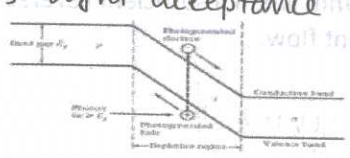
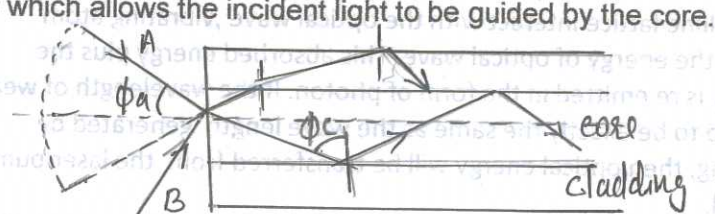


**SCHEME OF EVALUATION**

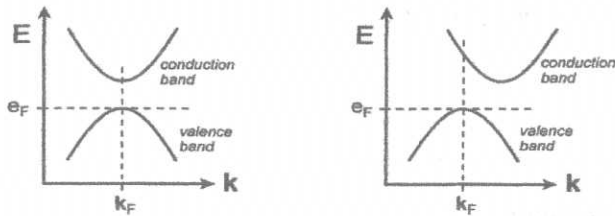
**1**

(Scoring indicators)

Revision : 2015 Course code :5045  
Course Title :Optical Communication

Qst. No.	Scoring Indicator	Split up score	Sub Total	Total
<p>I</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p>	<p><b>PART A</b></p> <p><b>Total internal reflection</b> is an optical phenomenon that occurs when a ray of light strikes a medium boundary at an angle larger than the critical angle with respect to the normal to the surface</p> <p>Numerical aperture is the light gathering ability of the fiber. It is defined as the sine of half of the angle of fiber's light acceptance cone.</p>  <p>Raman optical amplifier, Semiconductor optical amplifier, EDFA</p> <p>Isolator allows light to pass through them in only one direction.</p>	<p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>	<p>10</p>	<p>10</p>
<p>II</p> <p>1</p> <p>2</p>	<p><b>PART B</b></p> <p>Absorption is the most important factor causing attenuation. Absorption is caused by three mechanisms. 1 –Absorption by atomic defects in the glass composition. 2 Extrinsic absorption by impurity atom .3 Intrinsic absorption by atoms that constitute fiber materials.</p> <p>Scattering is the loss of energy due to imperfections in the fiber .</p> <p>Compositional fluctuations can cause refractive index variations causes scattering</p> <p>Dispersion is the phenomenon of spreading of light pulse.</p> <p>It is the maximum <b>angle</b> of a ray (against the fiber axis) hitting the fiber core which allows the incident light to be guided by the core.</p> 	<p>3x2=6</p> <p>3</p> <p>3</p>	<p>6</p> <p>6</p>	<p>6</p>

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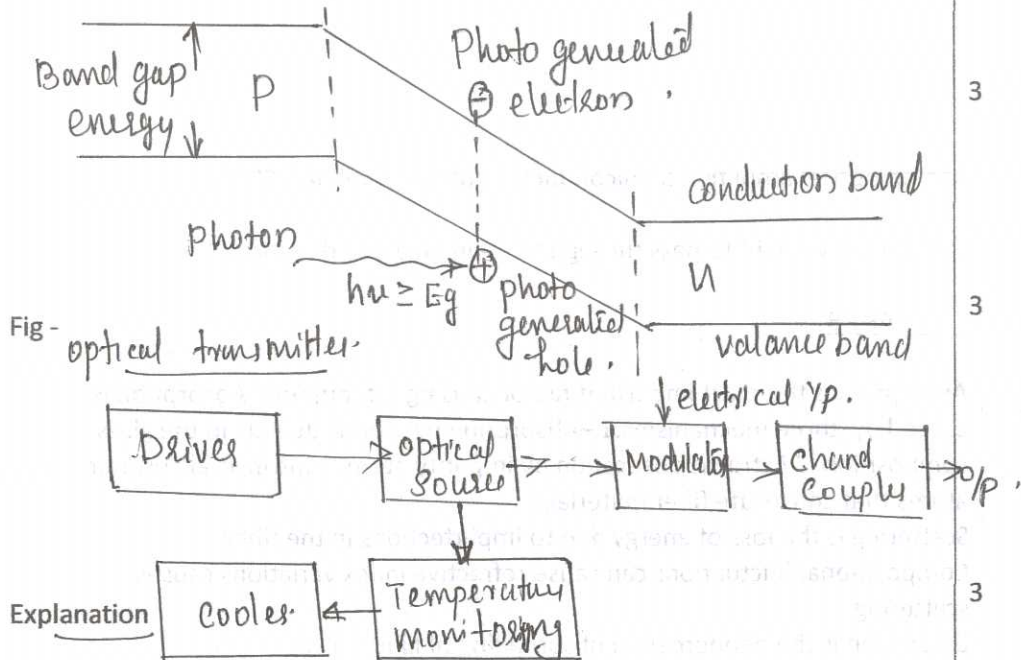


