| USN | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

3rd Internal Assessment Test-July 2022

| Sub: | Fiber Optics and Networks | | | Sub Code: | | 17EC82/15EC82 | Branch: | ECE/TCE |
|---|---|---|---|---|---|---|---|---|
| Date: | 17-07-2022 | Duration: | 90 min's | Max Marks: | 50 | Sem / Sec | 8th E Section | |

| | | | OBE | |
|---|---|---|---|---|
| | Answer any FIVE FULL Questions | MARKS | CO | RBT |
| 1(a) | With layout explain 2*2 Mach-Zehner interferometer. | [05] | CO1 | L1 |
| 1b) | Explain designand operation of polarization independent isolator. | [05] | CO1 | L1 |
| 2(a) | Briefly discuss Raman Amplifiers. | [05] | CO1 | L3 |
| (b) | Explain the basic operation of long haul circuit switching telecommunication networks. | [05] | CO1 | L3 |
| 3(a) | Explain 4*4 OADM with miniature switching mirrors. | [06] | CO1 | L3 |
| (b) | Explain MEMS Actuation method with neat diagram. | [04] | CO1 | L3 |
| 4 | With the help of energy level diagram,explain the amplification mechanism in EDFA amplifier. | [10] | CO1 | L1 |
| 5 | Explain a optical packet switched network with neat diagram. | [10] | CO1 | L3 |
| 6(a) | Explain IPV6 packet with extension header. | [06] | CO1 | L3 |
| 6(b) | Explain ATM Protocol architechture. | [04] | CO1 | L1 |
| 7 | Explain the concept of optical burst switching. | [10] | CO1 | L3 |
| 8 | Explain public communication network with neat diagram. | [10] | | |

| Course Outcomes | | Modules covered | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | Classification and working of optical fiber with different modes of signal propagation. | **1** | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CO2 | Describe the transmission characteristics and losses in optical fiber communication. | **2** | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | Different kind of optical sources used for communication as well as optical transmitter and receiver. | **3** | 1 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CO4 | Optical multiplexers, optical amplifiers | **4** | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| CO5 | Different optical networks | **5** | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

Solution IAT 3

Fiber Optics & Networks

**Q.1a ) With layout explain 2X2 Mach-Zehnder interferometer.**

Solution 1.a) Mach-Zehnder Interferometer Multiplexers

The Mach–Zehnder check interferometer is a highly configurable instrument. In contrast to the well-known Michelson interferometer, each of the well-separated light paths is traversed only once.

If the source has a low coherence length then great care must be taken to equalize the two optical paths. White light in particular requires the optical paths to be simultaneously equalized over all wavelengths, or no fringes will be visible. As seen in Fig. 1, a compensating cell made of the same type of glass as the test cell (so as to have equal optical dispersion) would be placed in the path of the reference beam to match the test cell. Note also the precise orientation of the beam splitters. The reflecting surfaces of the beam splitters would be oriented so that the test and reference beams pass through an equal amount of glass. In this orientation, the test and reference beams each experience two front-surface reflections, resulting in the same number of phase inversions. The result is that light travels through an equal optical path length in both the test and reference beams leading to constructive interference.[4][5]

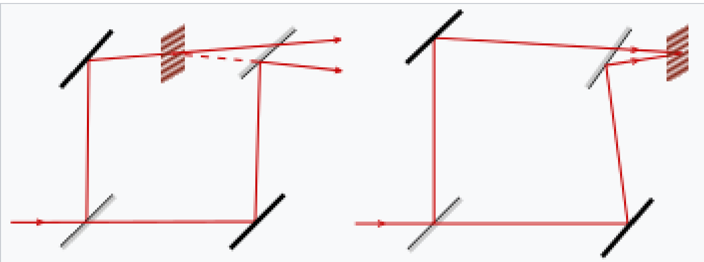


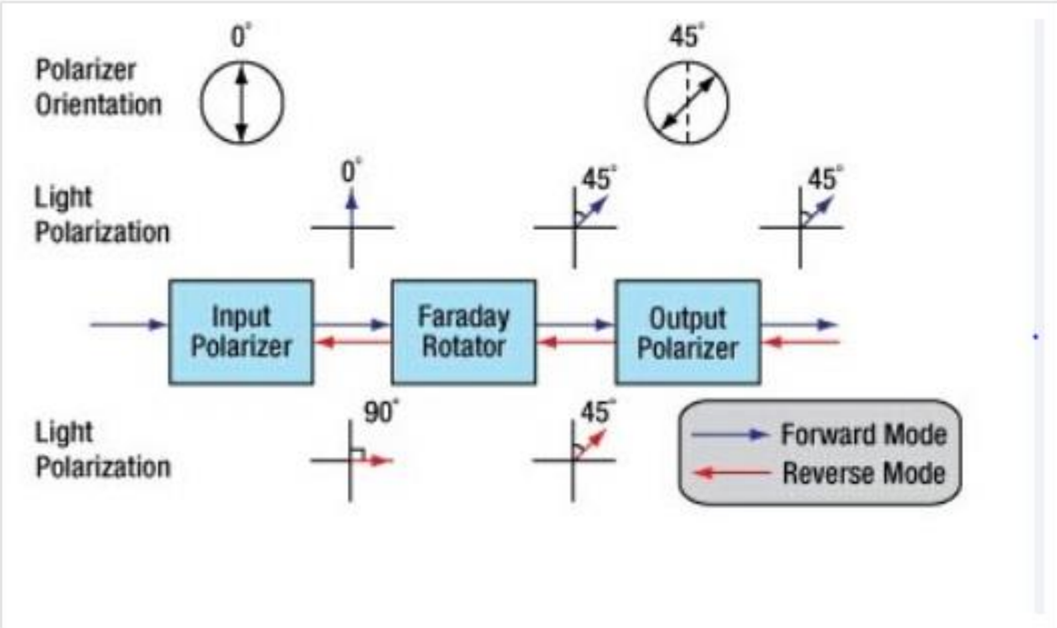
Figure. Localized fringes result when an extended source is used in a Mach–Zehnder interferometer. By appropriately adjusting the mirrors and beam splitters, the fringes can be localized in any desired plane.

