Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2015/2016

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|---|---|---|
| COURSE NAME | : | OPTOELECTRONICS |
| COURSE CODE | : | BWC 40603 |
| PROGRAMME | : | 4 BWC |
| EXAMINATION DATE | : | DECEMBER 2015/JANUARY 2016 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **FIVE (5)** QUESTIONS ONLY |

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

**ANSWER FIVE (5) QUESTIONS ONLY**

**Q1** (a) By illustrating a simple diagram, states the law of refraction.

(7 marks)

(b) Analyse the waveguide condition. You may use specific equation and simple diagram in your analysis.

(10 marks)

(c) A planar dieletric waveguide has a core thickness of 25 μm. The refractive indices of the core and cladding are 1.45 and 1.43. The light to be guided has a wavelength of 900 nm. What is the V-number of the waveguide?

(3 marks)

**Q2** (a) By illustrating simple diagram, compare between the step index fiber and graded index fiber.

(15 marks)

(b) The optical power launched into a single mode optical fiber from a laser diode is approximately 1 mW. The detector at the output requires a minimum power of 1 nW to provide a clear signal. The fiber operate at 1.31 μm and has an effective attenuation coefficient of 0.40 dB $km^{-1}$. What is the maximum ideal length of fiber that can be used without inserting a repeater?

(5 marks)

**Q3** (a) (i) State the three main part of laser system.

(3 marks)

(ii) Discuss the main function of the optical resonator of the laser system.

(7 marks)

(b) (i) Sketch the four level system of laser emission.

(4 marks)

(ii) Point out the principle operation of the four level system of laser.

(6 marks)

**Q4** (a) (i) Illustrate a simple diagram of p-n junction light emitting diode.
(2 marks)

(ii) Illustrate the band diagram of the p-n junction light emitting diode.
(5 marks)

(iii) Point out the photon emission process of the light emitting diode.
(7 marks)

(b) What is the differences of the direct and in-direct semiconductor?
(6 marks)

**Q5** (a) Differentiate briefly the electro-optic, acousto-optic and magneto-optic effect.
(6 marks)

(b) By using an example, explain the uses of

(i) electro-optic modulator,
(3 marks)

(ii) acousto-optic modulator.
(3 marks)

(c) (i) Propose **two (2)** devices to be used for light detection.
(2 marks)

(ii) Explain the operation principle of one of the light detecting devices as you propose in **c(i)**.
(6 marks)

**Q6** (a) By sketching simple diagram of fiber Bragg grating (FBG) structure and refractive index profile, explain the FBG principle.
(11 marks)

(b) By sketching a simple diagram, point out the operation principle of fiber-optic Mach-Zehnder interferometer.
(9 marks)

**- END OF QUESTION -**

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## LIST OF EQUATIONS

| | |
|---|---|
| $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ | $c = \frac{\omega}{k} = \frac{1}{\sqrt{\mu_O \varepsilon_o}}$ |
| $E = hf = h\frac{c}{\lambda}$ | $\frac{\sin\theta_1}{\sin\theta 2} = \frac{n_2}{n_1} = \frac{v_1}{v_2}$ |
| $I = I_0 \cos^2\theta$ | $\left[\frac{2\pi n_1(2a)}{\lambda}\right]\cos\theta_m - \phi_m = m\pi$ |
| $m \le \frac{2V - \phi}{\pi}$ | $V - number = \frac{2\pi a}{\lambda}\left(n_1^2 - n_2^2\right)^{1/2}$ |
| $\alpha_{dB} = \frac{1}{L}10Log\left(\frac{P_{in}}{P_{out}}\right)$ | $v_p = \frac{\omega}{\beta}$ |
| $\alpha_B = A\exp\left(-\frac{R}{R_c}\right)$ | $J = \rho v$ |