LASER TECHNOLOGY

The term laser is an acronym for Light Amplification by Stimulated Emission of radiation. A laser is an optical device which emits a single coloured light in the form of one single beam. It differs in frequency and vibrations from other lights. It works on the operation of free electrons. The first working laser was demonstrated on May 16, 1960 by Theodore Miman at California, USA. Since then laser is used for several reasons. Different types of materials are used to produce lasers. There are gas lasers, chemical lasers, dye lasers and many others.

APPLICATION:

1. Commercial use: The first application of laser was in the supermarket barcode scanner in 1974. Later it was used in the compact disc reader in disc players and computer disk drives. The latest common use of laser is in printers.

2. Industrial use: Lasers are used for cutting and welding of metals in industry. They are used to drill holes and shape hard materials like plastic and wood. Lasers are also used for inscribing letters on materials. Lasers cut with precision and does not leave uneven marks. They can be directed by computers and easily handled.

3. Distance and velocity measurement: Distances can be measured with lasers by calculating the time taken by light to reach that distance. The Portable Velocity meters are devised using the laser lights to detect the speed of moving car.

4. Medical use: Laser is put to a wide range of use in the medical field. Laser operations are sterile, bloodless surgery which even takes less recovery time. A laser not only cut the skin sharply but also seals it simultaneously. Its use in the area of optics is remarkable. It is used to repair the retina, treat glaucoma, and also cataract. It is used in the removal of cancer and tumors, removal of dental caries, and treatment of fractured bones. Lasers are also widely used in cosmetic
surgery. It is used for hair removal, skin spot and birthmark removal and also fat removal surgeries.

5. **Optical communication:** Lasers are used in the fiber optic cables for long distance communication through them. Signals formulated by lasers are used to communicate information.

6. **Environmental studies:** Lasers are used in pollution control and monitoring environment. A beam of light is sent in the atmosphere to detect and measure suspended particles.

7. **Defense:** Lasers are used into radars in finding the range of targets. They are also used in signal light guns used in air force to direct an airplane during radio signal failure. Modern weaponry is equipped with lasers to specify direction of shooting and conceal the source of shooting. They are also used in distracting devices effective in creating confusion among the enemy.

8. **Holography:** Holography is a technique in which lasers are used to produce three dimensional pictures. This technique uses the reflection of laser light and creates an interface which gives depth to the picture. Holographic images are widely used for varied purposes today such as authentication purpose, brand promotion, decoration and also labeling and sealing.

9. **GIS/GPS mapping:** When used with Geographical Information systems, lasers help to derive details about a certain area with specification. They are used in various fields like urban planning, cartography and advertising and marketing. Lasers can be connected to GPS devices to collect data related to remote areas. With the help of lasers the slope distance, angular distance and inclination of the area can be measured. It is beneficial for trekking, geographical and geological surveys.

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**SATELLITE TECHNOLOGY**

Artificial satellites are objects that are placed in the earth's atmosphere; they are connected to systems on the earth. Satellites can receive data from and send data to earth in the form of signals. They can be connected to numerous programmes and systems at one point of time.

The world’s first satellite named Sputnik I was sent in space in 1957 by Soviet Union. Since then numerous satellites have been sent in space by several countries. A satellite is launched in space with the help of a rocket. The rocket gives necessary thrust to the satellite to attain velocity and evolve around the earth in a certain
momentum. Gradually habitable space stations developed which maintained better control and observe satellites. In India, the Indian Space research Organization (ISRO) is responsible for research, development and operations of space systems.

A. Uses of space technology:

Satellites are used for a large number of purposes. The structure and functioning of the satellite is designed depending upon the purpose. Following are the various uses of space technology:

1. Navigation: Navigation satellites can be connected to Satellite navigation systems to attain exact location of the systems within a radius of few metres. The receiver system can get information such as latitude, longitude and altitude from radio signals sent by the satellites in space. To obtain such data the receiver has to connect to two or more satellites. Global Positioning Systems (GPS), designed by the USA, is a satellite navigation system most widely used today. This system is available in independent devices, vehicles, airplanes and also mobile phones. Today, France and Japan are on their way to develop a regional GPS. The GPS aided Geo- Augmented Navigation is a planned implementation of a regional satellite based augmentation system developed by India. Such navigation systems help to guide aircrafts during difficult weather conditions, help people find way in unknown regions and track lost people and machines through their GPS signals.