Collimated sources result in a nonlocalized fringe pattern. Localized fringes result when an extended source is used. In Fig. 2, we see that the fringes can be adjusted so that they are localized in any desired plane. In most cases, the fringes would be adjusted to lie in the same plane as the test object, so that fringes and test object can be photographed together.

The Mach–Zehnder interferometer's relatively large and freely accessible working space, and its flexibility in locating the fringes has made it the interferometer of choice for visualizing flow in wind tunnels and for flow visualization studies in general. It is frequently used in the fields of aerodynamics, plasma physics and heat transfer to measure pressure, density, and temperature changes in gases.

Mach–Zehnder interferometers are used in electro-optic modulators, electronic devices used in various fiber-optic communication applications. Mach–Zehnder modulators are incorporated in monolithic integrated circuits and offer well-behaved, high-bandwidth electro-optic amplitude and phase responses over a multiple-gigahertz frequency range.

**Q.1 b)Explain design and operation of a polarization independent isolator.**
Sol.1.b)
**Polarization Independent Isolator**
The polarization independent isolator also consists of three parts, an input birefringent wedge, a Faraday rotator, and an output birefringent wedge. Light traveling in the forward direction is split by the input birefringent wedge into its vertical (0°) and horizontal (90°) components, called the ordinary ray (o-ray) and the extraordinary ray (e-ray) respectively. The Faraday rotator rotates both the o-ray and e-ray by 45°. This means the o-ray is now at 45°, and the e-ray is at −45°. The output birefringent wedge then recombines the two components.

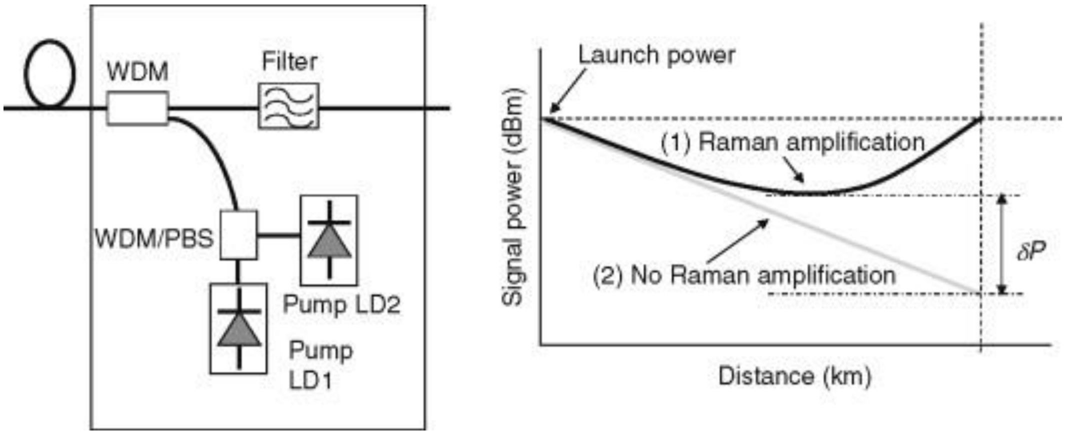



Light traveling in the backward direction is separated into the o-ray at 45, and the e-ray at −45° by the birefringent wedge. The Faraday Rotator again rotates both the rays by 45°. Now the o-ray is at 90°, and the e-ray is at 0°. Instead of being focused by the second birefringent wedge, the rays diverge. The picture shows the propagation of light through a polarization independent isolator. While polarization dependent isolator allows only the light polarized in a specific direction, polarization independent isolator transmit all polarized light. So it is usually widely used in optical fiber amplifier.

**Q. 2 a) Briefly discuss Raman amplifiers.**

Sol.2 a) Raman Amplifiers

Raman amplification is an alternative amplification technology and has been increasingly implemented in long-haul system. The Raman amplifier is different from the EDFA in that it is a distributed amplification system. Figure shows a schematic of the Raman amplifier and power profile along the transmission line.




Raman amplifier.

The Raman amplifier makes use of stimulated Raman scattering (SRS) within the fiber, which transfers the energy of higher-frequency pump signals to lower-frequency signals. The amplification occurs along the transmission fiber for the distributed Raman amplifier. The typical configuration is a backward pump scheme, as indicated in the Figure, which would introduce less noise.1 The low-noise feature and large gain bandwidth make Raman amplification very attractive to long-haul systems. In some applications, such as when a large span or extra-wide bandwidth is required, the Raman amplifier is the only one that can be used. This amplifier requires much higher power than the EDFA. In practice, a Raman amplifier uses multiple pump lasers to realize high gain and flatness. Using a polarization multiplexer, two pump lasers with the same center frequency can be used to double pump power and reduce the polarization dependency of Raman gain. It is also common to use a WDM coupler to add up two to three pump lasers with different center frequency. When using a different wavelength, pump power can be increased, and bandwidth is enlarged as well. By adjusting the ratio of these pump powers, Raman amplifier can achieve flat gain. To obtain optimum performance, the pump power of each laser has to be set according to the signal spectrum received.

