Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	BIOMEDICAL OPTICS
COURSE CODE	:	BEU 41303
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	DECEMBER 2018/JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS IN THIS BOOKLET

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

Q1 (a) Define Huygen's principle.

(4 marks)

(b) Name **TWO (2)** types of light reflection and draw their reflection pattern.

(4 marks)

(c) Total internal reflection (TIR) occurred when incoming light refracted at an angle larger than 90° upon arriving at the boundary of two media of different reflective index. The angle at which TIR starts is known as critical angle. Given that light travel from water into air,

(i) Determine its critical angle.

(3 marks)

(ii) Evaluate if TIR would occur for ray travelled from water into glass (n =1.55).

(2 marks)

(d) Young's double slit experiment showed that light passes through a pair of closely spaced narrow slits would produce a pattern of alternating bright and dark fringes on a distant screen. Calculate the angle between the fifth dark fringe and its central maximum for Young's double slit experiment if the light wavelength, λ = 530 nm, spacing between the slits, d = 10 μm, and distance between the slits and screen, L = 1 m.

(5 marks)

(e) White light passes through two slits 0.50 mm apart, an interference pattern is observed on screen 2.5 m away. The first order bright fringe resembles a rainbow with violet and red light at opposite ends. The violet light is at a distance of 2.0 mm while the red is at 3.5 mm from the center of the central white fringe.

(i) Calculate the wavelength for the violet and red light.

(8 marks)

(ii) Discuss your observation on the distance of violet light from the central white fringe if the slit width is increased to 1.0 mm. Use calculation to justify your answer.

(4 marks)

Q2 (a) Compare between longitudinal and lateral chromatic aberration.

(4 marks)

(b) Explain with the help of a diagram, the formation of virtual image using positive lens.

(6 marks)

(c) With the help of a diagram, trace the ray's path and validate the formation of the image at the infinity if the object is placed at focal length, f_L = 2 cm, of a symmetrical positive thin lens.

(8 marks)

(d) Lens is made from glass of refractive index n, with radius of curvatures, R_1 and R_2. Calculate the focal length of the lens using Lensmaker formula given that n = 1.3, R_1 = 10 mm and R_2 = 5 cm.

(6 marks)

(e) An object of height 2 mm is placed in front of two thin symmetrical coaxial lens in contact (lens 1 and lens 2) with focal length f_1 = -20 cm and f_2 = -10 cm. The object is located at 8 cm from lens 1.

(i) Calculate the distance between the lens and the image.

(7 marks)

(ii) Evaluate the size of the final image and state if the image formed is upright or inverted direction.

(6 marks)

Q3 (a) Name **TWO (2)** advantages of Photomultiplier Tube (PMT) compared to P-type intrinsic N-type (PiN) photodiode.

(4 marks)

(b) Discuss the working principle of Charge-Coupled Detector.

(6 marks)

(c) Quantum efficiency is a parameter used to describe number of electron produced per number of photon absorbed. Given that a P-type intrinsic N-type (PiN) detector has a quantum efficiency of 15% at a wavelength of 680 nm. At a wavelength of 850 nm, the responsivity is triple the responsivity at 680 nm. Calculate the quantum efficiency of this detector at 850 nm.

(6 marks)

(d) A P-type intrinsic N-type (PiN) photodiode has dynamic range value of 110 dB and noise floor of 1 μV(rms). Determine the maximum signal value (in *Vrms*) of this device.

(4 marks)

Q4 (a) Discuss differences in the safety standard and practice when using class 2 and class 4 laser.

(8 marks)

(b) One of the keys to the operation of a laser is stimulated emission process in an active medium. Given that in the stimulated emission for a certain helium/neon laser, the energy difference is 1.54 eV. Calculate the wavelength of light emitted by this laser.

(5 marks)

- **END OF QUESTION** -