In a **direct band gap semiconductor**, the top of the valence band and the bottom of the conduction band occur at the same value of momentum. In an **indirect band gap semiconductor**, the maximum energy of the valence band occurs at a different value of momentum to the minimum in the conduction band energy.

4

When an incident photon has an energy greater than or equal to band gap energy of semiconductors the photon can give up its energy and excite an electron from valence band to conduction band. when a sufficient reverse bias is applied the photo carriers generate a current flow.

5



6

Raman amplifier works on the principle of Raman scattering. When a vibrating atom in a crystalline lattice interact with the optical wave, vibrating atom absorb some of the energy of optical wave. This absorbed energy plus the vibrating energy is re emitted in the form of photon. If the wavelength of weak signal is selected to be exactly the same as the wave length generated by Raman scattering, then optical energy will be transferred from the laser pump into weak signal.

- 7 1)Low coupling loss .2)Interchangeability . 3)Ease of assembly and use. 4)Low environmental sensitivity. 5)Low cost and reliable construction. 6)Ease of connection.

**PART C**

III Step Index fiber-Refractive index of core is uniform through out and step change at the cladding boundary.

(a) Graded index fiber-The refractive index of the core is made to vary in the parabolic manner .Max refractive index present at the centre.

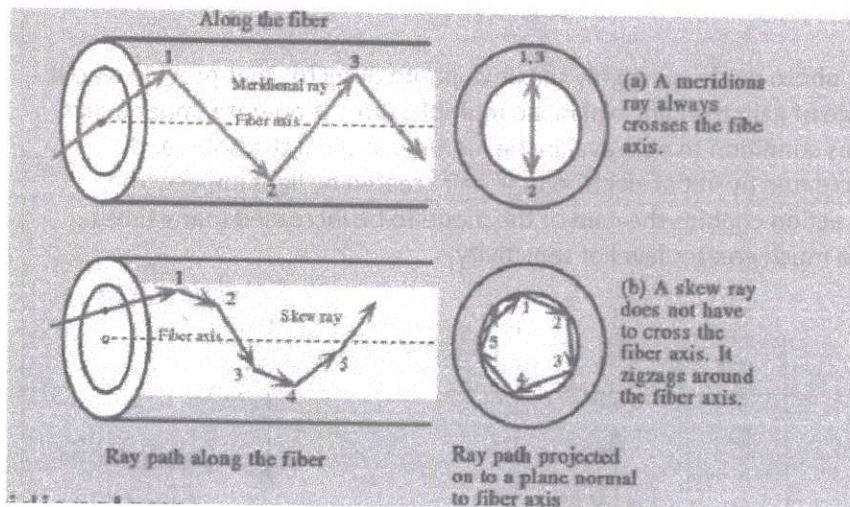
Single mode step index fiber

Multimode step index fiber

Multimode graded index fiber

Explain each with figure

(b) Meridional rays-These rays are confined to the Meridional plane. It always intersect the axis of fiber. Skew rays : Rays that travel through the fiber with out passing through the centre axis of the core. Skew rays follow a helical path .Difficult to track.



IV (a) Glass Fiber –Consist of oxide glasses. To produce different refractive index for core and cladding, fluorine or various oxides are added

Active glass Fiber-Incorporating rare earth elements like erbium or neodymium into a normally passive glass.

Plastic optical Fiber-For high speed services high bandwidth graded index polymer optical fibers are used