**Q.2 b)Explain the basic operation of long-haul circuit switching telecommunication networks.**

Sol 2.b)Long Haul Networks

- A long-haul network as the name implies is a network connecting several regional or national networks together.
- These networks are also referred to as core or backbone networks and they also interconnect other long-haul networks to extend global interconnectivity between national domains.
- A current long-haul optical network typically comprises point-to-point DWDM links with optical regenerators at end points and with erbium-doped fiber amplifiers (EDFAs) placed between the end terminals as shown in Figure .
- Moreover, an optical 3R regenerator is often used at typically 600 km intervals to reduce overall signal degradation on the link.
- Using the above network structures it is possible to interconnect optical networking nodes situated in different cities around the globe.

- For example, a European network organization euNetworks carries a high capacity optical fiber long-haul network.
- It extends over a 5400 km route and interconnects 18 cities in five countries: namely Germany, France, Belgium, the Netherlands and the UK.
- Two submerged cables link Europe to the UK while long-haul optical fiber links interconnect the metropolitan area networks of the 18 cities.
- Similarly, 30 major cities in the United States are also interconnected by a long-haul optical fiber network as illustrated in Figure 15.30.
- Improvements in transmission systems incorporating DWDM, advanced signal modulation formats and extended forward error control play a significant role in making the above longer haul distances feasible.
- Moreover, the majority of existing long-haul DWDM networks operate at channel rates of either 2.5 Gbit $s^{-1}$ over 64 or more channels and 10 Gbit $s^{-1}$ with up to 40 wavelength channels.
- But it is apparent that transmission rates from 40 to 160 Gbit $s^{-1}$ per channel with more than 100 wavelength channels will be deployed in the near term.
- Submerged or transoceanic optical fiber networks typically cover very long distances between the continents (i.e. in the 3000 to 10 000 km range) where most of the optical fiber cable lies in deep sea water.
- In order to construct such long-length ultra long-haul networks both the fiber attenuation and dispersion must be reduced so that they have minimum impact.
- Moreover, submerged networks primarily use repeaters that only reamplify the signal (i.e. 1R amplifiers are commonly referred to as repeaters in submerged deployments).
- Optical amplifiers also require electrical power which is fed to them through insulated copper cables that run down the length of the fiber cable.
- Submerged systems therefore demand the highest fiber transmission performance under the most stringent optical power budgets and the harshest environmental conditions.
- The various elements that comprise a submerged cable system are shown in Figure 15.31.
- This system basically consists of two sections with dry and wet plants residing on dry land (i.e. landing section) and in sea water (i.e. submerged section).
- The landing station houses the terminal equipment that interconnects the optical signal from the submerged cable and passes it on to a terrestrial system.
- The underwater cable includes repeaters, gain equalizers and branching elements to facilitate access to other landing stations.

**Q.3 a)Explain 4X4 OADM with miniature switching mirrors.**

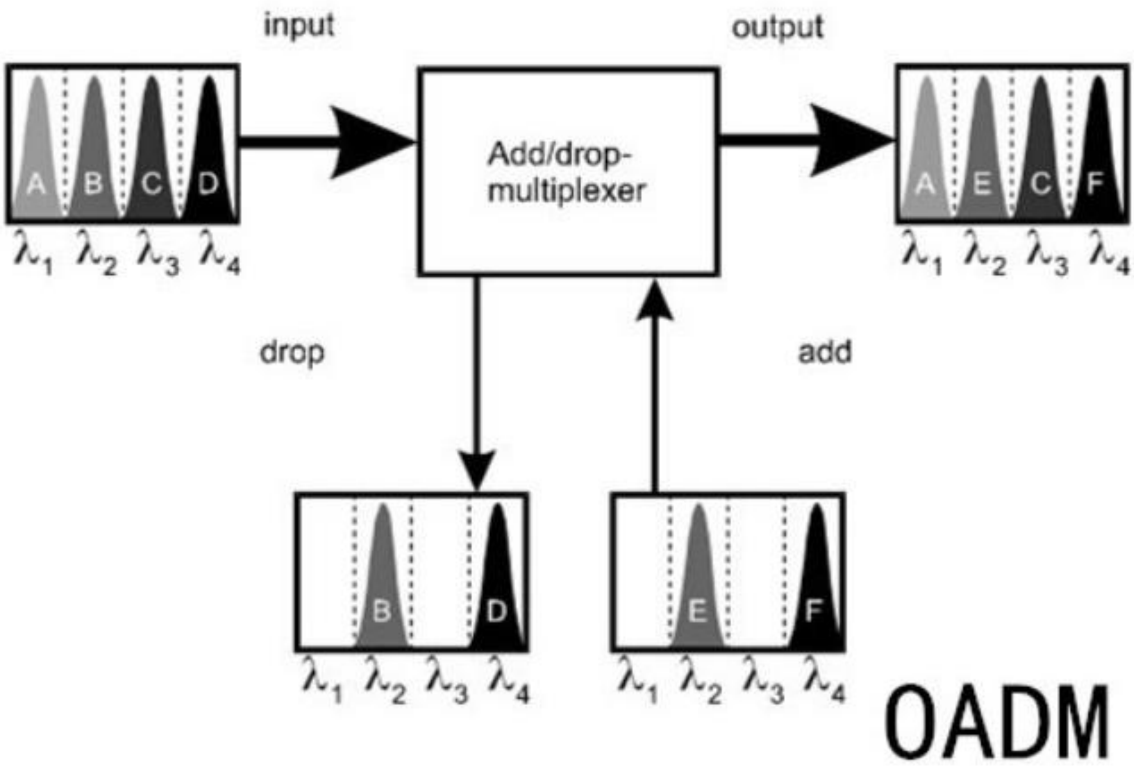
Sol 3.a) OADM (4x4)

An **optical add-drop multiplexer** (**OADM**) is a device used in wavelength-division multiplexing systems for multiplexing and routing different channels of light into or out of a single mode fiber (SMF). This is a type of optical node, which is generally used for the formation and the construction of optical telecommunications networks. "Add" and "drop" here refer to the capability of the device to add one or more new wavelength channels to an existing multi-wavelength WDM signal, and/or to drop (remove) one or more channels, passing those signals to another network path. An OADM may be considered to be a specific type of optical cross-connect.

