UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	PHOTONIC DEVICES
COURSE CODE	:	BED 40902
PROGRAMME	:	BEJ
TEST DATE	:	DECEMBER 2018 / JANUARY 2019
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS PAPER CONSISTS OF **FOUR (4)** PAGES

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Q1   (a)   (i)   Determine **ONE (1)** reason of coherent light beam (lasers) as a preferred carriers compared to microwave signals for photonic device applications.

(2 marks)

         (ii)   Nowadays, photonics devices namely Light Emitting Diode (LED) have been widely used to replace the Compact Fluorescent Lighting (CFL) bulb. Analyse **TWO (2)** advantages of LED over CFL to the indoor and / or outdoor lightning applications.

(4 marks)

   (b)   (i)   Compare and explain briefly **ONE (1)** theoretical situation of photon emission between direct band gap and indirect band gap, respectively.

(4 marks)

         (ii)   Define term of Photoluminescence.

(2 marks)

   (c)   (i)   Analyse the usage of difference energy (work gap) information between highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO).

(4 marks)

         (ii)   Different application of photonics devices can be produced by manipulating from electron-hole pair such as recombination and separation processes. Explain briefly the element production that can be formed from each processes. Then, identify **ONE (1)** device can made from it.

(3 marks)

   (d)   As R&D photonics engineer, one of the task is to fabricate a green LED that can work in visible wavelength, 495–570 nm. The material use for device fabrication is titanium dioxide (TiO_2) that having a band gap of 3.2 eV.

         (i)   Calculate the wavelength that can be produced from given material.

(4 marks)

         (ii)   Analyse does the above material suitable for producing LED in visible wavelength. Suggest any action or process need to be taken.

(2 marks)

Q2   (a)   (i)   Sketch and label clearly the construction of Light Emitting Diode (LED) in forward bias.

(5 marks)

(ii)   Explain the process of light emission when external voltage is applied.

(5 marks)

(b)   (i)   Distinguish **TWO (2)** elements that determine the LED colour.

(4 marks)

(ii)   Give **THREE (3)** examples of LED materials that usually emit red, white and bright blue lights.

(6 marks)

(c)   (i)   Examine which area that charge carrier recombine and emit light.

(2 marks)

(ii)   Sketch the graph of output characteristic of LED. (Hint: Forward current vs output light)

(3 marks)

Q3   (a)   A photodetector has a p–n junction that converts light photons into current. The absorbed photons make electron–hole pairs in the depletion region. Analyse the absorption operation of photodetector using direct and indirect bandgap.

(10 marks)

(b)   (i)   A photodetector has an area of 5×10^{-2} cm^{-2} is irradiated with yellow light whose intensity is 20 mW.cm^{-2}. Assuming that each photon generated as one electron-hole pair, calculate the number of pairs generated per second.

(5 marks)

(ii)   Analyse the situation will a silicon photodetector be sensitive to the radiation from a GaAs.

(4 marks)

(c)   With the aid of a diagram, explain the structure and operation of a PIN photodiode.

(6 marks)

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Q4   (a)   Discuss the difference between thermal solar cell and photovoltaic solar cell.

(5 marks)

(b)   Explain the mechanism of energy conversion from light to electricity in photovoltaic solar cell.

(5 marks)

(c)   The process of electron-hole recombination will degrade the photovoltaic solar cell performance. Analyse the reasons.

(5 marks)

(d)   **Figure Q4(d)** shows a solar powered device being used to recharge a mobile phone. On average, the solar cells produce 0.6 joules of electric energy each second. This solar cells have an efficiency of 0.15.
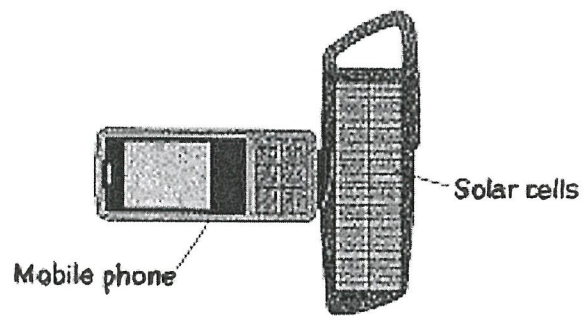

Figure Q4(d)

(i)   Calculate the average energy input each second to the device.

(4 marks)

(ii)   Energy from the sun is stored by a rechargeable battery inside the device as shown in **Figure Q4(d)**. Analyse **THREE (3)** factors that would affect the time it takes to fully charge the battery.

(6 marks)

-END OF QUESTIONS-