2. Weather forecasting: Modern weather forecasting is done with the help of a compound system consisting of weather satellites, remote sensing systems, advanced radars and complex weather data analysing machinery and computer programmes. Weather satellites send photographs of earth at regular intervals to the forecasting department. The department can analyse the climate and predict weather through the continuous data coming in from the satellites. Satellites are used to monitor and record information related to ocean level rise, sea surface temperature, and snowfall and ice bodies around the world.

a. Geostationary Operational Environmental Satellites (GOES): there are two GOES satellites; the GOES East and GOES West. This satellite revolves at the speed of the earth. It constantly monitors various areas of the planet and gives updates information through photographs at every 15minutes. These are critical for identifying severe weather, storms and hurricanes.
b. Polar Operational Environmental Satellites (POES): POES orbit the earth longitudinally from pole to pole from a lower altitude than GOES. Based on the information obtained from POES meteorologists can develop models to predict weather conditions. Data from POES series is also useful for a wide range of environmental monitoring applications such as volcanic eruptions monitoring, global vegetation analysis etc. They are beneficial for long term analysis of weather conditions. Active emergency locator beacons also can be detected by POES, which is beneficial during rescue operations.

1. Communication: All wireless communication of modern times is based on satellite connectivity. Radio, television, cell phones and internet work through satellite information. Long distance communication has connected remotest places. With development in broadcasting technology, faster sending and receiving information has become possible. Cell phone network providers are setting up more number of towers at every place possible to provide better coverage. Satellite communications are increasingly used to transmit information to remote areas which do not have cell phone reception.

2. Disaster management: Satellites help to predict and detect natural calamities like storms, hurricanes and even volcanic eruptions early. Evacuation and other precautionary activities thus become possible. During disasters satellites are only option of communication. Thus satellites have become indispensable parts of climatic disaster management.

3. Scientific research: Satellite gathers information about all aspects of the earth such as atmosphere, geology, ocean and also the moon. They also collect information about the space, other planets and the sun. Such information gathered by satellites is useful for research. It is through satellites that scientists are able to study the mars and have sent robotic missions on the planet. Other such exploratory satellite is currently observing the Jupiter.

4. Observation of earth’s surface: Observation satellites help to observe many features of the earth. They help to locate freshwater resources, oil resources and mineral resources and observe forest life.

B. Global Positioning system (GPS)

Global positioning system or GPS is the only operational Global Navigational Satellite System. It is a set of satellites and control systems that allow a specially designed GPS receiver to
determine its location anywhere on earth. The receiver gets connected to more than 20 satellites at a time to determine its exact location. It has wide range of applications today. It was developed by the Department of Defense of the US.

Uses of GPS

1. Military: Primarily developed for the military, the GPS allows accurate targeting of various military weapons including cruise missiles.

2. Automobile: Cars can be equipped with GPS receivers which display moving maps and information about location, speed, directions, nearby streets and landmarks. The GPS can act as a tracking device and thus can be helpful to locate a lost or stolen car. Cyclists use GPS in racing and tours to plot their way through congested spaces and especially mountain ranges and places with no direction signs.

3. Aircraft: GPS in the aircrafts are also designed to give information about the nearest landing option, mountain passes and other direction suggestions. It can be connected to the autopilot option for better navigation.

4. Hikers: Hikers venture in unknown and isolated areas. GPS helps them to determine their position precisely. It can be very helpful if somebody gets lost away from the team.

5. Tracking devices: GPS tracking devices can be attached to vehicles, persons and pets to record their position at regular intervals and locate them at any point of time. GPS functionality is used in emergency conditions to locate cell phones. This system is helpful for the police to track movement and gather evidence.

6. Integration with GIS: GPS can be integrated with the GIS (Geographic Information System) to get accurate information from the field for the purpose of mapping. Customized computer software’s are prepared that can analyze data from GPS and reduce positioning errors in the GIS.

7. Satellite communication: The antennas used for satellite communication can be incorporated with GPS to provide exact location of the moving systems like the train or ship.

8. Weather prediction: Specialized GPS satellites help to study earth’s atmosphere with the help of a technique known as GPS occultation. This includes study and calculation of bending of GPS satellite signals to determine atmospheric conditions like air density, temperature, moisture etc.
Marketing: Some companies have combined GIS systems and survey based research to help the companies decide where to open new branches, target advertising and use new methods of advertising.

