

**CONFIDENTIAL**



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2013/2014**

COURSE NAME : BIOMEDICAL OPTICS  
COURSE CODE : BEU 41303  
PROGRAMME : 4 BEJ  
EXAMINATION DATE : JUNE 2014  
DURATION : 3 HOURS  
INSTRUCTION : ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

**CONFIDENTIAL**

- Q1**
- (a) List **TWO** (2) types of reflection. (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  $40^\circ$ . By referring to the reflective index data,  $n$  given in Figure **Q1(b)**, estimate the angle of refraction inside the quartz. (6 marks)
- (c) Two converging lenses, with the focal length  $f_1 = 10\text{ cm}$  and  $f_2 = 15\text{ cm}$  are placed  $40\text{ cm}$  apart, as shown in Figure **Q1(c)**. An object is placed  $60\text{ cm}$  in front of the first lens.
- (i) Determine the position of the final image formed by the combination of the two lenses. (9 marks)
- (ii) Calculate magnification of the final image formed by the combination of the two lenses. (6 marks)
- Q2**
- (a) Name **THREE** (3) types of noise categorized under temporal noise. (6 marks)
- (b) The noise equivalent power of a detector with area  $1\text{ cm}^2$  is measured at  $2 \times 10^{-8}\text{ W/Hz}^{-1/2}$  with a bandwidth of  $1\text{ Hz}$ . 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 pn junction photodiode which has the responsivity shown in Figure **Q2(c)**. Its photosensitive area is  $0.01\text{ cm}^2$  (diameter of  $113\text{ }\mu\text{m}$ ) and this device is used under a reverse bias of  $10\text{ V}$  when the dark current is  $0.5\text{ }\mu\text{A}$ .
- (i) Calculate the light intensity at wavelength of  $1300\text{ nm}$  that gives a photocurrent equal to the dark current. (7 marks)
- (ii) Determine the Quantum Efficiency of this device at the peak responsivity. (5 marks)

- Q3**
- (a) Describe **THREE** (3) fundamentals of laser. (6 marks)
- (b) In your own words, 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 0.045 s during the surgery. (5 marks)
- (ii) Determine the power of the corresponding laser if  $100 \times 10^{16}$  photons are generated within the duration of 0.05 s. (6 marks)
- Q4**
- (a) Explain the principle of operation of pulse oximetry with the aid of a diagram. (4 marks)
- (b) Propose the application of optics in Endoscopy. (8 marks)
- (c) Given that the power of the incident light is 100 mW, and the absorption and scattering coefficient of this sample are given by  $10 \text{ cm}^{-1}$  and  $5 \text{ cm}^{-1}$ , respectively.
- (i) Determine the power of light propagating this sample with thickness of 10 mm. (5 marks)
- (ii) Calculate the corresponding light attenuation value. (4 marks)
- (iii) Find the light attenuation value if scattering coefficient of this sample is given by  $20 \text{ mm}^{-1}$  (assuming incident power, sample thickness and its absorption coefficients remain the same). (4 marks)

- END OF QUESTION -

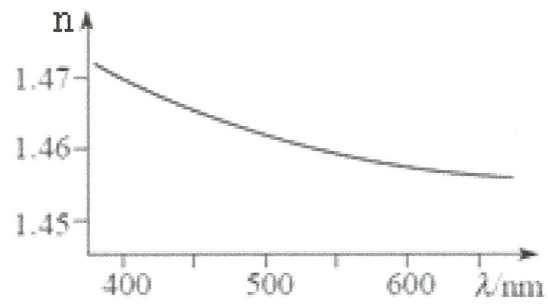
**FINAL EXAMINATION**

SEMESTER/SESSION: SEM II/2013/2014

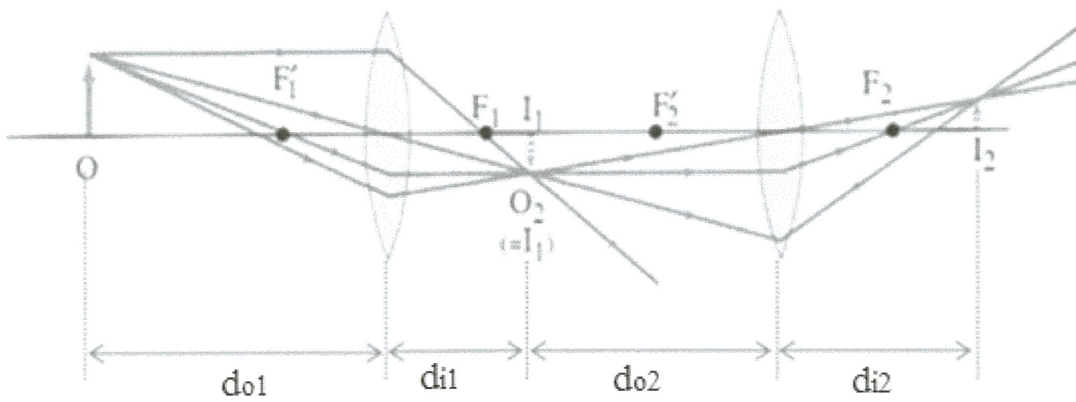
PROGRAMME : 4 BEJ

COURSE NAME : BIOMEDICAL OPTICS

COURSE CODE: BEU 41303



**FIGURE Q1(b)**



**FIGURE Q1(c)**

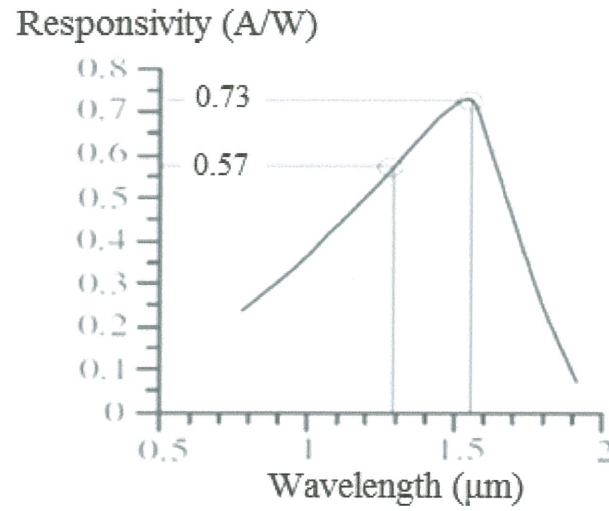
**FINAL EXAMINATION**

SEMESTER/SESSION: SEM II/2013/2014

PROGRAMME : 4 BEJ

COURSE NAME : BIOMEDICAL OPTICS

COURSE CODE: BEU 41303

**FIGURE Q2(c)**