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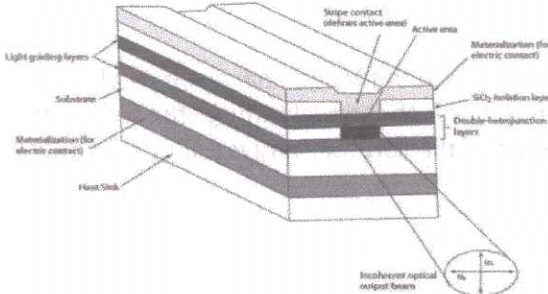
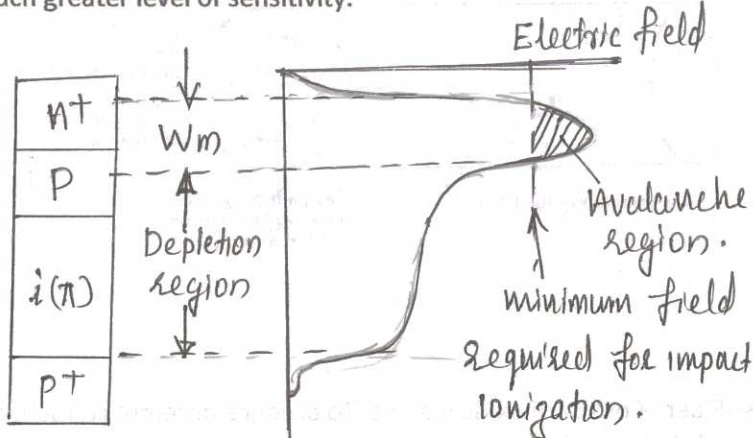
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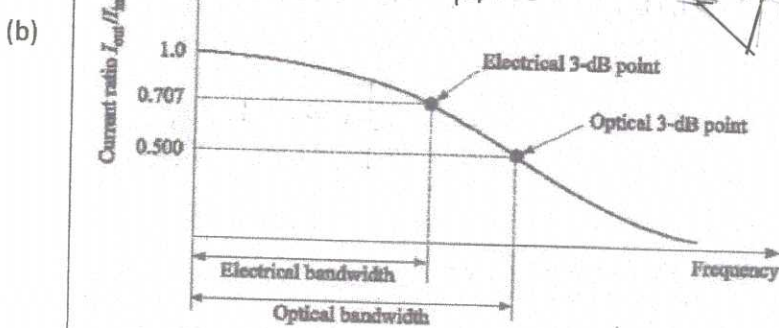
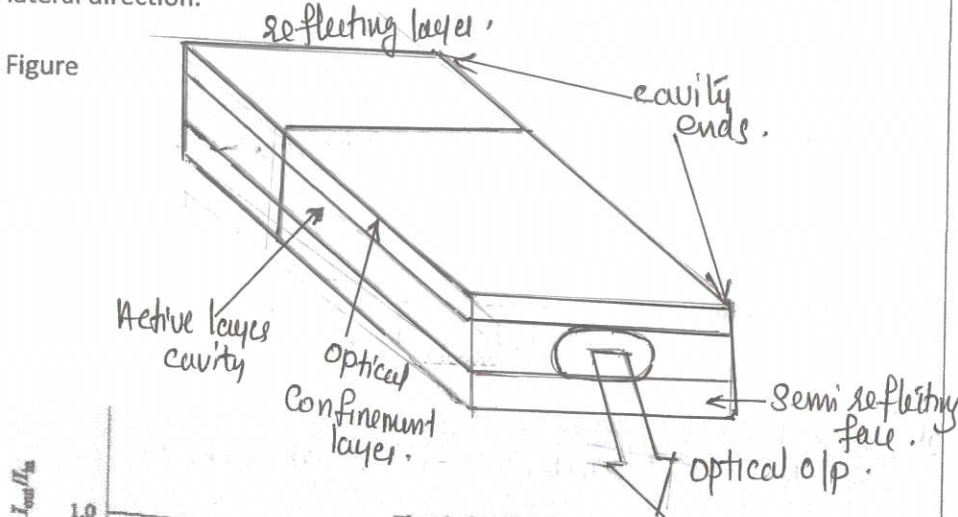
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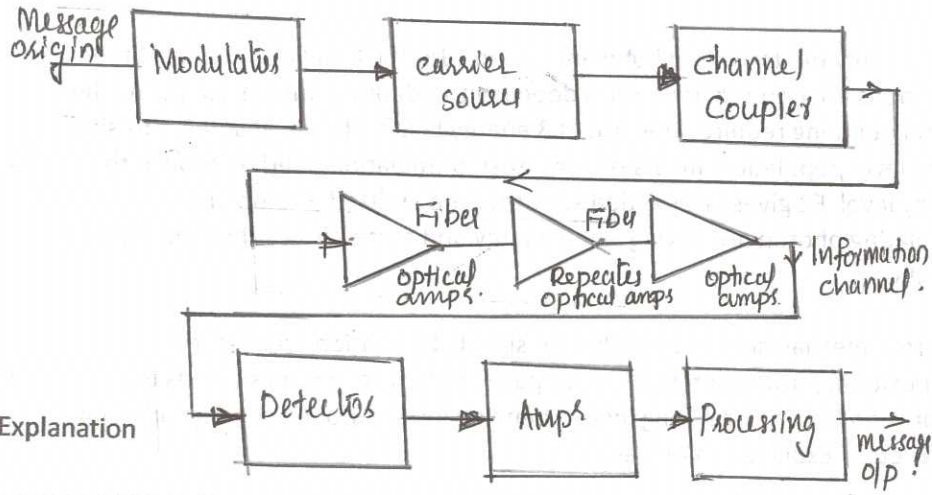
<p>(b)</p>	<p>Enormous potential bandwidth          Long distance transmission          Small size and low weight          Immunity to interference and cross talk          Signal security          Ruggedness and flexibility          Low transmission loss</p>	<p>4</p>	<p>7X1=7</p>	<p>15</p>
<p>V (a)</p>	<p>Explanation</p> <p style="text-align: center;"><b>Edge Emitting LED (ELED)</b></p> 	<p>4</p>	<p>8</p>	<p>15</p>
<p>(b)</p>	<p>Avalanche photo diode is a highly sensitive photo detector that provide a built in first stage of gain through avalanche multiplication. It operate under a high reverse bias condition to able avalanche multiplication of the holes and electrons created by initial electron hole pair created by light impact. The avalanche action enables the gain of the diode to be increased many times , providing a much greater level of sensitivity.</p> <p>Figure</p> 	<p>4</p>	<p>7</p>	<p>15</p>
<p>VI (a)</p>	<p>Laser diode is an improved LED, in the sense that uses stimulated emission in semiconductor from optical transitions between distribution energy states of the valence and conduction bands with optical resonator structure such as Fabry-Perot resonator with both optical and carrier confinements. Laser diodes have three distinct radiation modes namely, longitudinal, lateral and transverse modes. • In laser diodes, end mirrors provide strong optical</p>	<p>5</p>		