INFORMATION AND COMMUNICATION TECHNOLOGY

The modern world is known as the IT world. The various advances in this field have changed the mediums and methods of communication drastically. New research and development in information and communication technology is poised to provide faster, easier and cheaper mediums of communication. IT or OCT deals with the use of electronic computer hardware and software to convert, store, protect, process, transmit and retrieve information. The use of IT has become an inseparable part of life today. Daily communication, business and even entertainment revolves around the various mediums of IT.

A. Applications of IT:

1. Telecommunication: Telecommunication is the electronic exchange of information it includes mediums like telephone, faxes, computers, pagers etc. Telephone is the most widely used modern technological medium of communication. Telegraph, now not in use, was also one of the fastest mediums of direct communication in earlier times. They used connection of direct cable wires for communication. With further progress radio signals, fiber optics and satellite communication replaced them. The fax machine is used to scan and send documents across regions through signals. Latest fax machines use a computer programme as receiver and are faster than the earlier ones.

2. Radio and television: Broadcast systems work on transmission of high frequency electromagnetic waves to numerous low powered receivers. The receiver is tuned to retrieve the signal containing audio and/or visual information. Both radio and television work on this principle. With advancement in broadcasting and satellite technology, television now works on digital signals. This has reduced distortions and improved quality of picture and sound.

3. Mobile phones: Mobile phones cellular phones have revolutionized communication in more than one ways. The first and foremost being constant connectivity a person can be contacted at any place on a mobile phone. Short Messaging Service (SMS) has become the fastest way of messaging in both formal and informal forms of communication and also business. The two forms of mobile
technologies namely Global System for mobiles (GSM) and Code Divisional Multiple Access (CDMA) provide wide range of functions on cell phones. CDMA is an improved technology providing better voice quality, better power management to enhance battery life and longer talk time. Today mobile phones are connected to internet services thus providing wider range of communication. This gives access to emails, sending and receiving of multimedia, web browsing and email. Varied commercial services like banking, paying bills, money transfer and shopping can also be done through mobile phones today.

4. Internet: Internet is a worldwide network of computers. It is seamless electronic network of computers all over the globe. It is a platform for communication, sharing information and even education. Computers connect each other through their unique Internet Protocol (IP) address. One a smaller level, (Local Area Network) LAN and Wider Area Network (WAN) services are available for internet connectivity. Modern computers are equipped with a LAN ports that can be connected with modem or internet cables. LAN extends only up to a few kilometers. WAN extends up to a thousand kilometers. Both give better privacy and security on a smaller level and are also cost effective.

Internet connectivity is the soul of information and communication technology in modern times. Emails are used for almost all the important official communications. Online banking has facilitated handling of banking transactions at any time of the day. Ticket reservations, shopping, availing network services and also registering to educational courses have become —online today.

5. Videoconferencing: Videoconferencing uses a set of telecommunication technologies to facilitate audio as well as video communication among two or more users. Official meetings, educational lectures, addresses for seminars can be conducted using this technology. It is also used for point to point or a two way communication among only two parties. The aim of a conference that is discussion, sharing documents, and arriving at solutions through presentations all of this can be achieved through videoconferencing. It has reduced distance between the communicators by allowing them to communicate.

B. Convergence of technology:

Meaning:

Each of the communication medium or technological form uses a certain medium and form of knowledge to function.
Technological convergence refers to the process in which more than one technology merge together into a new form that brings together different media and applications. Technological convergence did not develop due to accident. It was the outcome of calculated and planned merger of technologies to achieve a certain common goal. The new converged technologies thus have revolutionized the world of information and communication. Earlier single medium had single function. For example; a radio to listen to songs. Today one computer can perform the function of communication through email and songs through its media player. This is an example of convergence.

Causes:

Various factors have been responsible for this convergence of technologies. Hardware of devices has been designed such that they cater to several functions at one time. The earliest mobile phones were used only for communication but gradually they could be used for listening to and recording songs. Today is the time of smart phones. They play media of any type, audio and video, connect to the internet, are mediums to play and allow social networking. The internet is one of the strongest mediums of technological convergence in the field of information and communication. It is medium of sharing information, entertainment and also communication. The latest models of televisions are equipped with internet connectivity and programme to share and view media from mobile phones as well. Satellite technology has been integrated with computer and cellular technology to enhance communication. The GPS and Wi-Fi services are the best example of this convergence.

