UNIT 30 MODERN DEVELOPMENTS IN SCIENCE AND TECHNOLOGY—II

Structure

30.1 INTRODUCTION

In Unit 29 we gave a brief description of some modern technologies, such as lasers, fibre optics, fission and fusion, space technology and biotechnology. We also discussed their applications and how society could benefit from their proper use. We continue the discussion in this unit and desribe other technologies, such as semiconductors, computers, artificial intelligence, robotics and materials technology. As you have studied in Unit 27, now-a-days the time interval between a scientific discovery and its use as technology has been considerably reduced. Therefore, an emerging area of study is that of being able to forecast future trends of research and development in science and technology. So, we will end this unit with a brief discussion of technology forecasting.

Objectives

After studying this unit you should be able to :

- state what a semiconductor is and describe briefly some semiconductor devices, such as p-n junction diodes, transistors and integrated circuits,
- describe briefly the working of the five basic units of a computer, and distinguish between computer hardware and software,
- explain what is meant by artificial intelligence,
- explain what a robot is,
- describe how the development of new materials has helped the advance of new technologies,
- describe the applications of each of the above mentioned technologies,
- discuss the importance of technology forecasting.

30.2 SEMICONDUCTORS

By now you have studied more than half of this course. You may have been to the study centre a few times. You might have taken lessons on audio cassette-recorders and watched video programmes on the television set. You may even have heard some programmes on the radio. All these gadgets that you have come across, the radio, television, taperecorders, video cassette-players are products of the semiconductor technology.

Semiconductors are the basis of all the sophisticated electronics we have today. Digital watches, calculators, aircraft, spacecraft, satellites, telephone exchanges, lasers and many more devices have components or equipment made up of semiconductors. There is hardly a tool, appliance or item of communication, long distance transportation, entertainment or defence that does not use semiconductor technology. These products and the semiconductors which are used in them have created great impact on many aspects of our social, cultural and economic development. Therefore, you may like to know what a semiconductor is.

30.2.1 What is a Semiconductor

You must have seen various metals like copper, iron or aluminium. They are all good conductors of electric current. You also know that many materials like wood, plastic or quartz do not conduct current. Such materials are called insulators. *A semiconductor, as the name indicates, is a material whose ability to conduct electric current is greater than that of an insulator but less than that of metals.* Silicon and germanium are the most commonly used semiconductors. Some other compounds like gallium arsenide, indium antimonide are also used.

mg is an abbreviation for milligram and 1 mg = 1/1000 gm.

The ability of semiconductors to conduct electricity depends critically upon their purity, or rather their impurity. A pure crystal of silicon or germanium acts more or less as an insulator. However if an impurity is added to the crystal it becomes more conductive. By the way, "impurity" does not mean a 50-50 mixture or even one part of impurity in ten parts of silicon. In useful semiconductors, a ton of silicon may have 1 mg of the element arsenic. Even the tiny bit of arsenic contributes surplus electrons to silicon, which then becomes a better conductor. Such a piece of silicon would be called an **n-type** semiconductor. On the other hand, a like amount of boron would cause a different kind of conduction to take place and the piece of silicon so treated would be called **p-type** semiconductor. The word 'doping' is used by scientists to describe introduction of such small impurities.

A pn junction diode allows current to flow if its p end is connected to to the positive end of the battery, thus acting as a switch. When the p end is connected to the negative end of the battery, it does not allow current to flow in which case the pn junction acts as an open circuit.

SAQ 1

Which one of the following statements is correct about germanium, a semiconductor? Its ability to conduct current is:

i) greater than copper and less than plastic.

ii) greater than copper and plastic.

iii) greater than plastic and less than copper.

iv) less than both copper and plastic.

30.2.2 Semiconductor Devices and their Uses

If a junction is formed between a p-type and an n-type semiconductor, the device called a **p-n junction diode** acquires a peculiar property. It conducts current only in one direction! Hence, it is used to convert alternating current (a.c.) into direct current (d.c) (see Fig. 30.1) The device acts as a switch in Fig. 30.1 (a). It acts as an open circuit in Fig. 30.1 (b). And since it is a non–mechanical switch, it acts very fast.

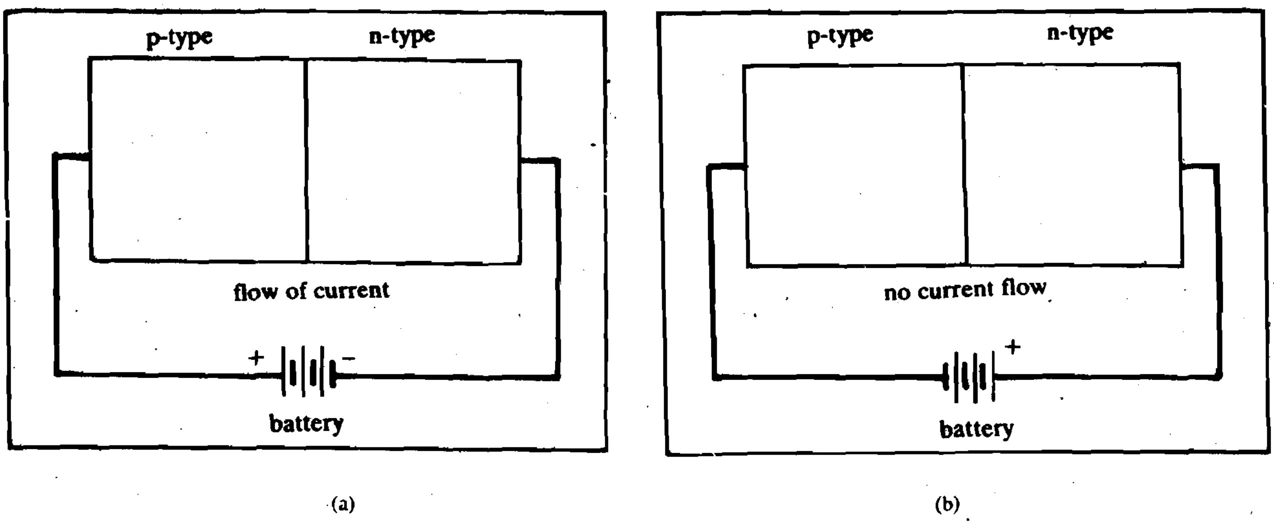


Fig.30.1 : (a) Current flows in a p-n junction diode only when its p end is connected to the positive end of a battery; (b) if the battery terminals are reversed, there is no flow of current.

