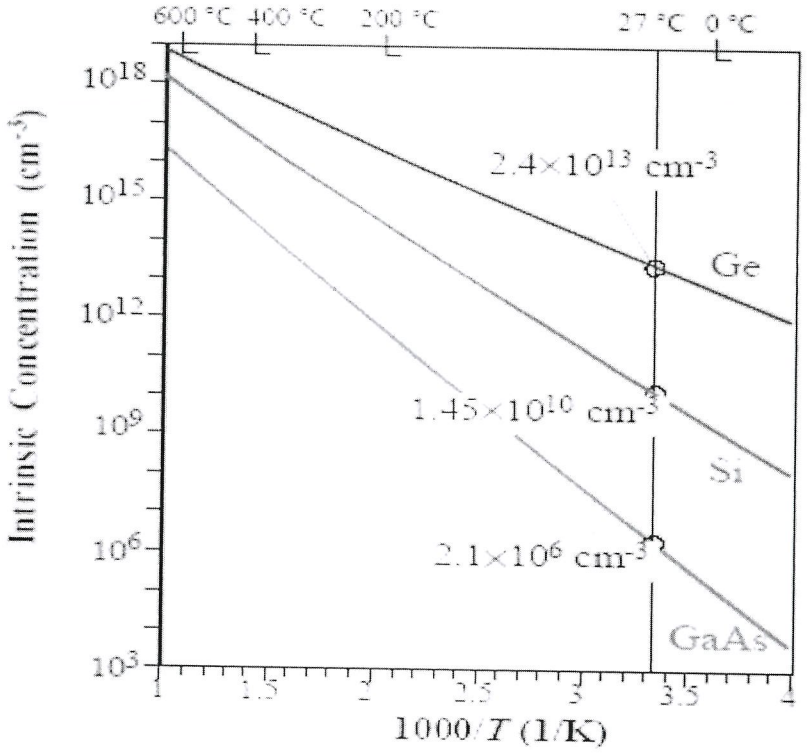

Figure Q2 (c)

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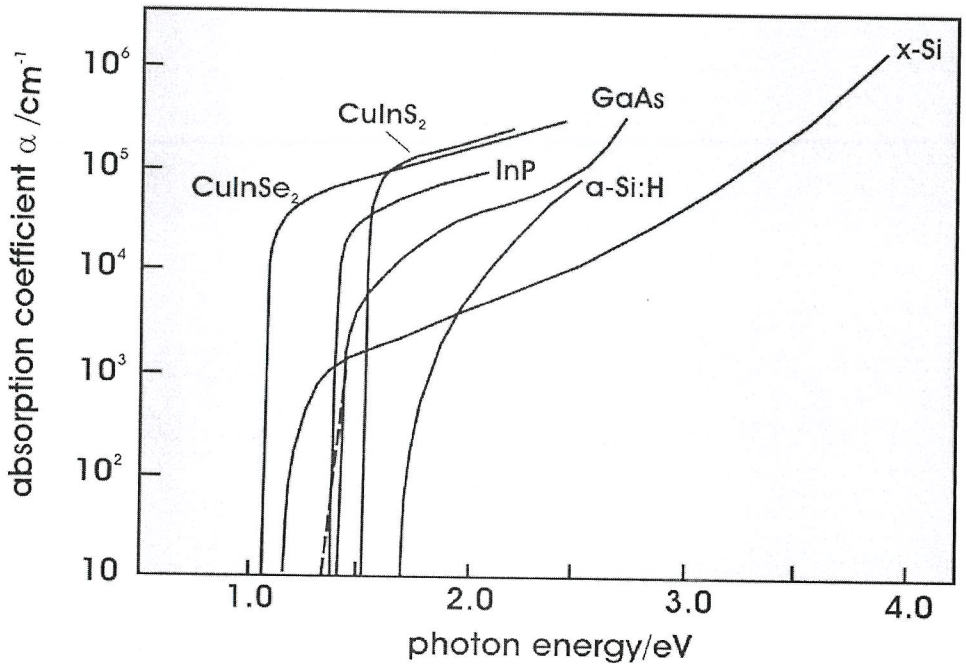

Figure Q4