feedback in longitudinal direction, so by roughening the edges and cleaving the facets, the radiation can be achieved in longitudinal direction rather than lateral direction.



Modulation bandwidth of LED can be defined in either electrical or optical terms. Normally electrical terms are used. So the modulation bandwidth is defined as the point where the electrical signal power  $P(w)$  has dropped to half its constant value resulting from the modulated portion of optical signal

VII (a)



Explanation

(b)

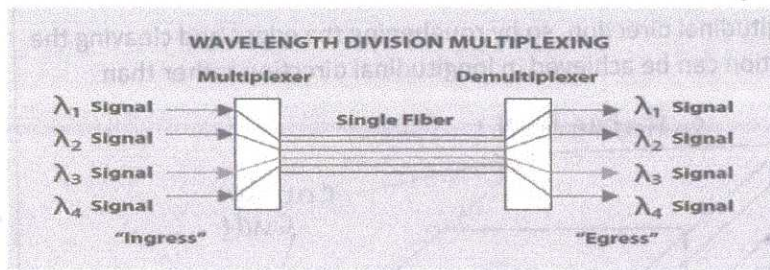
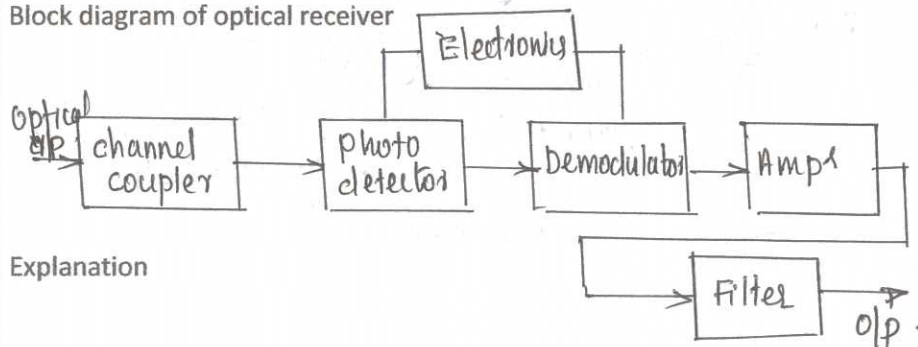