More complicated devices using n-p-n or p-n-p combinations of semiconductor material are called **transistors**. They have even more interesting properties. They can be so connected to batteries that a small variation of current on one side, can lead to a large variation on the other side. In technical jargon, the transistor can 'amplify' small signals. Transistors can also be connected to other electrical components (resistors, capacitors etc.) to produce a.c. of high frequency.

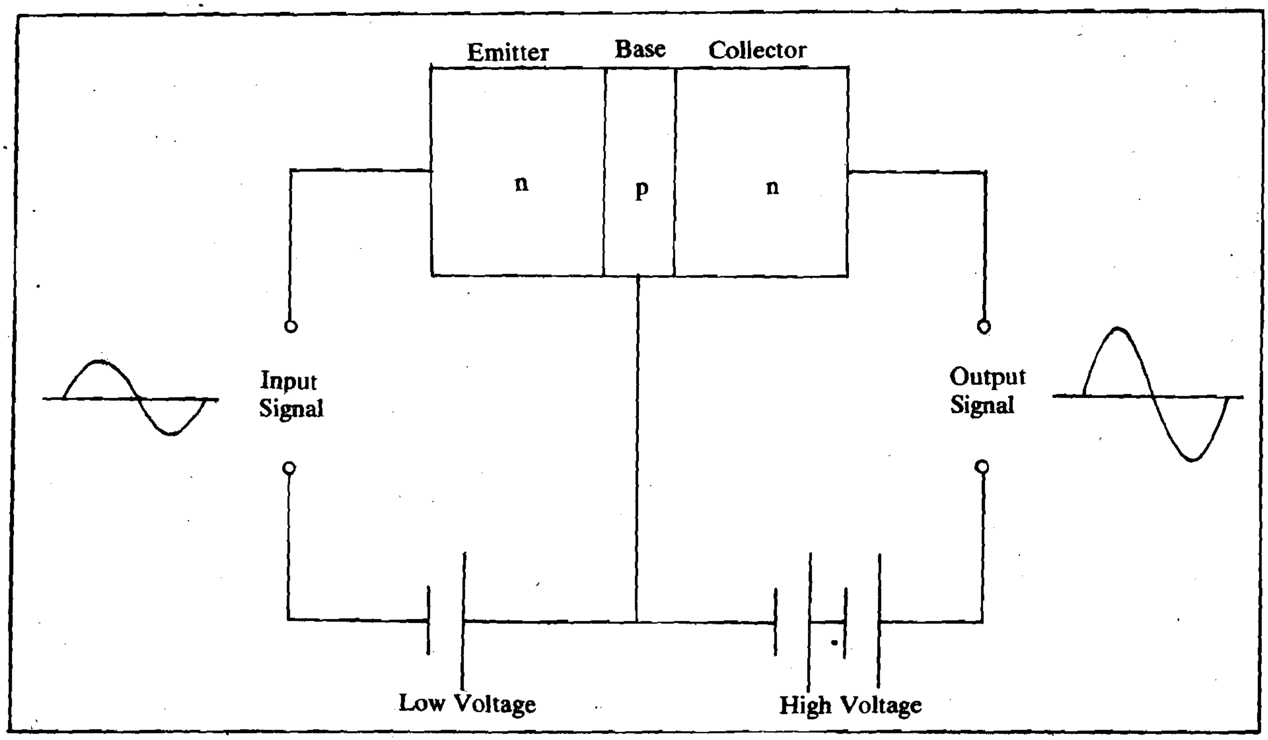


Fig. 30.2 : An n-p-n- transistor.

Semiconductor devices are extremely small in size. Their properties can be controlled at will. This may be done by changing the amount of doping or by introducing more sections of p-type or n-type semiconductors on the same crystal. A large number of new semiconductor devices have been made in this way. Further, by suitable methods, they can be produced in a large chain or according to a desired pattern on a non-conducting surface called a chip. When a large number of semiconductor devices are produced on a single chip to perform specific functions, the resulting device is called an **integrated circuit** (IC). Because of their small size and their sturdiness, and because they consume almost no energy, these devices have become very popular as components in TV sets, computers and many kinds of instruments used for communication and control.

With the present state of technology, we are able to produce millions of semiconducting elements on a chip of 1 sq. cm., reducing the size and weight of the equipment. For example, in the 1950s a three ton computer costing a few crore rupees occupied a large room. Less than four decades later, a microchip based computer costing a few thousand rupees and no larger than a big brief case can outdo its forerunner. Radio transmitters or receivers as small as the head of a pin can be produced. This kind of development opens up many possibilities. For example, the flow of blood in the veins in a human body can be monitored by tiny semiconducting devices.

SAQ 2

Match the semiconductor devices listed in column 1 with their descriptions listed in column 2.

