# DIGITAL ASSIGNMENT – 2

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**Q.1**

Write any three possible application of optical fibres.

**A.1**

1**)** MEDICAL FIELD:

→The most significant and prevalent applications of fibre optics in medicine are in the imaging and illumination components of endoscopes. Flexible and rigid multi-fibres composed of step-index fibres and graded-index imaging rods are extensively used for visualization of internal organs and tissue which are accessible through natural openings or transcutaneously (passing, entering, or made by penetration through the skin **transcutaneous** infection).

The fabrication techniques of optical fibres for imaging and illumination are considered in juxtaposition to their current applications in communications with emphasis on the different technologies involved. The design of distinct endoscopes is described with a detailed review of their use in various medical specialities. Low-loss optical fibres are employed to transmit laser energy for surgery and photocoagulation. Multicolour laser light is transmitted through a single thin optical fibre to provide adequate illumination for viewing and colour photography.

Other uses of fibre optics in medicine include remote spectrophotometry, pressure and position sensing, or scintillation counting and other applications, such as intravascular pressure transducers and in vivo oximeters.

2**)** MILITARY:

→Fibre optic links offer many advantages for a variety of military uses. On the practical side, optical fibre 1s lightweight, compact. flexible, reliable, inexpensive, strong. and commercially available in very long lengths. Technically. optical fibre has a carrier frequency in the terahertz range and 1s capable of transmitting large bandwidth signals, having an optical attenuation as low as 0.2 dB/km with no inherent microwave loss. Furthermore, the fibres are easy to access and free from electromagnetic interference. The above properties lead to numerous military applications that can be grouped as following:

(1) delay lines and communication links,

(2) data buses and computer use,

(3) coherent communication and signal processing,

(4) sensors for various measurands of military interest and

(5) active tethers for remote vehicles.

Simple communication systems consisting of point to point links operating at a few Mbit/s are now being deployed. Delay lines that operate out past X-band (10 GHz) serve as local oscillators, remote transmitters, and buffers for signal processing; these delay lines have time-bandwidth products approaching 105 which is unobtainable with other technologies. Fibre optic sensors that measure acoustic fields. magnetic fields. rotation rates, temperature. etc. are invaluable for military systems.

3**)** LIGHTING & IMAGING:

→The light in a fibre-optic cable travels through the core (hallway) by constantly bouncing from the cladding (mirror-lined walls), a principle called **total internal reflection**. Because the cladding does not absorb any light from the core, the light wave can travel great distances.

However, some of the light signal **degrades** within the fibre, mostly due to impurities in the glass. The extent that the signal degrades depends on the purity of the glass and the wavelength of the transmitted light (for example, 850 nm = 60 to 75 percent/km; 1,300 nm = 50 to 60 percent/km; 1,550 nm is greater than 50 percent/km). Some premium optical fibres show much less signal degradation -- less than 10 percent/km at 1,550 nm.

Fibre optic cables are used for lighting and imaging and as sensors to measure and monitor a vast range of variables. It is also used in research, development and testing in the medical, technological and industrial fields.

Fibre optics are used as light guides in medical and other applications where bright light needs to shine on a target without a clear line-of-sight path. In some buildings, optical fibres are used to route sunlight from the roof to other parts of the building. Optical fibre illumination is also used for decorative applications, including signs, art and artificial Christmas trees.

Optical fibre is an essential part of the light-transmitting concrete building product, LiTraCon which is a translucent concrete building material.

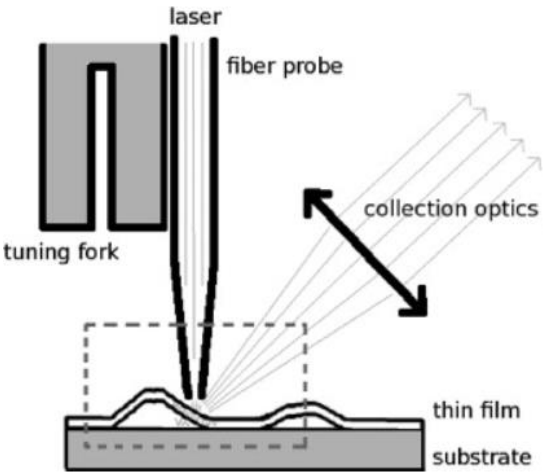
**Q.2**

Describe how optical fibre has revolutionized the "near field imaging technology"

**A.2**

Near field imaging is a technique that allows us to achieve resolution up to an order of magnitude below that of conventional far field optical microscopy. Since the imaging is performed at optical wavelengths it retains many of the advantages of optical microscopy while simultaneously eliminating the major disadvantage, posed by the diffraction limit. The resolution of this system is governed primarily by the size of the aperture used to collect the light and the distance between the scanning aperture and the sample. Hence by fabricating apertures smaller than the wavelength of light used, we obtain sub-wavelength resolution. In addition, near field imaging also allows the evanescent fields from surface waveguides and D-fibres to be measured directly.

**Near-field optics** is that branch of optics that considers configurations that depend on the passage of light to, from, through, or near an element with subwavelength features, and the coupling of that light to a second element located a subwavelength distance from the first. The barrier of spatial resolution imposed by the very nature of light itself in conventional optical microscopy contributed significantly to the development of near-field optical devices, most notably the near-field scanning optical microscope, or NSOM.




NSOM is based on use of nanoscale light source, detector or scattered scanned in close proximity to sample surface. In this way the diffraction limit of conventional optics can be overcome.

The primary components of an NSOM setup are the light source, feedback mechanism, the scanning tip, the detector and the piezoelectric sample stage. The light source is usually a laser focused into an optical fibre through a polarizer, a beam splitter and a coupler. The polarizer and the beam splitter would serve to remove stray light from the returning reflected light. The scanning tip, depending upon the operation mode, is usually a pulled or stretched optical fibre coated with metal except at the tip or just a standard AFM cantilever with a hole in the centre of the pyramidal tip.

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