A traditional OADM consists of three stages: an optical demultiplexer, an optical multiplexer, and between them a method of reconfiguring the paths between the demultiplexer, the multiplexer and a set of ports for adding and dropping signals. The demultiplexer separates wavelengths in an input fiber onto ports. The reconfiguration can be achieved by a fiber patch panel or by optical switches which direct the wavelengths to the multiplexer or to drop ports. The multiplexer multiplexes the wavelength channels that are to continue on from demultiplexer ports with those from the add ports, onto a single output fiber.

All the lightpaths that directly pass an OADM are termed *cut-through lightpaths*, while those that are added or dropped at the OADM node are termed *added/dropped lightpaths*.

The WDM signal contains multiple wavelength channels. When these wavelengths enter into the main input of OADM, they can be selected to enter the drop output ports according to your application requirements. Correspondingly, the add ports will input the required wavelength channels. And those irrelevant wavelengths will directly pass through OADM and then be multiplexed with the added wavelengths together leaving the main output. Therefore, the function of OADM is to download necessary local signals and upload signals for the user of next node.




Q.3b)Explain MEMS actuation method with neat diagram.

Sol.3b) MEMS

- MEMS is an acronym for *micro electro-mechanical* systems.
- These are miniature devices that can combine mechanical, electrical, and optical components to provide sensing and actuation functions.

- MEMS devices are fabricated using integrated-circuit compatible batch-processing techniques.
- They range in size from micrometres to millimetres.
- The control or actuation of a MEMS device is done through electrical, thermal, or magnetic means such as micro gears or movable levers, shutters, or mirrors.
- MEMS devices are mainly used widely in :
    - Automobile air-bag deployment systems
    - Ink-jet printer heads
    - For monitoring mechanical shock and vibration during transportation of sensitive goods
    - biomedical applications for patient activity monitoring and pacemakers.
- MEMS technologies are used in light wave systems for:
    - Variable optical attenuators
    - Tunable optical filters
    - Tunable lasers
    - Optical add/drop multiplexers
    - Optical performance monitors
    - Dynamic gain equalizers
    - Optical switches

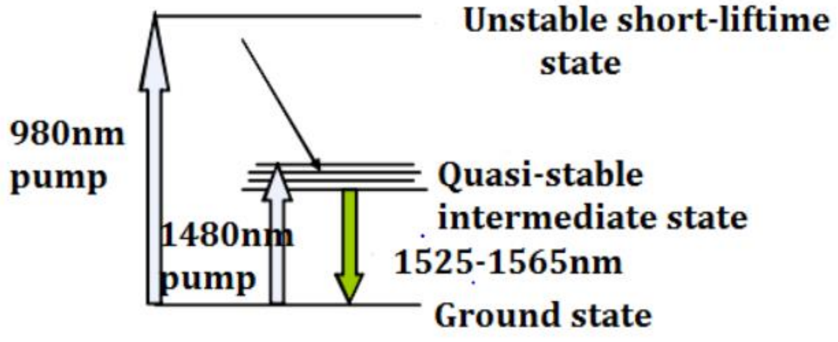
**Q.4) With help of energy level diagram, explain the amplification mechanism in EDFA amplifier**

Sol 4) EDFA :

Erbium-doped fiber amplifier (EDFA) is an optical repeater device that is utilized to boost the intensity of optical signals being carried through a fiber optic communications system. An optical fiber is doped with the rare earth element erbium so that the glass fiber can absorb light at one frequency and emit light at another frequency.