1	2
a) p-n junction diode	i) a single small chip containing a large number of semiconducting devices in a definite pattern.
b) transistor	ii) devices in which one side of the semiconducting crystal is p type and the other n type.
c) integrated circuits	iii) devices using p type or n type semiconductor sandwiched between two n type or p type semiconductors, respectively.

Indeed, the semiconductors, tiny and fragile as they are, have come to occupy an important place in our societies. As we have said earlier, the development of semiconductor technology has had a deep influence on the way we live and on the possibility of man's control over nature. Apart from providing jobs to millions, as well as means of recreation, it has worked wonders in global communication. However, fears have been expressed that this kind of development of very versatile equipment will throw people out of jobs. For example, computers will make large clerical staff unnecessary. Or robots will throw factory workers out of jobs.

But even in the past, old technologies were replaced by new ones, e.g., horse-drawn carriages by motor driven vehicles. And the past experience shows that while society progresses in this way, a whole lot of new employment opportunities are created. For instance, introduction of motor vehicles has created jobs in manufacture, maintenance and repair which are at least as numerous, or even more in number, than the jobs of tonga drivers and veterinary doctors looking after horses. In the same way, semiconductor technology has created job opportunities of its own. The difference is that these jobs require education and training. Thus, the solution lies not in rejecting the new technology but in retraining and orienting people to fit into new kinds of jobs, using the new technology.

As you have read just now, semiconductor technology has many applications, computers being the foremost among them. Let us find out more about the computers.

30.3 COMPUTER TECHNOLOGY

You may not have seen a computer yet. But their presence in your life is a fact that cannot be ignored. Your school marksheets may have been prepared on a computer, the electricity and water bills that you receive may be made on a computer. If you book your railway ticket in a big city like New Delhi, it will be done on a computer. The cheque books issued by banks are computerised. Indeed, computers have entered many aspects of our lives.

A few decades ago, there were only a few computers in our country. They were enormous and expensive machines. They were often used for special scientific purposes. Thus, they had little direct impact on the lives of most people. But, because of the advances in semiconductor technology, things have changed now. Thousands of computers, from small relatively cheap units to large and expensive computers can be found in offices, factories, schools, hospitals, banks, airports, railway stations and homes. Plans are already afoot to equip each district headquarter in India with a computer which will be linked through satellite communication with a large central computer. This computer "network" will maintain all kinds of up-to-date information for the whole country. Indeed computers have become a way of life with us. They have tremendously increased our capacity to exchange information, undertake planning down to the grass roots level and facilitate solution of very complex problems.

30.3.1 Computers at Work

Computer networks link computers through various communication channels like satellites, telephone lines on optical fibres and a special device called modem. The linking of computers all over the world through networks such as INTERNET has made communication faster. It has also provided access to a variety of information right at our doorstep.

The computer is a simple machine and should not be held in awe. Basically, a computer simply accepts information and stores it. It then processes information, for example, arranges it in some order, adds numbers or multiplies them. Finally, it produces the desired information on an output device, for example, on a screen where it can be seen, or on paper. This is much like what we ourselves do daily. We absorb information through our senses, our brains store and process it and then we act. To give an example, if we are asked to multiply two numbers, our brain accepts the input through our eyes or ears, stores the numbers and carries out the multiplication. The answer may then be told orally or recorded on a piece of paper.

The only difference here is that a computer can do all these tasks much faster than us. Calculations and paperwork that would take weeks, months or years for us to do, can be done in a few seconds or minutes on a computer. For instance, the average individual can make 5 to 10 simple calculations per minute. The average computer can make 10,000 complex calculations per second. Fast computers can make millions of complex calculations in a second. And there would not be a single error in any of these calculations. Computers can also store a large amount of data. It is because of these factors that the computers are being used in almost all walks of life.

There are two major aspects of computers, **hardware** and **software**. *All the complex electronic circuitry and various other magnetic and mechanical devices make up computer hardware. Computer software consists of a set of instructions or programmes which run the computer hardware. A* ***programme*** *is a set of instructions which the computer executes step by step.* We will now describe these two aspects in brief.

Computer Hardware

The computers used today are many and varied. But each one of them has five basic units. These five units are shown in a block diagram (Fig. 30.3). Study it carefully and answer the following question.

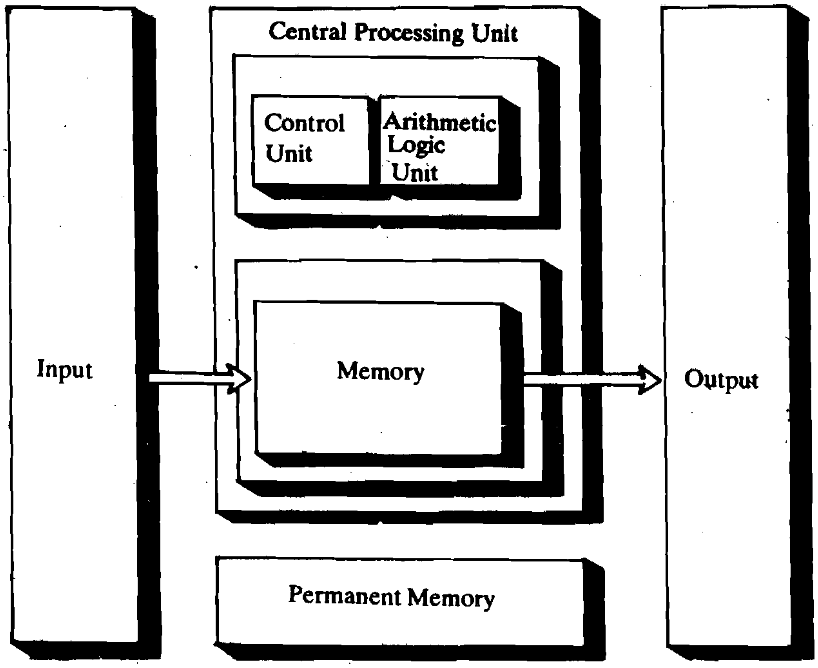


Fig. 30.3 : The five basic units of a computer

SAQ 3

What are the five units of a computer? List them here.