Benefits:

Convergence plays an important role in society from the economic, social, and development perspective. It can influence the way in which governments develop appropriate policy while looking for social welfare. It provides a wide range of efficient and lower-cost, innovative and new value-added products and services. Technological convergence brings new opportunities to meet development goals and bridge the digital divided; a single service provider can offer different products and services. It can help to build such infrastructure that becomes base of a strong network of basic services in the nation such as prompt medical emergency services, police help lines, easier access to government services through interactive websites etc. Convergence allows new opportunities in business because of scope for innovation and development. This can be observed in the Mobile phone technology as well as wide range of service providers. Consumers have wide range of options to choose from to satisfy their multiple needs at one time with the best and cost effective mediums.
Biotechnology

Biotechnology is based on biological concepts designed for use in medicine, food and agriculture. It is a science that combines other disciplines such as genetics, molecular biology, and microbiology. It involves the use of living organisms and their products to improve our lives and environment. Biotechnology can be defined as the application of technology in life science to develop commercial products.

Since centuries people have been using biotechnology. The micro organisms were used for making yogurt, vinegar, yeast, cheese, beer. Our predecessors used these methods to make their life easier. In recent years the branch of genetic engineering has emerged from the application of biotechnology. It is associated with the genetic modification of plants or bacteria for its use in industry and agriculture. It involves the manipulation and synthesizing of DNA, thereby inserting it into another organism by changing the genetic set up of that organism. An organism that is created through this method is referred to be a genetically modified organism. This technique can be used in various fields for ex; in medicine it is used to make insulin, zebra fish is used for experiments, genetically modified foods are being widely used.

Applications:

1. Medicine: In medicine biotechnology is used in various areas namely;
   a) Pharmacogenomics: This study examines the response of human beings to drugs due to some genetic properties. In other words it is a study of a relationship between pharmaceuticals and genetics. Therefore the aim of this branch of medicine is to develop drugs that can adapt to every man’s genetic setup, to find more accurate method of amount of drug dosage to be given to every patient. Better vaccines can be developed by organisms transformed by means of genetic engineering.
   b) Pharmaceutical products: Biotechnology has been successful in developing medicines to treat hepatitis B, cancers, arthritis, cardiovascular disorders etc. It has developed diagnostic devices to be used to define the target patient population. For ex; the drug named Herceptin can be used to treat breast cancer in women whose cancer cells shows the protein HER2. Genetic engineering is used to create animal models of human diseases to study cancer, obesity, heart diseases, diabetes etc. Potential cures can be tested on these animals. Genetically modified crops have also been used to make drugs.
c) Genetic testing: It involves direct examination of DNA molecules to determine the sex of a fetus, prenatal diagnostic screening, forensic testing, presymptomatic testing for predicting the risk of disorders. Gene therapy is also used for replacing defective human genes with functional copies. It can be used to treat genetic as well as acquired diseases.

1. Agriculture:

a) Increases productivity: To increase the productivity of crops they can be modified with the help of biotechnology by modifying their genes and new characters are imparted in them.

b) Increases resistance to climate change: Genetically modified crops can withstand adverse situations like droughts or salty soil.

c) Increases nutritional value: Proteins in foods may be modified to increase their nutritional quality for ex; cereals can be modified to provide amino acid much needed for human body.

d) Increases the taste and enhances the appearance of food: With the help of biotechnology the process of spoilage of food can be slowed down so that it could be transported to the customers in fresh conditions. This improves the taste, texture and appearance of food. It has proved to be beneficial for farmers in developing countries.

e) Reduces dependency on fertilizers and pesticides: Most recent application of biotechnology is the development of soil bacterium that produces proteins with insecticidal qualities thereby reducing the use of chemical pesticides and fertilizers at the same time.

2. Research:

Genetic engineering provides greater help to natural scientists. A wide range of organisms can be transformed into bacteria for storage. Bacteria can be grown stored cloned much easily and almost indefinitely at -80 degree Celsius. Once the gene is isolated it can be stored inside bacteria for the purpose of research.

3. Industry:

Micro organisms can be used in industrial processes to produce chemicals, antibiotics, pharmaceuticals. Using living organisms for chemical synthesis reduces many risks. Some
important products such as wine, beer and many fermented beverages and products are made by process involving use of microorganisms. Organisms have been modified to degrade oil spilled on water body.

NANO TECHNOLOGY

Nanotechnology is the latest but fastest growing field of technology. Research in this field is increasing at a growing rate; it is an interdisciplinary application, integrating with other fields of science like physics, biology, molecular chemistry and engineering.