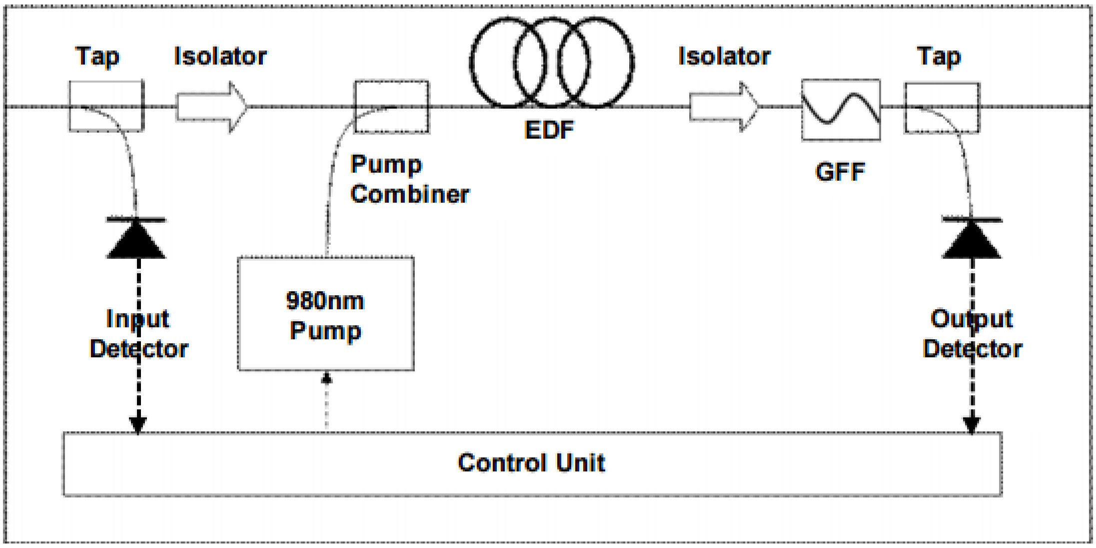
EDFA Working Principle

The erbium-doped fiber (EDF) is at the core of EDFA technology, which is a conventional silica fiber doped with Erbium. When the Erbium is illuminated with light energy at a suitable wavelength (either 980 nm or 1480 nm), it is motivated to a long-lifetime intermediate state, then it decays back to the ground state by emitting light within the 1525-1565 nm band. The Erbium can be either pumped by 980 nm light, in which case it passes through an unstable short lifetime state before rapidly decaying to a quasi-stable state, or by 1480 nm light in which case it is directly excited to the quasi-stable state. Once in the quasi-stable state, it decays to the ground state by emitting light in the 1525-1565 nm band. This decay process can be stimulated by pre-existing light, thus resulting in amplification. EDFA working principle is shown in the Figure 1.




aisc configuration of EDFA

EDFA configuration is mainly composed of an EDF, a pump laser, and a component (often referred to as a WDM) for combining the signal and pump wavelength so that they can propagate simultaneously through the EDF. In principle, EDFAs can be designed such that pump energy propagates in the same direction as the signal (forward pumping), the opposite direction to the signal (backward pumping), or both direction together. The pump energy may either be 980 nm pump energy, 1480 nm pump energy, or a combination of both. Practically, the most common EDFA configuration is the forward pumping configuration using 980 nm pump energy, as shown in the Figure 2.



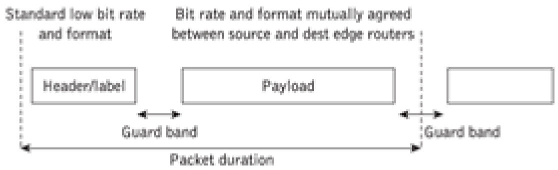

Q.5) Explain an optical packet switched network with a neat diagram.

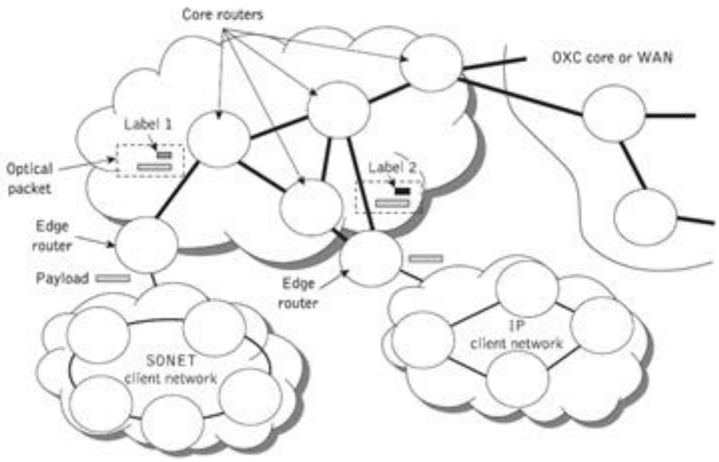
Optical packet-switched networks:

In an optical packet-switched (OPS) network data is transported entirely in the optical domain without intermediate optoelectrical conversions. An optical packet switch performs the four basic functions of routing, forwarding, switching and buffering. The routing function provides network connectivity information often through preallocated routing tables, whereas forwarding defines the output for each incoming packet (i.e. based on a routing table). The switch directs each packet to the correct output (i.e. defined by the forwarding process) while buffering provides data storage for packets to resolve any contention problems which may occur during packet transmission.

Figure shows the overall structure of a typical packet. It contains a header or label and the payload (i.e. data) and it requires a guard band to ensure the data is not overwritten. The label points to an entry in a lookup table that specifies to where the packet should be forwarded. Such a labeling technique is much faster than the traditional routing method where each packet is examined before a forwarding decision is made. At the receiving node these labels are required to be recognized from the lookup table and then the data is reassembled sequentially. Since labels define the routing criteria it is therefore sometimes referred to as label switching, which includes several functions involved in the labeling technique such as assignment (or writing) recognition (or reading), swapping (or exchanging) and forwarding etc.

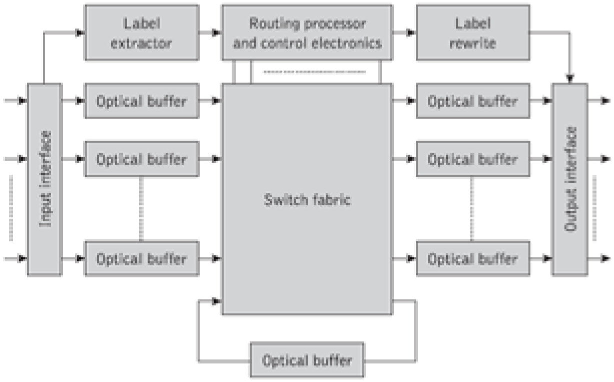
The process of address lookup, however, can be replaced by address matching using optical correlators, which are switching devices employing digital logic gates to perform optical pattern recognition similar to detecting an address from a lookup table. A set of optical correlators can therefore determine whether a packet is destined for a particular switch by correlating the address encoded into the packet with the switch's own address. If there is a match, the payload is extracted and processed. Otherwise, the packet is forwarded to the next switch.