.... , ... , ... , ... , ... ,

You have put down **input** as one. If you were to use the computer, you would feed in your information and instructions using an input device such as a typewriter-like keyboard (Fig. 30.4a). The information and the programme will be lodged in a computer **memory** which could be something like a gramophone record (called a "floppy disc" because of its flexibility) or on a tape.

Once the programme is fed in the computer, the **control unit** takes over. It selects the instructions, puts them in a sequence and directs other units to carry out their operations. It acts like the central nervous system of the computer body.

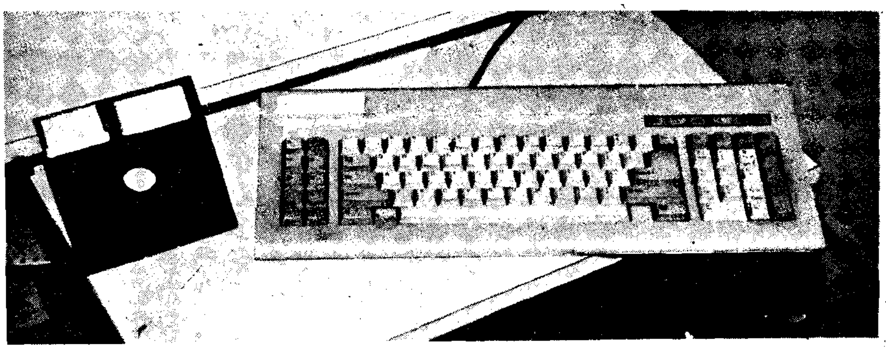
For example, the control unit directs the memory to supply certain numbers to the **arithmetic and logic unit** (ALU) and tells the arithmetic and logic unit to add, subtract, multiply or divide numbers as the case may be.

The control unit and ALU together are called the **central processing unit (CPU).** This is the most important part of a computer. Numerous transistors and components constituting integrated circuits (ICs), about which you have already read in the previous section, make up the electronic circuits of a CPU.

Finally, the control unit enables the **output** to obtain finished results. The results could be displayed on a monitor like the TV screen, or could be printed on a paper by the printer. They could also be transferred to a floppy disc (Fig. 30.4b).

The overall control is exercised by the person operating the computer. Lights, switches and buttons enable the computer operator to monitor what the various units of the computer are doing at any moment.

(a)



(b)

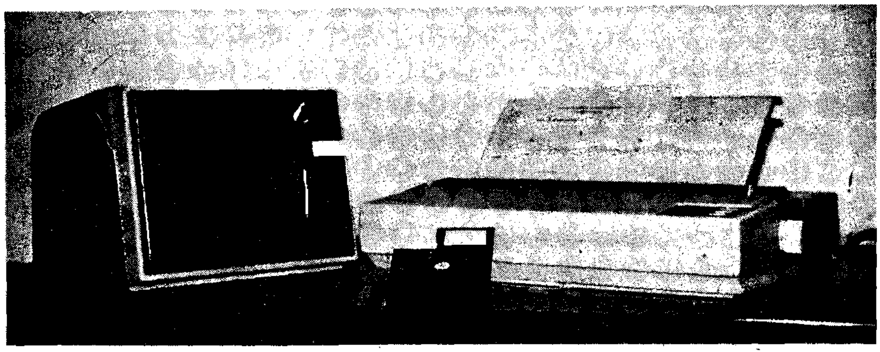


Fig. 30.4 (a) Some input devices and (b) output devices.

SAQ 4

a) Fill in the blank spaces in the following statements about computers, using the words given below:

Computers have the advantage of .... and .... over the human brain. They can make .... of calculations per second without making a single .... They can also store .... amounts of .... and ....

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large, thousands, accuracy, data, mistake, information, speed

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b) Match the computer components given in column 1 with their characteristics/functions listed in column 2.

1		2	
i)	Computer hardware	a)	transfers the data from the user to the memory of ALU.
ii)	Input	b)	is made up of a set of programmes.
iii)	Memory	c)	displays, records or prints information.
iv)	Control Unit	d)	comprises of all magnetic tapes, printers and the electronic circuitry.
v)	Arithmetic and Logic Unit	e)	is responsible for the storage of data.
vi)	Output	f)	like a traffic officer, it directs the flow of instructions between various units.
vii)	Computer Software	g)	compares two numbers, adds, subtracts, multiplies or divides numbers.

Computer Software

Computer hardware will do nothing until we tell it what to do. In other words, we must give it a programme to execute. A computer will do only what it is programmed to do and nothing else. It cannot think the way we do. Through proper programmes, a computer can be instructed to carry out not only simple arithmetical operations, but also very complex calculations and reasoning, apart from keeping accounts and making out bills etc. There are two types of computer software, the **application software** and the **systems software**.

Application software is a set of programmes to solve problems or produce information or data. These programmes are written in special code or notation or "languages". They are given names such as BASIC, FORTRAN, COBOL, PASCAL etc. Some are more suitable for accounting, others for mathematical calculations or logical processes.

The systems software provides the link between computer hardware and application software. The code or programming language is converted into appropriate electrical signals necessary for the operation of the hardware. The systems software is not controlled by the user, it is built into the system.

SAQ 5

a) Is FORTRAN a language of application software or systems software or both?

