Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	LASER TECHNOLOGY
COURSE CODE	:	BWC 31403
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) (i) Sketch a simple diagram of an electromagnetic (EM) wave.
(2 marks)

(ii) Define the electromagnetic wave based on the sketched diagram.
(2 marks)

(b) Calculate the wavelength of a

(i) 60 Hz EM wave,
(ii) 93.3 MHz FM radio wave,
(iii) beam of visible red light from a laser at frequency 4.74×10^{14} Hz.
(6 marks)

(c) (i) One of the unique properties of laser light is directionality. By sketching a simple diagram, correlates between directionality and beam divergence of a laser light.
(6 marks)

(ii) Explain on the collimation of a laser beam.
(4 marks)

Q2 (a) (i) By sketching a simple diagram, explain on the Boltzmann's Law.
(6 marks)

(ii) By sketching a simple diagram, discuss on the population inversion.
(4 marks)

(b) (i) What are the differences between spontaneous and stimulated emission?
(4 marks)

(ii) Discuss the four-level system of laser generation.
(6 marks)

Q3 (a) (i) Sketch a simple diagram of basic laser resonator. Explain the function of each part of the laser resonator.

(5 marks)

(ii) Discuss systematically on the circulating power of laser light in the resonator.

(5 marks)

(b) (i) Suppose you want to do laser ranging experiment to measure the distance from the earth to the moon. You would aim a pulse of laser light at the retroreflector left on the moon by the astronauts. By very carefully measuring how long it took the pulse to travel to the moon and back, you would be able to figure out the distance. The laser wavelength, λ is 1064 nm and the beam waist, w_0 is 1.0 mm radius. The approximate earth-moon distance is 3.84×10^8 m. Calculate the beam radius, w.

(4 marks)

(ii) **Figure Q3(b)(ii)** shows a concave-convex configuration. Calculate the g-parameters.

(6 marks)

Q4 (a) Q-switching is a technique for producing pulsed output from a laser.

(i) Explain further the physical principal of Q-switching.

(4 marks)

(ii) By sketching a simple diagram, discuss the principle of electro-optic Q-switches.

(6 marks)

(b) (i) List two main differences between the Q-switched and mode-locked laser.

(4 marks)

(ii) By sketching a simple diagram, explain the mode-locked laser generation.

(6 marks)

Q5 (a) (i) What is non-linear optics?

(2 marks)

(ii) By sketching a simple diagram, explain on the process of 3rd harmonic generation of pulsed laser from a fundamental 1064 nm.

(8 marks)

(b) Why the diode pumped solid-state lasers (DPSS) is much preferable than the flashlamp pumped solid-state lasers for low and medium power lasers?

(4 marks)

(c) (i) Sketch a simple diagram of epitaxial layers of InGaN diode laser.

(4 marks)

(ii) Based on the sketched diagram as in **Q5(c)(i)**, find out the purpose of the metal contacts and cladding layer.

(2 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION: SEM II/2016/2017 PROGRAMME : BWC
COURSE NAME : LASER TECHNOLOGY COURSE CODE: BWC 31403

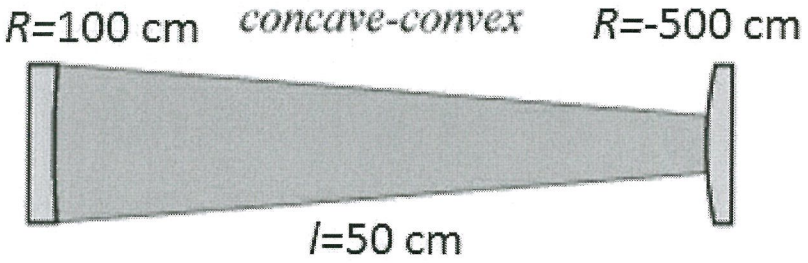

Figure Q3(b)(ii)

LIST OF EQUATIONS

$c = f\lambda$	$\theta = 2.44\,(\lambda / D)$
$N_i = N_0 \exp-\left(\frac{E_i}{k_B T}\right)$	$P_{out} = \tau P_{circ}$
$w = w_0\left[1+\left(\frac{\lambda z}{\pi w_0^2}\right)^2\right]^{1/2}$	$R = z\left[1+\left(\frac{\pi w_0^2}{\lambda z}\right)^2\right]$
$g_1 = 1-\frac{l}{r_1}$	$g_2 = 1-\frac{l}{r_2}$
$0 \le g_1 g_2 \le 1$	

LIST OF CONSTANTS

(1) Speed of light : 3×10^8 m/s