Meaning:

Nanoscience and nanotechnology involve the ability to see
And to control individual atoms and molecules. A nanometer (nm) is one-billionth of a meter, smaller than the wavelength of visible light and a hundred-thousandth the width of a human hair. Scientists are able to work on such small atoms with a help of specialized designed machines such as the scanning tunneling microscope (STM) and the atomic force microscope (AFM). The atoms and molecules can be changed in such manner to fit in the composition of a new product or a product can be deconstructed to its atomic level to use its atoms in some other application.

Applications of nanotechnology:

1. Electronics: Nano scale transistors are faster and more powerful. They can store a huge amount of information in small size. Such small size compact storage devices are used in the making of motherboards of computers. Magnetic random access memory (MRAM) made using nano particles can store the entire data of a computer effectively during a system crash or emergency shutdown. Displays of televisions, laptops and mobiles are made of OLED. Organic Light Emitting Diodes are nano structured polymer films which give brighter picture and better image quality.

2. Medicine: Nano technology has the potential to enhance medical and biotechnological tools. Use of nano crystals in biological tests such as MRIs can give more specific information as they enhance biological imaging by locating and identifying specific cells and biological activities. Nanotechnology can help in early diagnosis of arteriosclerosis through such imaging. Nanoparticles are used in the treatment of cancer cells with minimum risk to tissue damage. Research is underway to use nanotechnology to spur the growth of nerve cells, e.g., in damaged spinal cord or brain cells. There are also
researches being conducted in the field of fertility and brain damages with the use of nanotechnology.

3. Cosmetics: Several cosmetic products contain nano particles. They help in better absorption of cleansing of the skin. They also act as anti-oxidants in complexion treatments, lotions and make up. Some hair strengtheners have nanodiamond plates to reduce friction.

4. Food: Nano composites in food containers to minimize carbon dioxide leakage out of carbonated beverages, or reduce oxygen inflow, moisture outflow, or the growth of bacteria in order to keep food fresher and safer, longer. Nano sensors are being developed to detect salmonella, pesticides, and other contaminates on food before packaging and distribution. Such Nano materials are being developed which will enhance taste of food and also have health benefits.

5. Cells and batteries: Nanotechnology is already being used in numerous new kinds of batteries that are less flammable, quicker-charging, more efficient, lighter weight, and that have a higher power density and holds electrical charge longer. Researchers are developing wires containing carbon nanotubes to have much lower resistance than the high-tension wires currently used in the electric grid and thus reduce transmission power loss.

6. **Energy:** Scientists are working towards greater use of nanotechnology in production of non conventional energy. Prototype solar panels incorporating nanotechnology are more efficient than standard designs in converting sunlight to electricity, promising inexpensive solar power in the future. A polymer material containing carbon nanotubes is being used to make windmill blades that are longer, stronger, and lighter-weight than other blades to increase the amount of electricity that windmills can generate. The use of nano particles in increasing energy efficiency of present machinery such as air coolers, pumps, fans and lights etc is being made.

7. Automobiles: Nano tube composites have a better mechanical strength than steel. Its use is encouraged in the manufacture of automobile parts. Cars are sprayed with Nano particles paints which provide smooth coating. Very powerful motors use memory alloys with nano particles. Use of efficient nano material catalysts is one of the solutions to convert harmful emissions into harmless gases. Window glasses of cars are being made of nano particles of self cleaning glass by dissolving small amounts of titanium particles.
Sports and toys: Nanoscale additives in polymer composite materials for baseball bats, tennis rackets, motorcycle helmets, can make them simultaneously lightweight, stiff, durable, and resilient. Use of carbon Nanotube in sports equipments make them stronger. Eye movements of dolls, robot movements are made using nanotechnology based motors.

Textiles: Use of nano particles in making fabrics helps them resist wrinkling, staining, and bacterial growth. Some clothes are produced which would give pleasant look of synthetic material and also comfort of cotton.

Space and defense: Nano materials are replacing conventional materials in the production of equipments. Nano particle based aero gels are used in spacecrafts and defense to reduce weight. Some special lightweight suits and jackets are made of aero gels. Use of nano particles in the production of light weight and energy efficient space craft’s cost of reaching orbit and travelling in space will be reduced considerably.

Environment: Nano technology is being used to develop solution stop water pollution by devising ways to use it for treatment of industrial waste, and making cleaning solvent for natural water reservoirs. Use of nano particles of hydrogen for storage or oil filters may reduce pollution due to vehicles. Nano technology can enable sensors to detect very small amounts of chemical vapours. This will allow tackling of air pollution.