....

b) In the space given below, draw a diagram showing the relationship between computer hardware, systems software, application software and the user.

30.3.2 Micros, Minis, Mainframes, 'Monsters' and their Uses

Computers come in many sizes and have a large range of computing abilities. The classification of the variety of computing systems in terms of size, cost and performance is a rather difficult task.

Yet one does hear or read about microcomputers, minicomputers, mainframes and supercomputers (or 'monsters'). This kind of a classification is quite arbitrary. The cost and performance capability of different machines are likely to overlap. For example, a powerful computer sold as a mini by its maker may do more computations, store more data and cost more than a small mainframe computer. Or often you may come across a powerful microcomputer which performs better and costs less than a minicomputer.

Small computers for use at home, office or business are called **microcomputers** or **personal computers (PCs)**. A large variety of tasks can be done on a PC. Its capacity to store and handle large volumes of data has found many uses in business. Bills and statements can be processed in much less time and with much less effort now. PCs help managers to organise and handle financial data, and plan accordingly.

A computer aided design (CAD) programme enables engineers to design and test their proposed product on the computer. In this way they are able to correct all the flaws in the trial design and come out with just the right product to manufacture. Interestingly, the complex ICs that make up the computer hardware are themselves designed on a computer.

At IGNOU, we use PCs as "wordprocessors" to type and correct the manuscripts of the courses you read (Fig. 30.5). With a typewriter, changing one misplaced word or deleting a paragraph might require retyping the whole page. In a PC, the text is stored on a floppy disc, and can be displayed on a screen, at will. We can make as many corrections, additions or deletions, as we want. We need to print the copy only after we are fully satisfied.

PCs can be linked with mainframe or supercomputers. Thus, users are now able to run their programmes on the mainframe computers and obtain results on their own PCs. As the integrated circuits technology has improved, PCs have become an inseparable part of our daily lives. Already people use PCs for preparing houshold budgets

At the first station, a robot pastes on each casing a computer printed label. The label tells which parts are to be fixed into which casings. At each succeeding station, robots read the label and follow the instructions. Finally, a laser printer prints the information about the product onto the casings. They are then automatically sorted, packaged and shunted off to the shipping dock.

Does it seem to be a scene from 2050 A.D.? Well, it's not. This is a real scene from a computerised factory in USA. The workforce in this factory is made up of robots. Robots work under the overall control of only four human technicians and produce 600 units per hour. What are these marvellous machines that are called robots? In this section, we'll learn about robots and robotics.

30.4.1 An Insight into Robotics and Robots

The science of designing, building and using robots is called robotics. And what is a robot? Many people think of robots as mechanical people that can see, hear, feel, walk and talk. This kind of a robot is yet a distant dream. *The robots in use today are basically computerised machines.* They can be programmed to do a variety of tasks. Let's take a look at a few examples that will help us understand what robots are.

A robot can be made to do a large number of jobs. For example, a robot can drill holes of several different sizes. Robots are also made to sort vegetables, shear sheep, pluck chickens, form rice cakes and assemble mechanical parts. Robotic trains carry commuters to and from work. Robots can even assemble delicate watches and computer components. In factories, robots do spot welding and spray painting.

A robot can also be programmed to change from one job to another and can be 'taught' to handle new tasks. For example, the same robot could drill a hole as well as place bolts into the holes drilled by it. A robot can do one thing for a while, then another and then yet another. For instance, it can select English character keys and put them into a few typewriters, then put Hindi keys into another few and then Arabic keys into a third batch. An industrial robot called 'T' can select its own tools from a rack, drill holes accurate to 0.005 inch and measure the perimeter of 250 different parts. It helps build F-16 fighter planes.

From these examples, it should be clear that *a robot is a computerised, multifunctional and reprogrammable machine that performs a large variety of tasks.*

However, there's more to a robot than what we've learnt yet. Through the use of artificial intelligence systems, robots have been given a wide range of human abilities. We will describe some of them in brief.

Giving Robots Sight

Robots can be made to 'see' an object or a scene. Optical sensors in a robot record the varying brightness of light coming from the object. To identify an object, the computer compares its brightness at each point, with the brightness at different points of an image stored in its memory. If the brightness matches, it "sees" the object and carries out the task it is programmed for (Fig. 30.6).

Robotic vision is tailored for specific jobs. In industry such vision systems help robots to install car windows or pick objects and place them elsewhere. 'Seeing' robots are used for simple inspection jobs,such as verifying whether bottles are filled to the proper level. A robotic quality control system can be used to detect flaws in products and remove the rejected ones.

Like every modern technology, robots are also used for modern warfare. An example of 'seeing' robots is the Tomahawk cruise missile which can carry several nuclear warheads and drop them on a target with deadly accuracy. It can be launched from a ship, a submarine or a ground unit, several thousand kilometres away from its target. Stored in its computer memory are a series of images of the landscape along its intended flight path. The missile surveys the landscape, matches the images with the ones stored in its memory. If it is drifting off course, it makes correction in its path. It makes a final adjustment before heading for the target.

