

- (b) A 16 channel DWDM system has a uniform channel spacing of 100 GHz and that the wavelength  $\lambda_1$  (corresponding to channel 1) is 1550 nm. Calculate
- (i) the wavelength spacing between channels 7 and 8 and  
(ii) the wavelength spacing between channels 15 and 16.

6 + 6 = 12

**Group - E**

- 8 (a) Draw and explain the basic format of an STS-1 SONET frame and STM-16 SDH frame. What is the transmission bit rate of basic SONET signal?
- (b) Discuss the architecture of four fiber BLSR (Bidirectional Line Switched Ring) with suitable schematic diagrams. What are its most important features?
9. (a) Draw the block schematic of the generic configuration of a UPSR (Unidirectional Path Switched Ring) with counter rotating protection path. Explain the flow of primary and protection traffic from one node to another.
- (b) What is meant by the term "SOLITON" ? Distinguish between Fundamental SOLITON and higher order SOLITONS.

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**M.TECH/ECE/2<sup>ND</sup> SEM/ECEN 5201/2018**  
**PHOTONICS & OPTICAL COMMUNICATION**  
**(ECEN 5201)**

Time Allotted : 3 hrs

Full Marks : 70

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group - A**  
**(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which of the following material is not suitable for fabricating a semiconductor LASER?  
(a)  $\text{Al}_{0.7}\text{Ga}_{0.3}\text{As}$  (b)  $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$   
(c)  $\text{In}_{0.74}\text{Ga}_{0.26}\text{As}_{0.57}\text{P}_{0.43}$  (d) GaAs.
- (ii) The dark current of a silicon APD operating in the wavelength region 800-1800nm is of the order of  
(a) 0.1-1 nA (b) 50-500 nA  
(c) 10-50 nA (d) 500-5000 nA.
- (iii) The no. of modes M in a multimode graded index fiber with modified frequency parameter V is given by  
(a)  $M=V/3$  (b)  $M=V^2/2$   
(c)  $M=V^2/3$  (d)  $M=V^2/4$ .
- (iv) Ga As has an energy bandgap of 1.43 eV .The maximum wavelength (in units of nanometers ) that can be absorbed by a Ga As photodetector is  
(a) 870 (b)1130  
(c) 1650 (d) 1850
- (v) Which of the following wavelengths is most suitable for pumping an Erbium doped fiber amplifier (EDFA ) ?  
(a) 850 nm (b) 980 nm  
(c) 1310 nm (d) 1550 nm.

- (vi) The receiver sensitivity of a coherent lightwave communication system can be improved (over Intensity Modulation/Direct Detection system ) by a factor of  
 (a) 3 db (b) 6 db  
 (c) 14 db (d) 20 db.
- (vii) In a fiber Bragg Grating, constructive interference at a wavelength  $\lambda$  takes place at the imaging plane when the rays are diffracted at an angle  $\theta_a$ . Which of the grating equation is satisfied? [With  $p$ , the grating period,  $m$ , the order of grating,  $\theta_i$  the incident angle.]  
 (a)  $P(\cos\theta_i - \cos\theta_a) = m\lambda/2$  (b)  $P(\sin\theta_i - \sin\theta_a) = m\lambda/2$   
 (c)  $P(\sin\theta_i - \sin\theta_a) = m\lambda$  (d)  $P(\cos\theta_i - \cos\theta_a) = m\lambda$ .
- (viii) The number of  $2 \times 2$  three db fiber couplers needed to construct a  $32 \times 32$  coupler is  
 (a) 12 (b) 16  
 (c) 32 (d) 80.
- (ix) The value of the intermediate frequency in heterodyne detection coherent communication system is of the order of  
 (a) 0.1 MHz (b) 100 MHz  
 (c) 10 GHz (d) 20 GHz .
- (x) The basic line rate for an OC -192 ( SONET, Synchronous Optical Network ) signal is  
 (a) 622.08 Mb/s (b) 2488.32 Mb/s  
 (c) 9953.28 Mb/s (d) 39813.12 Mb/s.

**Group - B**

2. (a) Distinguish between a semiconductor LED and a LASER. Draw and explain the light emission from a semiconductor hetero-junction LED with the help of suitable schematic diagrams.
- (b) Design a suitable quaternary  $In_{1-x}Ga_xAs_yP_{1-y}$  alloy for being used for fabrication of semiconductor LED at (i) 1010 nm, (ii) 1330 nm. Given  $E_g = 1.35 - 0.72y + 0.12y^2$  for lattice matched system  $y = 2.2x$ .  
**(2 + 4) + 6 = 12**
3. (a) Draw suitable curves indicating the variation of total dispersion with wavelength for (i) standard optimized, (ii) dispersion shifted and (iii) dispersion flattened silica glass fibers. What is meant by  $V$  number of a fiber?

- (b) Discuss with suitable diagrams the principle of operation of a p - i - n photodetector .What is meant by responsivity of a photodetector? Distinguish between a p - i - n photodetector and an Avalanche photodetector.

**6 + 6 = 12****Group - C**

4. (a) Discuss the key system design consideration for point-to-point digital optical fiber link for light source, detector and optical fibers.
- (b) A 1300 nm single mode optical fiber link in 1Gb/s metro network have components with the following parameter values (i) LASER diode that emits 1mW in fiber flylead ,(ii) p - i - n photodiode with sensitivity of -20dbm at 1gb/s ,(iii) optical fiber with attenuation of 0.3 db/km at 1300 nm, (iv) a 1db connector loss at each end of the link ,(v) a system margin of 6db. Find the maximum link length.  
**6 + 6 = 12**
5. (a) Discuss the link power budget and rise time budget in a point-to-point digital link. Mention the important system considerations for choice of optical source, optical detector and optical fiber.
- (b) In a digital fiber optic link, the transmitter rise time is 0.25 ns, the receiver rise time is 0.12 ns, the GVD dispersion parameter  $ID I = 1.7$  ps/ nm. km , length  $L = 100$  kms and the NRZ (Non-Return-to- Zero) bit rate is 0.5 Gb/s. Calculate the system rise time and determine the feasibility of the transmission link.

**6 + 6 = 12****Group - D**

6. (a) What is an optical phase locked loop? Derive an expression for the receiver current in a homodyne detection system in coherent lightwave communication system. Mention one important disadvantage of the homodyne detector system.
- (b) Draw the PSK, ASK, and FSK modulation format for the binary data pattern 10111001.  
**6 + 6 = 12**
7. (a) What do you understand by the term "Dense Wavelength Division Multiplexing (DWDM)"? Draw a neat sketch showing the implementation of a Wavelength Division Multiplexing system.