Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	FIBER OPTIC TECHNOLOGY
COURSE CODE	:	BNF 43103
PROGRAMME CODE	:	BNF
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) Explain the following attenuation mechanisms in silica optical fiber:

(i) Intrinsic absorption
(ii) Extrinsic absorption
(iii) Rayleigh scattering

(7 marks)

(b) Fiber dispersion can severely limit the useful bandwidth of the fiber. Several important dispersion parameters can cause the spreading of light pulse in time as it propagates down the fiber. With the aid of suitable diagrams, explain fiber modal dispersion.

(5 marks)

(c) A multimode step index fiber has a relative refractive index difference of 2% and a core refractive index of 1.5. The number of modes propagating at a wavelength of 1.3 μm is 1000. Calculate:

(i) The cladding refractive index
(ii) The numerical aperture
(iii) The diameter of the fiber core

(8 marks)

Q2 (a) Explain the concept of absorption, stimulated emission, and spontaneous emission.

(6 marks)

(b) Optical sources, LED and LASER, convert electrical signal to a light wave.

(i) Describe briefly the basic operating principle of LED and LASER.

(2 marks)

(ii) Sketch the typical output power spectrum of LED and LASER. For LASER, illustrate the output spectrum when operating below and after threshold current.

(6 marks)

(c) An LED guiding region emits 8 mW and has a refractive index of 3.61 at the operating wavelength. For a diode current of 20 mA, determine:

(i) The external quantum efficiency.

(2 marks)

(ii) The power leaving of the LED surface.

(2 marks)

(iii) The responsivity.

(2 marks)

Q3 (a) List and describe **TWO (2)** primary characteristics of light detectors.

(4 marks)

(b) Given a silicon photodetector having the following specifications: responsivity is 0.5 A/W and 3 dB bandwidth is 500 MHz. Find:

(i) The current which will be produced if it is incident by a -43 dBm optical ray.

(3 marks)

(ii) The rise time of the photodetector.

(3 marks)

(c) When 3×10^{11} photons each with a wavelength of 0.85 μm are incident on a photodiode, an average 1.2×10^{11} electrons are collected at the terminals of the device. Determine:

(i) The quantum efficiency.

(3 marks)

(ii) The responsivity of the photodiode.

(3 marks)

(d) Discuss how temperature can change silicon PIN photodiode noise.

(4 marks)

Q4 (a) List **TWO (2)** types of optical coupler that is available in the market.

(2 marks)

(b) You are required to characterize a biconical-tapered coupler of unknown specification as shown in **Figure Q4(b)**. The power injected from the laser source into the coupler is 5 mW. The measured output power shows a reading of 0.7 mW, 2.8 mW and 1.5 μW for P_2, P_3 and P_4, respectively. Determine the:

(i) Coupling ratio
(ii) Insertion loss
(iii) Excess loss
(iv) Directivity

(8 marks)

(c) Erbium-doped fiber amplifier (EDFA) and LASER use stimulated emission to operate.

(i) Draw a block diagram of a basic EDFA and explain the function of every component of the basic EDFA.

(5 marks)

(ii) The EDFA can be extended to become a fiber laser. Suggest **TWO (2)** ways to modify the EDFA to become an erbium-doped fiber laser (EDFL). Also, state the difference between laser and EDFA.

(5 marks)

Q5 (a) UniFi is a broadband service by Telekom Malaysia (TM) that uses fiber optics to deliver high speed internet, phone and internet protocol TV (IPTV) services to customers' homes. From your understanding illustrate the network from the central office to the in-home networks. Please specify the type of lasers, fibers, number of users and the technology that suitable to describe UniFi systems.

(10 marks)

(b) Laser diode with an input power of 0.5 mW is launched into a fiber. The launch amplifier has a gain of 25 dB; the following fiber has a length of 100 km and a loss of 0.25 dB/km. This is followed by an inline amplifier having sufficient gain to bring the power level back same as the output power of launching amplifier. The following fiber has the same attenuation with 150 km of length. A preamplifier next boosts the power level of 0.5 mW.

(i) Compute the gain of the preamplifier.

(8 marks)

(ii) Plot the signal power level (in dBm) as a function of position along the fiber system.

(2 marks)

-END OF QUESTIONS –

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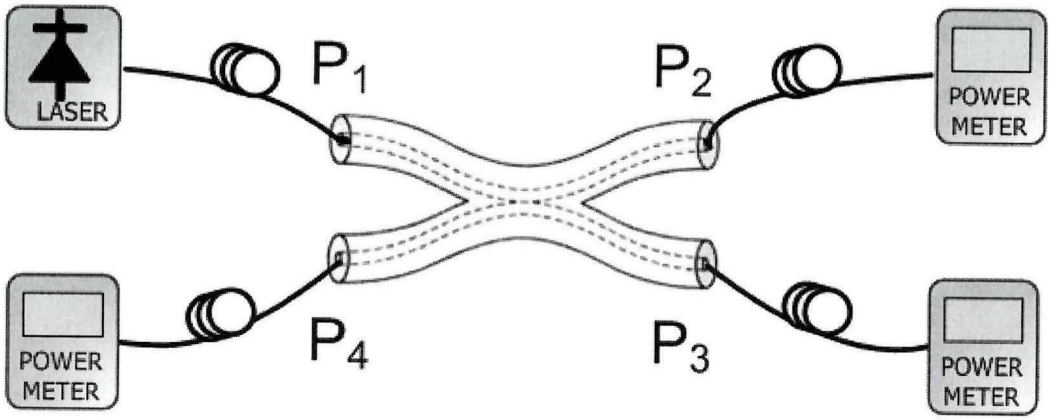

Figure Q4(b)