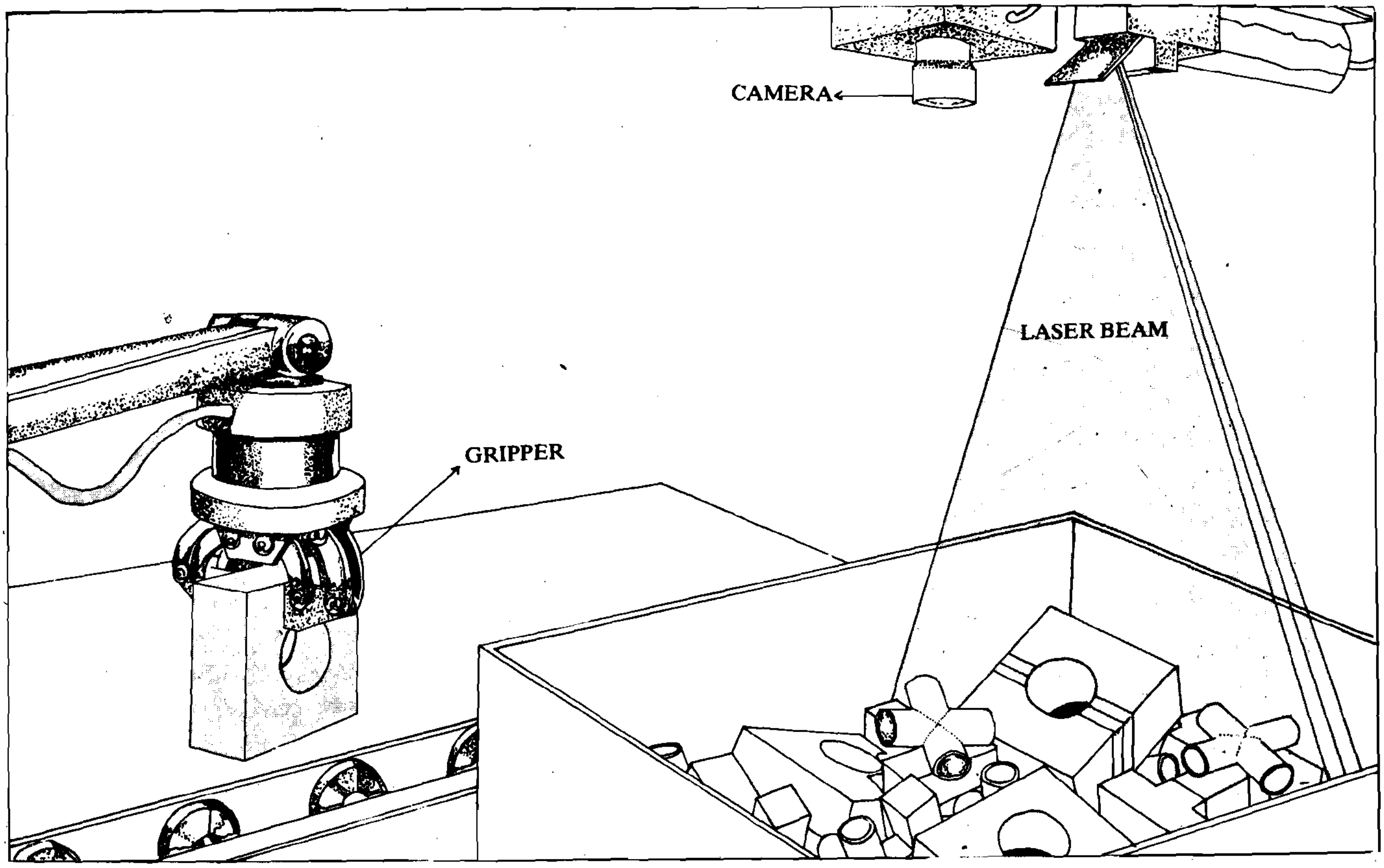

Fig. 30.6 : A bin-picking robot. A laser is used to illuminate a bin full of parts of varied shapes and sizes. A camera records the brightness of the objects at different points. The inbuilt computer programme looks for unique features in the brightness pattern of the object. The computer then positions and closes the gripper to pick it up.

Robot Arms in Action

A robot can be designed to act like a human arm. Robot specialists draw on the skills and resources of both computer science and mechanical engineering to build robots with "arms" In the course of a work, the joints of a robotic arm may have to move into many positions. Hundreds of thousands of numbers corresponding to these positions are stored in a robot's memory. Special mechanical devices in the arm translate those numbers into elementary movements.

Typical robot arms do not have fingered hands. Instead, special purpose devices are fitted to serve as arms. With the help of these devices, the same robot could spray paint using a spray gun, or weld metals, or pick up objects to put them in an order (Fig. 30.7).

Walking Robots

Sit back for a while and try to think of a few advantages our legs have over wheels in moving around.

Wheels can't climb stairs. They can't also step over obstacles or go through narrow spaces or move on soft or uneven ground. Humans and animals can choose the foot-holds that offer the best support, specially in mountains. In fact, about half the earth's surface is such that it is very difficult for wheels to move on it. Creeping, climbing, balancing, walking and running are all possible for legged creatures. Our legs can also bend at knees which makes adjustment easy.

Therefore, a robot must be given legs so that it is able to move around easily. Making legged robots has proved to be a challenging job in robotics. Although computers have been built into legged vehicles, the problems of balance, coordination and walking on rough ground have proved difficult to solve.

Along with robot movement, building in natural flexibility, manual, touch and hearing ability in robots are active areas of research in robotics these days.

Naturally, robot eyes, ears, hands and legs have a long way to go before they can approach human ability. Robotic skills of sensing and thinking are elementary at best. Do not forget

The fuels are other kinds of materials—either in solid or liquid state which have to be light, give off a lot of energy on burning, and must be such as to burn fast or slow according to control. These materials have allowed loads of something like 200 tons to be lifted off from the earth by a powerful space rocket. 200 tons is the weight of 200 average sized cars!

