الكترونيات ضوئية

Kafrelsheikh University
Faculty of Engineering
Department: Electrical Engineering
Year: 3rd Electronics and communications (R-2007)
Subject: Optical electronics
Instructor/Examiner: Bedir Yousif

Final Exam of 2nd semester 2017/2018
Code: ECE 3208
Time allowed: 3 hours
Full Marks: 100 Marks
Exam Date: 30 /05/2018
Number of Pages: Two Pages

Based on course specs ILOS

Relationship between Course Intended learning outcomes (ILOs) and National Academic Reference Standards (NARS)

Field	National Academic Reference Standards (NARS)			
	Knowledge & Understanding	Intellectual Skills	Professional Skills	General skills
academic standards that the course contribute in achieving it	a.4, a. 8	b.2, b.3, b.5	c3	d7

Solve All the following problems:

Q-1 — 35 Marks

A — 15 M

1- **Mention** in brief, what are the meant by: Population inversion, active medium gain threshold in LASER source, Direct and indirect recombination bandgap semiconductors. iii. Longitudinal and transverse modes in LASER cavity.

2- Explain the differences between
i. Two level, three level and four level system for lasing emission
ii. LASER and Avalanche photodetector.

3- A photodiode has a quantum efficiency of 65% when photons of energy 1.5×10^{-19} J are incident upon it.
(a) At what wavelength is the photodiode operating?
(b) Calculate the incident optical power required to obtain a photocurrent of 2.5 μA when the photodiode is operating as described above.

B — 20 M

1- Calculate the transmission bit rate of optical fibers communication system in visible region?

2- Drive an expression for the chromatic dispersion in optical fibers?

3- A multimode graded index fiber exhibits total pulse broadening of 0.1 μs over a distance of 15 km. Estimate: (a) the maximum possible bandwidth on the link assuming no Inter-symbol interference;(b) the pulse dispersion per unit length; (c) the bandwidth–length product for the fiber.

4- A GaAs injection laser has an optical cavity of length 250 μm and width 100 μm. At normal operating temperature the gain factor $\bar{\beta}$ is 21×10^{-3} A cm^{-3} and the loss coefficient A per cm is 10. Estimate the threshold current density and hence the threshold current for the device. It may be assumed that the cleaved mirrors are uncoated and that the current is restricted to the optical cavity. The refractive index of GaAs may be taken as 3.6.

Q-2 — 35 Marks

A — 20 M

1- Design a Fabry-Perot cavity for a ruby laser contains a crystal of length L cm with a refractive index of n. The peak emission frequency from the device is 545.45 THz and the number of longitudinal modes is 3×10^5 . Determine n, L if the separation wavelength is 4 nm.

2- Compare the approximate radiative minority carrier lifetimes in gallium arsenide and silicon when the minority carriers are electrons injected into the p-type region which has a hole concentration of 10^{18} cm^{-3}. The injected electron density is small compared with the majority carrier density, if the recombination coefficient Br for Si is $1.79 \times$

	$10^{-15}\ cm^3S^{-1}$and GaAs is $7.21 \times 10^{-10}\ cm^3S^{-1}$ 3- The quantum efficiency of a particular silicon APD is 80% for the detection of radiation at a wavelength of 0.9 μm. When the incident optical power is 0.5 μW, the output current from the device (after avalanche gain) is 11 μA. Determine the multiplication factor of the photodiode under these conditions. 4- AlGaInAs/InP laser, operating at 1550 nm for absolute temperature 20000 K. a- Calculate the ratio between Einstein's stimulated emission coefficient to spontaneous emission coefficient?
B 15 M	1- A multimode step index fiber gives a total pulse broadening of 95 ns over a 5 km length. Estimate the bandwidth–length product for the fiber when a nonreturn to zero digital code is used. 2- A glass fiber exhibits material dispersion given by $\lvert\lambda^2(d^2n_1/d\lambda^2)\rvert$ of 0.025. Determine the material dispersion parameter at a wavelength of 0.85 μm, and estimate the rms pulse broadening per kilometer for a good LED source with an rms spectral width of 20 nm at this wavelength. 3- How to reduce various types of dispersion in optical fibers?
Q-3	30 Marks
A 15 M	1- What are the major requirements for an optical fiber communications emitters and detectors? 2- A multimode step index fiber has a numerical aperture of 0.3 and a core refractive index of 1.45. The material dispersion parameter for the fiber is 250 ps nm^{-1} km^{-1} which makes material dispersion the totally dominating chromatic dispersion mechanism. Estimate (a) the total rms pulse broadening per kilometer when the fiber is used with an LED source of rms spectral width 50 nm and (b) the corresponding bandwidth–length product for the fiber. 3- Drive an expression for the quantum efficiency and responsivity in photodetectors?
B 15 M	1- Calculate the photocurrent of photodetector that has absorption coefficient of $5 \times 10^5\ cm^{-1}$,the width of absorption region is 500 μm, and reflection of surface 0.4 at the photons rate $3 \times 10^{11}\ photons\ per\ second$. 2- State the main differences between photodiode detector and photovoltaic cell? 3- GaAs has a bandgap energy of 1.43 eV at 300 K. Determine the wavelength above which an intrinsic photodetector fabricated from this material will cease to operate.

Best regards
Assistant Prof. Dr. Bedir Yousif