Figure 1: Basic WDM Technology Diagram

Explanation

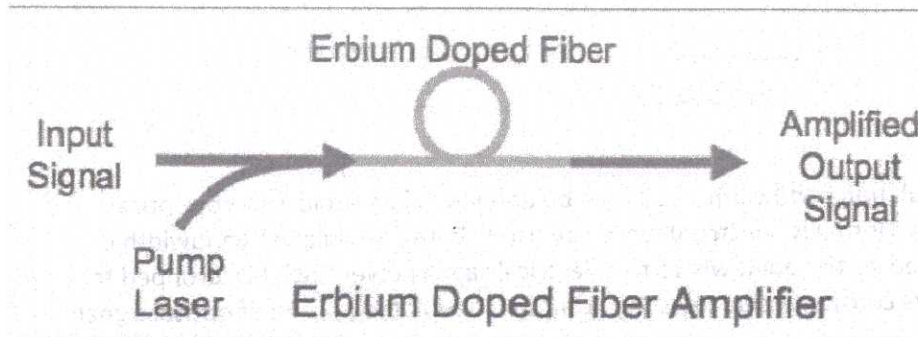
Block diagram of optical receiver

VIII (a)



Explanation

(b)



In EDFA only the transition between E2 and E1 is 100% radiative and all other transitions are non radiative. Silica doped with erbium is known as EDFA. The optical pumping requires the use of 3 energy levels. Hence at some threshold pump level population inversion may exist. Stimulation of erbium ion in the energy level E2 gives laser action such that the emitted photon and stimulating photon are having same energy and same phase. Thus the signal is amplified.

IX (a)

Different mechanisms responsible for signal attenuation are material composition, purification level, wave guide structure and these leads to Absorption losses, Scattering losses, bending losses, mode coupling radiation losses etc - Explanation of losses

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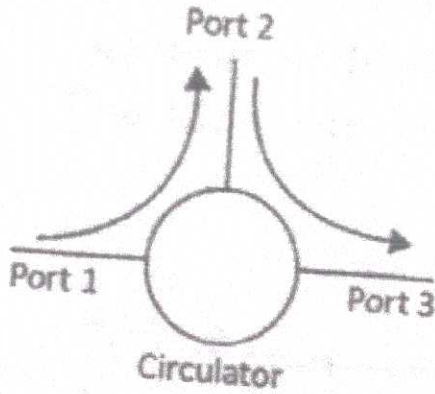
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# Optical circulator

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Multi port ( minimum three) non reciprocal passive componen

(b)



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Optical circulator is a non reciprocal multiport passive device that directs light sequentially from port to port in only one direction. used in optical amplifiers, add/drop mux and dispersion compensation modules

3

Optical couplers are passive devices used to split and combine light streams. A star coupler combines signals from many inputs and divide them among several output fibers. A Device with 2 inputs and 2 outputs would called 2X2 coupler. this is fabricated by twisting together, melting together and pulling two single mode fibers so that they get fused together over a uniform section of length.

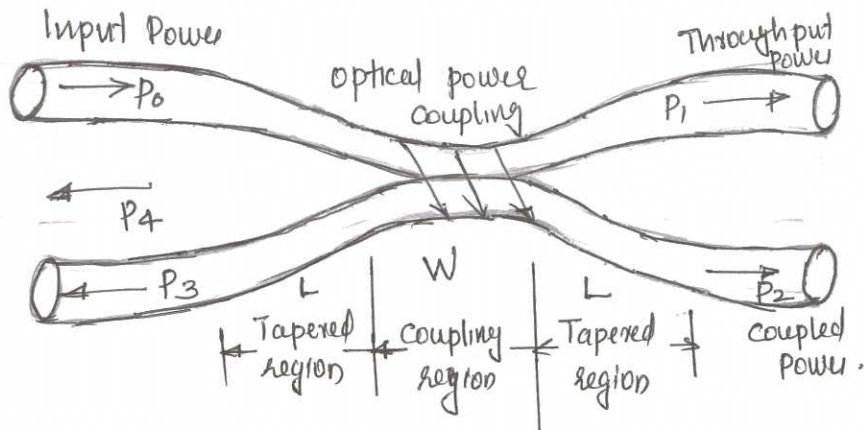
X  
(a)

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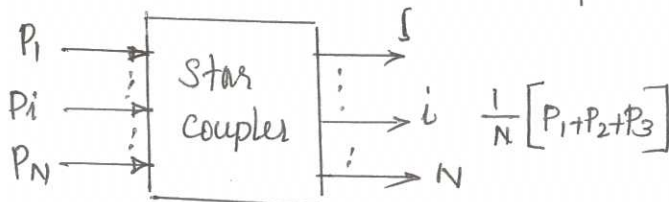
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Figures of 2X2 coupler, star coupler

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(b)	<p>Fusion Splicing  Mechanical splicing  V-Groove Splicing</p> <p>Explanation each <del>with figure</del></p>	<p>8</p> <p>1</p> <p>3x2=6</p>	<p>7</p>	
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