Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	PHOTONIC DEVICES
COURSE CODE	:	BED 40902
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JUNE 2017
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS

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

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Q1 (a) In microelectronic semiconductor fabrication, band gap is very important to determine the applications.

(i) Describe the importance of direct and indirect band gap.

(4 marks)

(ii) Illustrate direct and indirect band gap to show the differences and provide one electronic application using those band gaps.

(6 marks)

(iii) Explain process to tune indirect band gap to direct bandgaps for silicon.

(2 marks)

(b) A semiconductor material has an optical band gap of 2.2 eV.

(i) Determine the light wavelength that would be absorbed by the material.

(4 marks)

(ii) Analyze **TWO (2)** properties of the n-type semiconductor material that suit the requirement of a solar cell device.

(2 marks)

(iii) Doping process is a technique to tune the semiconductor material band gap. Analyze the reason for the decrement of band gap as a result of introducing metal ions into the material.

(2 marks)

(c) Electron excitation is divided into two types.

(i) With the aid of diagram, differentiate the radiative and non-radiative transition of a semiconductor material.

(4 marks)

(ii) Identify the technique of measurement to determine the radiative and non-radiative transition of materials.

(1 mark)

Q2 (a) Solar cell is one of the fastest growing renewable energy sources.

(i) Distinguish the mechanism of energy conversion from light to electricity in solar cell.

(5 marks)

(ii) Draw the conceptual diagram of electron separation for solar cell devices.

(2 marks)

(iii) Analyze the process of electron-hole recombination which degrade the solar cell performance.

(4 marks)

(b) The CEO of TR Sdn Bhd offers a position of Material Engineeer with a task to produce blue LED using ZnO with band gap of 3.3 eV. Propose the process to produce a new product by using band alignment strategy.

(8 marks)

(c) Sketch a single junction LED and explain its application in electronic devices.

(6 marks)

Q3 (a) Design a basic laser diode configuration and explain the operation how laser can be emitted.

(8 marks)

(b) Explain the quantum efficiency and analyze its application in optoelectronic design.

(8 marks)

(c) The emerging of nanotechnology has enhanced the performance of laser diode. Draw the schematic diagram of a laser diode employing nanostructures and analyze the reason the performance could be enhanced.

(9 marks)

Q4 (a) Based on **Figure Q4(a)**,

(i) Deduce the equation for field factor and energy conversion efficiency.

(8 marks)

(ii) Calculate the efficiency and field factor.

(2 marks)

(b) A solar cell company is hiring a process engineer to manufacture a solar cell using Indium tin oxide (ITO), Cuprous oxide (Cu_2O), Zinc oxide (ZnO) and Aluminium (Al) with parameters as shown in **Table 1**.

Table 1: Semiconductor material parameters

Material	Band gap energy (E_g)	Valence energy (E_v)	Conduction energy (E_c)
ZnO	3.3 eV	-7.4 eV	- 4.1 eV
ITO	-	-	- 4.8 eV
Cu_2O	2.2 eV	-5.4 eV	- 3.2 eV
Al	-	-	- 4.3 eV

(i) Draw the energy band alignment using data in **Table 1**.

(10 marks)

(ii) Construct cross section of single junction solar cell using the materials given.

(5 marks)

- END OF QUESTIONS –

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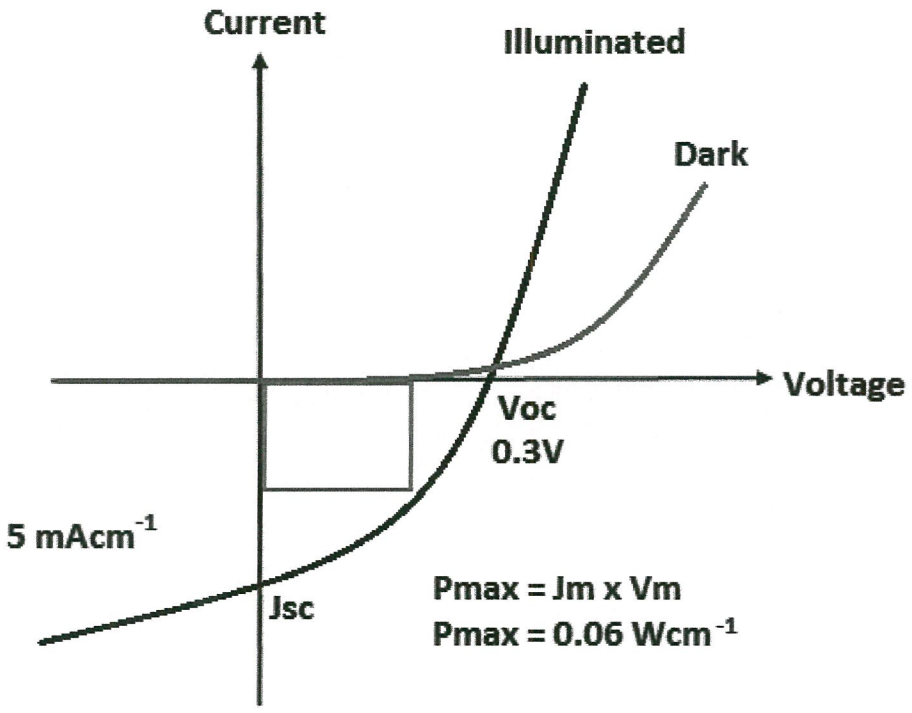

Figure Q4(a)