Course no: EEE G591                                          Max. Marks :70
Course Title: Optical Communication     (**Open-Book- 45)**          Weightage  : 35%
Date           : 27-12-2022                                     Duration    : 3Hrs

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**Q.1**: Discuss important design issues to be taken in Soliton system design mentioning clear specifications. In a fiber with GVD parameter of 0.5 ps$^2$/km , the 40 Gbps soliton system sees the dispersion length as 250 km, comment on the interaction issues.Also predict safe link length and suggest some suggestion to improve this.

(8)

**Q.2**: Design a Raman amplifier to pump 1500 nm wavelength  and comment on different types of pumping and their important features. If the same system also has to amplify a channel at 1560 nm , suggest the additional modification in the design.

(8)

**Q.3**:  A lightwave system is to be designed at 1.55µm for a single channel bit rate of 10Gbps for a 400 Km link Show the appropriate system blocks needed to implement the project with relevant specifications.

(8)

**Q.4**:   In a standard SI fiber with 8 µm diameter, the V parameter is measured as 2.2  at 1.5 µm source for mono-mode operation. Find

(i)   numerical aperture of the fiber
(ii)  spot size at 1.4  µm wavelength
(iii)  maximum data rate at 1.4 µm assuming $\lambda_z$ as 1.3 µm with S as 0.08ps/km.nm$^2$
(iv)   data capacity achieved if 10 optical channels are to be multiplexed in the fiber keeping residual dispersion magnitude as 2ps/km.nm to avoid FWM. Assign suitable channel wavelength and mention their respective maximum theoretical data rate.
(v)  estimate maximum cross phase shift for γ as 3W$^{-1}$/km and α as 0.2 dB/km for 10 channels mentioning the condition for this maximum to happen. (Assume each channel power is 5 mW and channel separation is critical to initiate XPM)

( 7.5))

**Q.5**:   An WDM system with 32 channels each working at 20Gbps are to be filtered using FP based filters having reflectance nearly 98%. Find the critical channel spacing for proper operation and also the length of the cavity of the filter. Comment on the hetero-wavelength crosstalk if any in this case. If this filter requires 1 dB power penalty then predict corresponding homo-wavelength crosstalk for a 10$^{-9}$ BER                                        ( 6)

**Q.6**: Find the final answers for the following:

(i)     A standard SM fiber having $\lambda_z$ as 1320 nm and S as 0.1 ps/km.nm$^2$, then the BL at 1500 nm assuming $\Delta\lambda$ as1 nm .

(ii)    A graded index multimode fiber provides minimum dispersion for $\alpha$=2 as 1.0 ns then in a SI fiber having same core size, axis index and cladding index the corresponding delay and supporting data rate for $\Delta$ value is 0.01.

(iii)   In a FP filter for 95% reflectance the number of channels to be selected for spectral efficiency of 0.8.

(iv)    In an optical fiber if dispersion length is 400 Km , find the non linear parameter ($\gamma$) for a fundamental soliton with peak power as 5 mW.

**(v)**    In a fiber two signals 200 and 206 THz are propagating, find the signal created through FWM.                                                                **( 7.5)**

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Course Title: Optical Communication    (**Close-Book- 25)**        Weightage  : 35%
Date          : 27-12-2022                                     Duration    : 3Hrs

Q1:A multimode optical fiber having core index as 1.5 and accepts 16% of incident light at 1500 nm. If the core diameter is 60 µm, then estimate :
    (i)  Number of modes
    (ii) index of cladding
    (iii) Delay / km
    (iv)  Data rate per km for a similar GI fiber with parabolically graded index
    (v)  If the same fiber is to be operated as single mode then discuss the conditions if any        **(5)**

Q2: An optical carrier at 210 THz is propagating through a SM fiber. Discuss the following:
    (i) Some signal is identified in backward direction only. Comment on the reason with description of the received signal spectrum and other specifications.
    (ii) If in another experiment different signals are identified in both the forward and backward directions then also discuss reasons, specifications.
    (iii) Discuss some solutions to mitigate the effects observed in (i) and (ii).        **(5)**

Q3: Discuss role of quantum internal efficiency and external efficiency of an ILD laser. Sketch and label the power Vs current for such lasers at temperatures T1 and T2 ( T2> T1).        **(5)**

Q4 : Discuss AWG routers concepts and conditions to use as demultiplexer. Find the expression for FSR and discuss suitable assumptions to make it more appropriate.        **(5)**

Q5: Discuss Electrooptic based external modulator design and design suitable AND, OR and EXR logical implementation using MZI based modulators.        **(5)**

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