Birla Institute of Technology and Science, Pilani
First Semester 2017-18
EEEF426 Fiber Optics and Optoelectronics
COMPREHENSIVE EXAM (December 2, 2017)
Part-A (Closed Book)

Max. Marks: 60 **Time: 90 min.**

Note:- Answer in same sequence of questions. Keep your answers short and to-the-point.
All questions carry equal marks.

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1. List inherent advantages of an optical fiber, those make it a suitable candidate in sensing systems.
2. What are the reasons for observing non-linear effects in optical fibers? How can SPM balance the broadening of pulse due to GVD?
3. Show a scheme for multiplexing four wavelengths from different sources using circulators and FBGs. Finally, drop the first wavelength at the last node.
4. Identify difference(s) between Fabry Perot Cavity based resonating source and an amplifier. What advantage TWA provides over FPA?
5. How can optoelectronic modulators be used as switches and routers in optical networks? Explain.
6. Explain the objective of p-n^+ junction in a reach through (p^+-i-p-n^+) avalanche photodiode.
7. List different methods employed practically to increase source-to-fiber coupling efficiency.
8. How OTDR helps in optical networks when used in field measurements. Mention merits of the technique.
9. How large effective area fibers (LEAFs) are developed? List applications where LEAFs may be applied.
10. What are the advantages of designing and developing a SMF near $V = V_C$?

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Part-B (Open Book)

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1. (a) The longitudinal modes of double-heterojunction GaAs/GaAlAs injection laser diode operating at a wavelength of 810 nm are separated in frequency by 100 GHz. If the refractive index of the active region is 3.6, calculate the length of the optical cavity and the number of longitudinal modes emitted. (b) Calculate the maximum allowed length of the active region for a single mode operation.

2. Consider a sinusoidally modulated optical signal $P(t)$ of frequency ω, modulation index m, and average power P_0 given by $P(t) = P_0(1 + m\cos\omega t)^2$. Show that when this optical signal falls on a photodetector, the mean square signal current $\langle i_s^2 \rangle$ generated consists of an average current component I_p and a signal current i_p given by, $\langle i_s^2 \rangle = I_p^2 + \langle i_p^2 \rangle = (\Re P_0)^2 + \frac{1}{2}(m\Re P_0)^2$, where, $\Re$ is responsivity.

3. (a) An uncoated FPA has facet reflectivities of 33% and a single pass gain of 5 dB. The amplifier has a 250 μm long active region, a mode spacing of 4 nm and a peak gain wavelength of 1.55 μm. Determine the refractive index of the active medium and the 3 dB spectral bandwidth of the device. (b) Also derive an approximate expression for the cavity gain of TWA for a 3 dB peak-trough ratio.

4. An input power of -27 dBm is fed to a 1.8 km long fiber Raman Amplifier (FRA). Attenuation coefficients for signal and pump wavelengths in FRA are 0.18 and 0.24 dB/km. The cross-sectional area of pump beam is 54 μm^2 and Raman gain coefficient is 6×10^{-14} m/W. The FRA is pumped by a laser of 33 dBm power. Estimate the gain (dB) provided by the FRA.

5. A germanium APD is incorporated into an optical fiber receiver with a 1000 Ω load resistance. When operated at a temperature of 220K, the minimum photocurrent required to give a SNR of 33 dB at the output of the receiver is found to be a factor of 10 greater than the dark current. If the noise figure of the following amplifier at this temperature is 1dB and the post detection bandwidth is 10 MHz, determine the avalanche multiplication factor.

6. Consider a MZI pressure sensor, show that the phase change $\Delta\varphi$ per unit length in the sensing arm due to change in pressure ΔP may be given by, $\frac{\Delta\phi}{L\Delta P} = \frac{2\pi}{\lambda}\left[n\frac{\Delta L}{L\Delta P} + \frac{\Delta n}{\Delta P}\right]$, where, the symbols have their usual meanings.