The packets in an OPS network can carry different types of traffic (i.e. voice, data and video) and therefore such an optical packet switching scheme can integrate existing SDH/SONET and IP-based optical networks. An example of an OPS network is illustrated in Fig. It shows a long-haul or core network connected to both a SONET and an IP network. The edge routers (i.e. network nodes at the edges) perform the functions of attaching and detaching a label as identified for labels 1 and 2 attached to two different optical packets being transmitted to specific networks (i.e. to the IP and SONET client networks). Within the OPS network, however, the core router only processes the label where the content of the payload remains the same (i.e. the payload can carry ATM traffic or IP packets at different bit rates). This routing function typically involves the following four steps which are: (a) extraction of the label from the packet; (b) processing of the label to obtain routing information; (c) routing of the payload and contention resolution if necessary; and (d) rewriting of the label and recombining it with the payload. When an OPS network is implemented and only the label is processed electronically for routing purposes with the payload remaining in the optical domain, the OPS network is generally referred to as an optical label-switched (OLS) network.

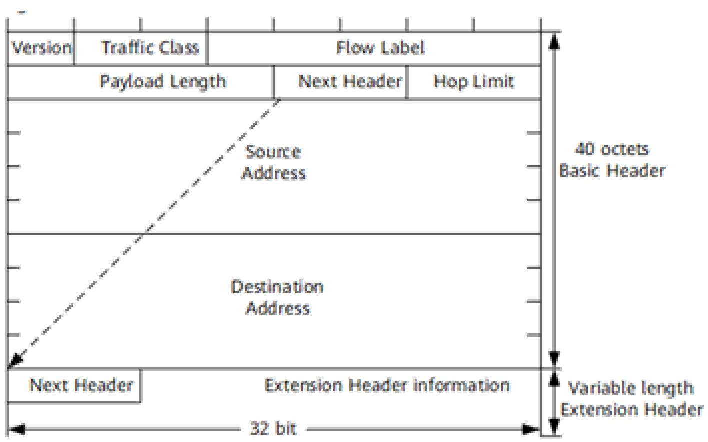
Figure depicts a generic OLS network configuration to route packets while also extracting and rewriting labels at input and output interfaces. In this particular implementation only the detached label is processed electronically and the payload (i.e. data) remains in optical buffers before being sent through the optical switch fabric to the desired output buffers. Finally, the routing processor and control section regenerate the label which is reattached with the data at the output interface.




Q. 6 a) Explain IPV6 packet with extension header.

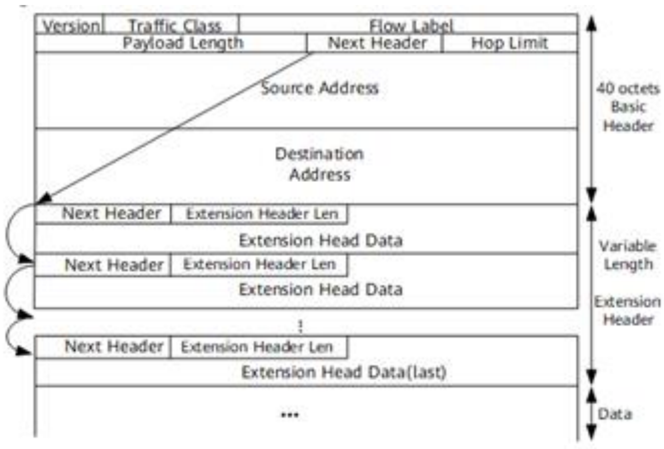
An IPv6 packet has three parts: an IPv6 basic header, one or more IPv6 extension headers, and an upper-layer protocol data unit (PDU). An upper-layer PDU is composed of the upper-layer protocol header and its payload, which maybe an ICMPv6 packet, a TCP packet, or a UDP packet. An IPv6 basic header is fixed as 40 bytes long and has eight fields. Each IPv6 packet must have an IPv6 basic header that provides basic packet forwarding information, and which all devices parse on the forwarding path.
An IPv6 basic header contains the following fields:
Version, Traffic Class, Flow Label, Payload Length, Next Header, Hop Limit, Source Address, Destination Address

Unlike the IPv4 packet header, the IPv6 packet header does not carry IHL, identifier, flag, fragment offset, header checksum, option, or padding fields, but it carries the flow label field. This facilitates IPv6 packet processing and improves processing efficiency. To support various options without changing the existing packet format, the Extension Header information field is added to the IPv6 packet header, improving flexibility. The following paragraphs describe IPv6 extension headers.




IPv6 Extension Header
An IPv4 packet header has an optional field (Options), which includes security, timestamp, and record route options. The variable length of the Options field makes the IPv4 packet header length range from 20 bytes to 60 bytes. When devices forward IPv4 packets with the Options field, many resources need to be used. Therefore, these IPv4 packets are rarely used in practice.
To improve packet processing efficiency, IPv6 uses extension headers to replace the Options field in the IPv4 header. Extension headers are placed between the IPv6 basic header and upper-layer PDU. An IPv6 packet may carry zero or more extension headers. The sender of a packet adds one or more extension headers to the packet only when the sender requests the destination device or other devices to perform special handling.

Unlike IPv4, IPv6 has variable-length extension headers, which are not limited to 40 bytes. This facilitates further extension. To improve extension header processing efficiency and transport protocol performance, IPv6 requires that the extension header length be an integer multiple of 8 bytes.




An IPv6 extension header contains the following fields:

- Next Header: 8 bits long. This is similar to the Next Header field in the IPv6 basic header, indicating the type of the next extension header (if any) or the upper-layer protocol type.
- Extension Header Len: 8 bits long. This indicates the extension header length excluding the Next Header field.
- Extension Head Data: Variable length. This includes a series of options and the padding field.