Great developments have taken place in materials which are called polymers, and consist of **long chains of small molecules joined end to end. Plastics are one kind of polymers used** extensively in machines and devices, and so commonly even in rural areas—in the form of cups, buckets, ropes, bags, rain-coats and other clothing etc. **Rubbers** are also polymers, and so are **ceramics** from which china-ware and all kinds of insulators are made. There has been great development in this field. Ceramic car engines are being developed which will be much lighter than the present cast steel and will be able to operate at a higher inner temperature and pressure. Engine weight may be reduced to a quarter of what it is today, and power may be increased four times. Ceramic magnets are now in common use; the ratio of the magnet's force to its weight has been increased more than a hundred times. Tiny magnets have now the strength of large old-time magnets.

An area of considerable excitement is the development of ceramic superconductors working at much higher temperatures than before. It was known for many years that certain materials became superconducting, when they were cooled to about minus **270 degrees celsius, i.e., a small voltage caused a huge current to flow in them, or their** resistance to flow of current became nearly zero. The property was of academic interest only because reaching 270 degrees below freezing temperature was itself a very difficult job.

Recent excitement is based on the fact that the temperature at which certain ceramics become superconductors has been found to be nearly 170 degrees higher! This strongly suggests that with modified ceramic materials we may, one day, have superconducting materials at room temperature. That would be wonderful, as it would revolutionise all electric power generation because machines would become tiny as compared to present heavy weights. Power transmission would change radically because there would hardly be any loss of power on the wires, and so would communication systems. It could make electric trains much cheaper to run, and perhaps lead to electric cars and trucks. Then it would be possible to replace the present pollution producing and non-renewable resource (oil) using vehicles.

Without going into details of other types of materials used in medicine and agriculture, some produced in chemical or drug factories and others by biotechnological means, it should be clear that new technologies and new materials go hand in hand — progress in one depends on the other. The motor car could never have succeeded without great advances in metallurgy and precise machining, lubricating oils and greases, petrol technology, electrical systems, and production of wear-resistant rubber, pneumatic tyres, synthetic materials etc. Materials have become a subject of research and development in their own right, and science has so advanced that we are near to the position of making materials with any desired set of properties.

SAQ 8

a) List at least two products made of each of the following materials
Metals, alloys, polymers, fibreglass, synthetic fibres, liquid crystals.

....

....

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....

b) What special kinds of materials have made possible advances in fibre optics, semiconductors, space technology and superconductors?

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....

30.6 TECHNOLOGY FORECASTING

With such power of science in relation to technology, and consequently to satisfy social need, the question arises, can technologies of the future be forecast? Can one say what kind of devices, machines, weapons etc. will be available ten years from now? This has become a relevant question from the point of general planning, let us say in a country like India. But equally, the answer to the question of future technologies is of interest to private manufacturers because their profits would depend on it.

The question is more complex than it appears at first sight. The path from science to technology and then to useful devices and goods in society is not straight forward. Scientific discoveries sometimes took several decades before society made use of them as devices, and, thus, produced the need to improve such devices, and add to technology and science. It was Faraday who discovered the laws of electric induction in 1831, on which all electric generators and motors are based, but the generators or motors were not needed. People were doing without them. You may think why they did not use electricity for lighting homes and street. The answer is simple. The bulb had not yet been invented. When the first hot filament lamp was invented, it could not burn for many hours because good vacuum pumps were not available. The greater hurdle was, however, the ability to sell electricity and make profit. This was cleared only in 1881 when Edison developed the electric power station from where electricity could be distributed, like water, to homes and factories. Its first extensive use was in factory lighting so that workers could work for longer hours after sunset. So, the idea or discovery made by Faraday had to wait for almost fifty years before other technologies and devices were developed, and business could make profits from sale of electricity and longer hours of factory work.

Although waiting periods between discovery and application have shortened now (see Sec. 27.2), in some technologies they are just a few years, the model described in the previous paragraph is still valid. There is scientific research in various branches; some of it is abstract or theoretical, some applied or practical and it makes certain technologies **possible**. But other technologies from other areas of research and development may be needed to convert the possible into **likely to be successful** technology. The society must also be ready to utilise it, or the market must be there to make profit (or it must be created by advertising!), before the likely becomes an **actually available** technology (see Fig. 30.8). Of course, this is a highly simplified picture. For example, time delays have not been shown, but they are involved at each stage, and the connections could be many more than shown here. You also know, at this stage of the Foundation Course, that today's great multinational corporations use advertising in a big way to create a market, to make people buy things which they could do without. They may be made ready to buy a thing simply because it is made to appear as a status symbol, or just because the neighbour has it.

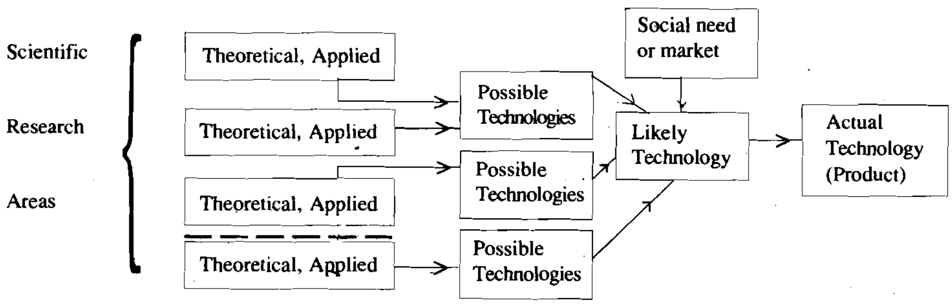

Fig. 30.8

The other side of the picture is that in order to foresee the technology of tomorrow, one has to keep an eye on the various areas of scientific research, as well as on social and economic aspects—not only in one country, but in the world at large. And one who is effectively able to do so stands to gain tremendously. More scientific research and technological development can be directed so as to obtain highly useful products—unfortunately, also weapons! A great amount of money is being spent by countries on research and development in order to keep ahead of others. Some countries spend a few percent of their gross national income on this enterprise. We in India spend, at present around 1%. And

c) Seema is a .... She specialises in designing programmes that are built in the computer to control its operation.

d) Feroze prepares software that allows a computer to perform specific functions. He is an ....

e) Sharon is a .... for a user organisation. She enters the data and monitors the computer as it runs.

