UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	PHOTONIC DEVICES
COURSE CODE	:	BED 40902
PROGRAMME	:	4 BEJ
EXAMINATION DATE	:	DECEMBER 2014/ JANUARY 2015
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

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

(i) Differentiate direct and indirect band gap.

(2 marks)

(ii) Illuminate both band gap to show the difference and provide one example for each.

(8 marks)

(iii) Explain the band gap type that would influence the performance of optoelectronic devices?

(2 marks)

(b) A semiconductor material has an optical band gap of 3.2 eV.

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

(2 marks)

(ii) Analyze **TWO (2)** properties of the semiconductor material that suit the properties with the optoelectronic device requirement.

(2 marks)

(iii) Doping process is a technique to tune the semiconductor material's band gap. Evaluate how could the band gap decreases when metal ions are introduced into the material.

(2 marks)

(c) Electrons excitation is divided into two.

(i) Differentite radiative and non-radiative transition of a semiconductor material.

(4 marks)

(ii) Determine 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) Explain the fundamental concept of solar cell and light emitting diode.

(3 marks)

(ii) Draw both concept to differentiate electron separation and recombination.

(4 marks)

(iii) Determine the recombination of electrons used for the light emitting diode fabrication.

(4 marks)

(b) You are an engineer in a light emitting diode (LED) producing company ABC. The CEO plan to produce a new product which is a red LED using Tin Sulfide (SnS) with band gap of 1.4 eV. Explain your strategies to present to your CEO to produce the new product.

(8 marks)

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

(6 marks)

Q3 (a) Design a basic laser diode and how does the design can emit the laser.

(8 marks)

(b) Explain the quantum efficiency and how does it become useful for the optoelectronic design?

(8 marks)

(c) The emmerging 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) Figure **Q4(a)** is the current-voltage (I-V) characteristic of a solar cell. Explain the field factor and energy conversion efficiency. Using the figure given, deduce the equation for field factor and energy conversion efficiency. Hence, calculate the efficiency and field factor of the information in the figure.

(10 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). Refering to the parameters in the Table **1**.

(i) Draw the energy band alignment.

(10 marks)

(ii) Construct a single junction solar cell using the materials given.

TABLE 1

Material	Band gap energy (E_g)	Valence energy (E_v)	Conduction energy (E_c)
TiO_2	3.2 eV	-7.0 eV	-3.8 eV
ITO	-	-	-4.8 eV
Cu_2O	2.2 eV	-5.4	-3.2 eV
Al	-	-	-4.1 eV

(5 marks)

- END OF QUESTION –

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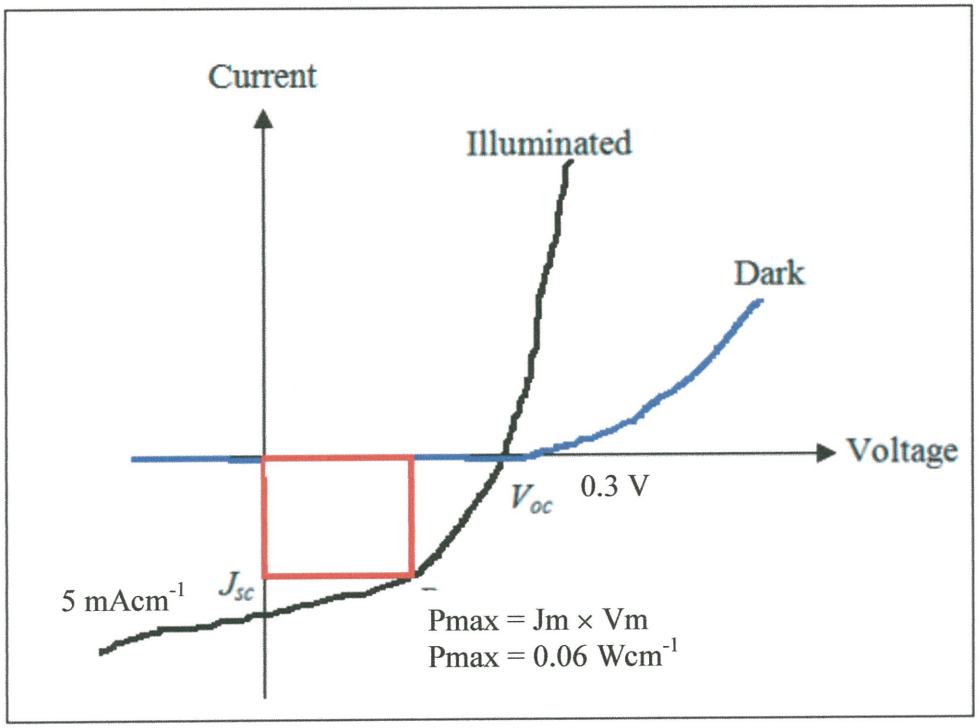

FIGURE Q4 (a)