Q. 6 b) Explain ATM protocol architecture.

Asynchronous transfer mode:

Asynchronous transfer mode (ATM) is a packetized multiplexing and switching technique which seeks to combine the benefits of packet switching and circuit switching. Asynchronous transfer mode transfers information in fixed size units called cells where each cell contains the information identifying the source of the transmission but which generally contain less data than packets. Unlike the fixed time division multiplexed technique where each user waits to send in the allocated time slot, ATM is asynchronous and therefore the time slots are made available on demand. To enable correct segmentation and assembly of different cells at the destination, each cell contains significant information in addition to data. An ATM cell comprises a header and payload data as shown in Fig. It contains 48 bytes of data with 5 bytes of header information. Each single byte in the header field includes different information to identify destination, path, channel and the error control bits. Before sending ATM cells carrying user data, a virtual connection between source and destination has to be established. All connections follow the same path within the network. During the connection setup each control bit (1 or 0) generates an entry in the virtual path identifier (or virtual channel identifier) translation table to inform the destination to receive the incoming packet.


Format of an ATM cell

Q. 7) Explain the concept of optical burst switching.

Optical burst switching networks:

Combining important aspects of optical circuit switching and optical packet switching results in optical burst switching (OBS). Moreover, as OBS operates at the subwavelength level it therefore provides for rapid setup and teardown of optical network lightpaths. This hybrid switching and routing technology uses electronics to control routing decisions but keeps data in the optical domain as it passes through each optical node. Packets with a common destination are aggregated in edge routing nodes into larger transmission units called a burst or a data burst (DB), each of which is transmitted separately from the data control packet called the burst header cell (BHC) containing necessary information (i.e. for switching and destination address). Figure illustrates the concept of OBS where four edge routers of a large network are shown to establish links between data sources (Tx) and receivers (Rx) individually or by using multiplexers or demultiplexers, respectively.

Optical bursts containing both the data burst and the BHC travel on a control channel. An idle channel on the access link is selected when a data burst is required to be sent, whereas the BHC travels on the control channel ahead of its associated data burst in time and is processed electronically at every node along the path. The OBS edge router, on receiving the BHC, assigns the incoming burst to an available channel on the outgoing link leading towards the desired destination and establishes a path between the specified channel on the access link and the channel selected to carry the burst. It also forwards the BHC on the control channel of the selected link, after modifying the cell to specify the channel on which the burst is being forwarded. This process is repeated at every routing node along the path to the destination. The BHC also includes an offset field which contains the time between the transmission of the first bit of the BHC and the first bit of the burst, and a length field specifying the time duration of the burst. One or several channels on each link can be reserved for control information that is used to control the dynamic assignment of the remaining channels to user data bursts. It should be noted that the WDM transmission links shown in Figure carry a number of wavelength channels and the user data bursts can be dynamically assigned to any of these channels by the OBS routers.

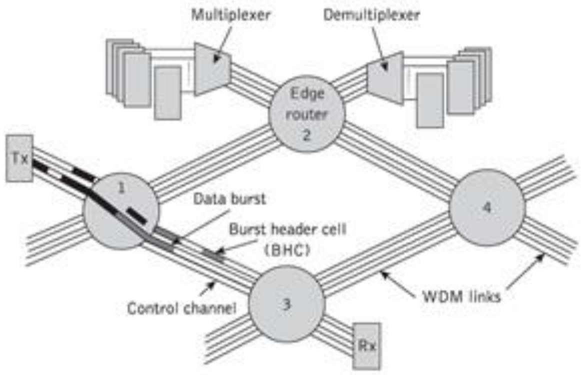
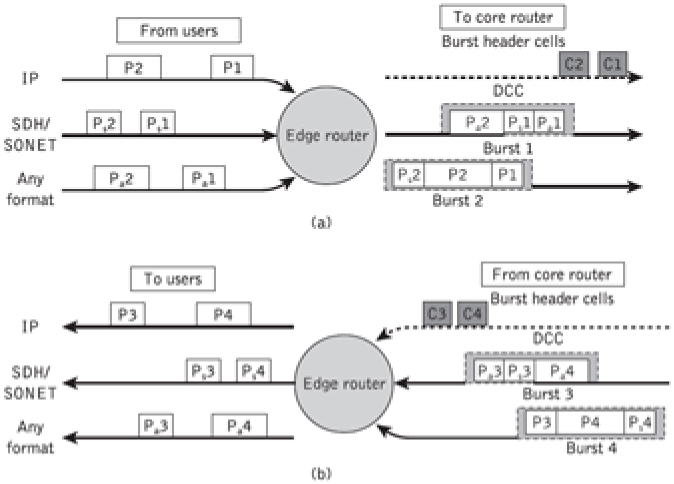



Figure below depicts the edge router’s function in more detail providing burst assembly and disassembly operations at ingress and egress, respectively. In Figure (a) each of the users operating on different formats (i.e. IP, SONET, ATM, WDM/DWDM, etc.) sends different data to the edge router. The router disassembles the data and issues BHCs (i.e. C1 and C2 shown in Figure (a)) on the data control channel (DCC) in advance for Burst 1 and Burst 2, respectively. Each burst may contain different data: for example, Burst 1 contains data Pa2, Ps1 and Pa2, where the subscripts a and s represent any format and SDH/SONET, respectively. In order to perform burst assembly as shown in Figure (b) the control channel provides BHCs (i.e. C3 and C4) for the data bursts Burst 3 and Burst 4, respectively. The users then receive their corresponding disassembled data that the edge router received from the core router.