Systems programmer, electronic engineer, computer operator, application programmer, hardware sales person.

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4) List at least three advantages of a robot.

....

....

....

5) State two reasons why technology forecasting is an important area of study today.

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....

....

....

30.9 ANSWERS

Self Assessment Questions

1) iii).

2) a) ii, b) iii, c) i.

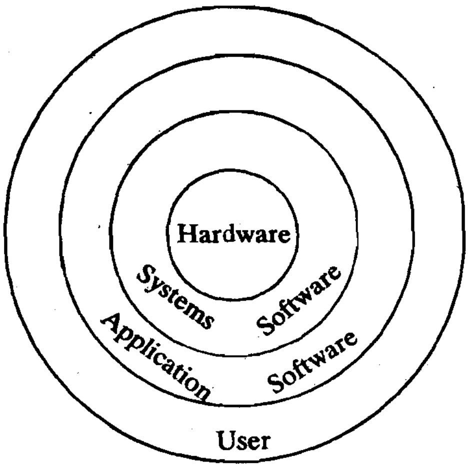
3) Input, Control Unit, Arithmetic and Logic Unit, Memory, Output.

4) a) speed, accuracy, thousands, mistake, large, data, information

b) i) d, ii) a, iii) e, iv) f, v) g, vi) c, vii) b.

5) a) Application software

b)



6) Artificial intelligence is the ability of a computer system to produce an output that seems to come from an intelligent human being.

7) a) An automatic machine is usually not computerised. It cannot be made to do any other job except the one for which it is made. It cannot also usually be recast for an entirely different use. A robot is a programmed computer which can do many jobs at a time and also can be reprogrammed for different uses.

b) A robot 'sees' by comparing and matching the brightness of an object with that of its image, stored in its computer memory. For robots to act as arms, hundreds of thousands of numbers giving their positions are stored in the robot's memory, which are used in the set of programme guiding the robot's application. Whenever the

gene splicing: joining pieces of DNA fragments

geostationary: moving so as to remain always above the same point on earth's surface

hologram: a photograph which on being illuminated produces an image of object in two or three dimensions

hydrogenation: chemical combination with hydrogen

indigenous commodity: originally from the country where it is found

infrastructure: the facilities, services and equipment that are needed for proper functioning

innovation: introducing new ideas and changes in the way something is done or produced

insulator: substance which does not conduct electrical current or heat

laser: special kind of light with several useful properties, such as coherence

lead time: the time gap between the discovery and its actual application in industrial procession

life expectancy: the average period that a person at a particular age is expected to live

malleable: substance that can be hammered or pressed out of shape without tendency to return to its original form or to fracture

manipulative skill: skilful way of controlling equipment

neural processing: processing of signals by neurons

nuclear fission: splitting of heavy atomic nucleus into smaller fragments, with release of neutrons and energy

nuclear fusion: union of atomic nuclei to form a heavier atomic nucleus with release of neutrons and energy

obsolete: out-dated

open circuit: an electrical circuit in which no current can flow

optical fibre: a special fibre used to carry signals on light beam

paradox: a situation that is strange because it involves two opposite facts which should not be true at the same time

petroleum pitch: residue left after the distillation of crude petroleum

pneumatic tyre: tyres inflated with air

polymer: a substance containing large molecules built as a chain with repeated units

resistor: device which offers resistance to the flow of current

robot: computerised machine which can do many jobs and be reprogrammed for use in other kinds of jobs

robotics: science of designing and making robots

sealant: a substance used for sealing gaps, cracks or leaks

semiconductor: solid substance whose ability to conduct current is greater than insulators and less than conductors

socialism: political and economic theory of social organisation which advocates that the community as a whole should own and control the means of production, distribution and exchange

spot welding: welding between points of metal surfaces in contact

stearine: a substance found in oils and fats, which is used in manufacturing soaps

superconductor: conductors that offer no resistance to flow of current

systems software: software built into the computer

tallow: animal fat

technology: application of science for problem solving

transistor: a semiconductor device with three electrodes used to amplify signals

turn key technology: technology that is ready to use

FURTHER READING

1. *New Guide to Science*, Isaac Asimov, Penguin, 1987.

Unit 28 Technology and Economic Development

Unit 29 Modern Development in Science and Technology – I

Unit 30 Modern Development in Science and Technology – II

Block 8 : New Perspectives

Unit 31 Perceptions and Aspirations

Unit 32 Science — The Road to Development

Audio/Video Programmes

Audio :

1) Science and Society (Block 1)
2) Astronomical Development in India (Block 3)
3) Measuring Astronomical Distances (Block 3)
4) Evolution of Man (Block 3)
5) The Forest Ecosystem (Block 4)
6) Population Pressure (Block 4)
7) Common Misconceptions about Health (Block 5)
8) Human Factors in Engineering (Block 6)
9) New Information Order (Block 6)
10) Technology and Self-Reliance (Block 7)
11) Nuclear Disarmament (Block 7)

Video :

1) Method of Science (Block 2)
2) A Window to the Universe (Block 3)
3) The Story of a River (Block 4)
4) Green Revolution (Block 5)
5) Infectious Diseases (Block 5)
6) Jean Piaget Development Stages of a Child (Block 6)
7) INSAT (Block 6)