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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017**

COURSE NAME : BIOMEDICAL OPTICS
COURSE CODE : BEU 41303
PROGRAMME : BEJ
EXAMINATION DATE : JUNE 2017
DURATION : 2½ HOUR
INSTRUCTION : ANSWER ALL QUESTIONS

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

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- Q1 (a)** List **TWO (2)** types of reflection. With the aid of diagram, explain the difference between these reflections. (4 marks)

- (b) A light ray is composed of red light ($\lambda = 650 \text{ nm}$) and is incident on a block of fused quartz glass at an angle of 40° . By referring to the refractive index data, n given in **Figure Q1(b)**, predict the angle of refraction inside the quartz. (6 marks)

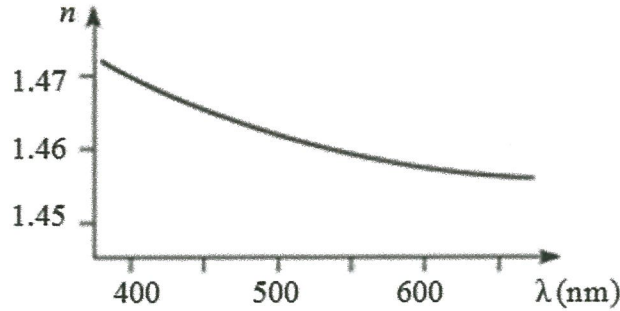


Figure Q1 (b)

- (c) Two converging lenses, with the focal length $f_1 = 10 \text{ cm}$ and $f_2 = 15 \text{ cm}$ are placed in contact. An object is placed 60 cm in front of the first lens.
- (i) Predict the position of the final image. (9 marks)
- (ii) Calculate magnification of the final image formed by the combination of the two lenses. (6 marks)

- Q2 (a)** Name **TWO (2)** classifications of noise in detection system and briefly explain their properties. (6 marks)
- (b) The noise equivalent power of a detector with area 1 cm^2 is measured at $2 \times 10^{-8} \text{ W/Hz}^{-1/2}$ with a bandwidth of 1 Hz . Calculate the power incident on the detector if the ratio of the noise voltage to the signal voltage is 10^{-6} . (7 marks)

- (c) Consider a commercial Ge positive-negative (p-n) junction photodiode which has the responsivity shown in **Figure Q2(c)**. Its photosensitive area is 0.01 cm^2 (diameter of $113 \text{ }\mu\text{m}$) and this device is used under a reverse bias of 10 V when the dark current is $0.5 \text{ }\mu\text{A}$.

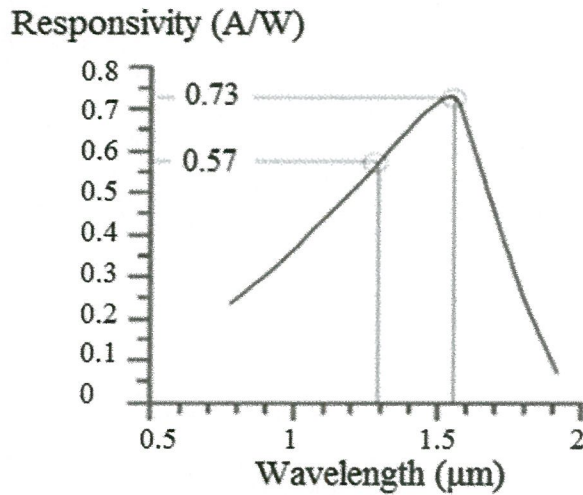


Figure Q2(c)

- (i) Determine the light intensity at wavelength of 1300 nm that gives a photocurrent equal to the dark current. (7 marks)
- (ii) Evaluate the Quantum Efficiency of this device at the peak responsivity. (5 marks)

Q3 (a) List **THREE (3)** properties of laser. In your own words, briefly explain each of the listed properties. (6 marks)

(b) With the aid of a diagram, describe working principle of laser. (8 marks)

(c) Lasers are now used in eye surgery. Given the wavelength of a certain laser is 514 nm and the power of the laser is 1.7 W .

- (i) Calculate the number of photons that are released if the laser is used for duration of 0.045 s during the surgery. (5 marks)

- (ii) Determine the power of the corresponding laser if 100×10^{16} photons are generated within the duration of 0.05 s. (6 marks)

Q4 (a) Propose the application of optics in endoscopy. (8 marks)

(b) Given that the power of the incident light is 100 mW, and the absorption and scattering coefficient of this sample are given by 10 cm^{-1} and 5 mm^{-1} , respectively

(i) Calculate the medium total attenuation coefficient. (2 marks)

(ii) Determine the power of light propagating this sample with thickness of 10 mm. (3 marks)

(iii) Calculate the corresponding light attenuation value in decibels (dB). (3 marks)

(iv) Find the light attenuation value if scattering coefficient of this sample is given by 20 mm^{-1} (assuming incident power, sample thickness and its absorption coefficients remain the same). (4 marks)

(v) Propose the new scattering coefficient value (in cm^{-1}) required to produce the detected light attenuation of 150 dB after light propagating through a medium with thickness of 20 mm and absorption coefficient of 10 cm^{-1} . (5 marks)

- END OF QUESTION -

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