It should be noted from Figure that the disassembly at egress edges (i.e. sending to users) is simpler than the assembly (or transmission) of the burst (i.e. burstification) at ingress edges. In the latter case, since different signal formats may be used then various signaling and control protocols can be employed to enable optical burstification and OBS routing. Furthermore, the reservation and scheduling of resources for the burst switching in this process are important factors where the former considers end-to-end burst transmission and the latter focuses on assigning and managing resources for individual bursts within OBS nodes.

Depending on the network dimension and granularity (i.e. burst size), either one- or two-way signaling protocols are used at the edge routers of an OBS network. With two way signaling, sending back an acknowledgment signal to confirm the safe arrival of the signal is required, whereas no such feedback mechanism is available when using one-way signaling protocols. One-way protocols include tell-and-go (TAG) and justenough- time (JET). These are also referred to as one-pass reservation protocols. Examples of two-way signaling protocols are tell-and-wait (TAW) and just-in-time (JIT), which are predominantly used for the purpose of burst reservation and scheduling. In case of the JET or TAG protocols, the burst transmission does not wait for the acknowledgment of successful end-to-end path setup and the burst transmission is initiated immediately, or shortly after the burst has been assembled following the control packet being sent out. If the burst transmission with the TAG protocol is delayed with respect to the control header, then the delay is referred to as offset time and can be reduced by compensating the processing times. In this scheme less bandwidth is therefore wasted but the burst drop rate increases and it is not considered to be as reliable. Due to the submillisecond burst duration assumed in TAG burst management, this scheme is usually considered for application in metropolitan and access networks where distances are comparatively short.

The JIT and TAW protocols utilize ATM delayed transmission and they wait for an acknowledgment before sending a burst. This process assumes conventional end-to-end transmission (i.e. virtual path) leading to a setup delay for the optical bursts (i.e. in the millisecond range for long-haul networks). If the intermediate switches are set in advance during the setup phase to avoid this delay, then the bandwidth wasted can be much higher than the bandwidth actually needed for burst transmission.

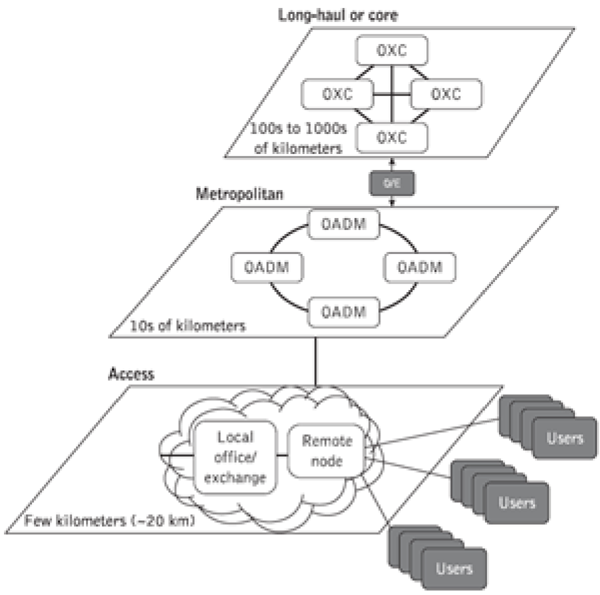
In addition to burst reservation, burst scheduling assigns and manages the resources for individual burst switching nodes. Burst scheduling schemes can be classified based on the duration for which resources are scheduled for a burst. The reserve-a-limited duration (RLD) and reserve-a-fixed duration (RFD) schemes are commonly adopted for burst reservation. The RLD requires the sender to signal the start and end of a burst and resources are explicitly reserved until the end of burst transmission. For each resource, the idle time (i.e. the duration when the resource is free or available) is recorded. The RFD scheme, however, considers the exact start and end time of bursts for resource scheduling. For example, the gaps (or voids) between already reserved bursts can be used for newly arriving bursts. Moreover, several designs have been used to optimize resource allocation of both the RLD and RFD schemes by improving wavelength selection or by minimizing voids.

Advanced techniques referred to as adaptive and autonomic OBS have also been proposed which can learn and adapt new routes after acquiring network information such as wavelength routing, wavelength selection, protection and the information related to the restoration mechanisms. Such OBS techniques use a feedback mechanism to optimize the selection of control and routing information and therefore they are capable of being both self-protecting and self-optimizing.

Q. 8) Explain public telecommunications network overview with neat diagram.

Public telecommunications network overview:

The telecommunications network providing services in the public domain is known as the public telecommunications network where the service providers (or carriers) offer a variety of services for the provision of voice, data and video transmission. A simple block hierarchy for the optical public telecommunications network is illustrated in Figure, which is divided into three tiers: long-haul, metropolitan and access networks. The long-haul network, also known as the core or sometimes the backbone network, provides national or global coverage with a reach of thousands of kilometers. These networks connect many metropolitan networks within a country or interconnect together several country-wide long-haul networks. Interconnection between optical nodes is generally accomplished by means of optoelectrical conversion and/or optical switches employing OXCs.




At the next lower hierarchal level resides the metropolitan area network (MAN), often called the metro, or sometimes the back-haul network. These networks offer a multiservice platform and may be confined to a region spreading to tens of kilometers. At present they are largely implemented using the ring topology. The interconnections between optical nodes in metro networks are also achieved using OADMs while the larger metro networks can also incorporate OXCs. The lowest tier in the hierarchy is the local access network which may be extended from a few hundreds of meters to 20 kilometers or so. Hence the access network provides the initial interface to the telecommunications network for residential and business customers. Although these networks can be configured based on the bus, star or ring topologies, the fiber access network configuration illustrated in Figure is currently gaining favor. The users are connected to a branching node known as a remote node (RN) which interconnects the users with the local office/telephone exchange. In order to provide larger interconnectivity, several local offices/exchanges are connected using a metropolitan area network.