CMR INSTITUTE OF TECHNOLOGY

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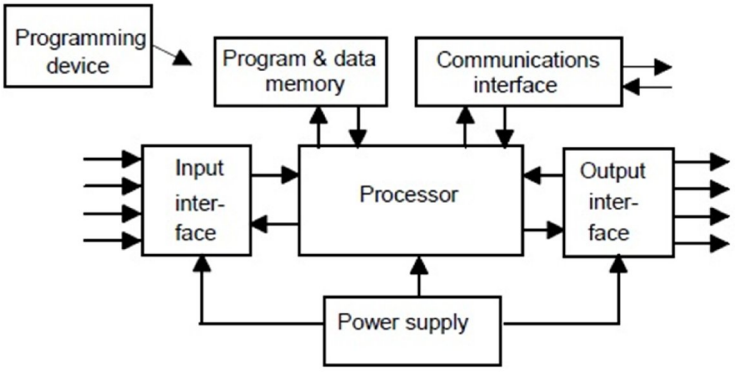
Internal Assessment Test 1 – SEPTEMBER 2016

Sub:	Programmable Logic Controllers					Code:	10EE752
Date:	07-09-2016	Duration:	90 mins	Max Marks:	50	Sem: 7	Branch: EEE

Note: Answer any five full questions. Sketch figures wherever necessary.

1) a) Explain the hardware of PLC with neat Block Diagram **6**



[+2M]

Fig.1. Hardware of the PLC System

PLC system has the basic functional components of processor unit, memory, power supply unit, input/output interface section, communications interface and the programming device. Fig.1 shows the basic arrangement.

- The *processor unit* or *central processing unit (CPU)* is the unit containing the microprocessor and this interprets the input signals and carries out the control actions, according to the program stored in its memory, communicating the decisions as action signals to the outputs.
- The *power supply unit* is needed to convert the mains a.c. voltage to the low d.c. voltage (5 V) necessary for the processor and the circuits in the input and output interface modules.
- The *programming device* is used to enter the required program into the memory of the processor. The program is developed in the device and then transferred to the memory unit of the PLC.
- The *memory unit* is where the program is stored that is to be used for the control actions to be exercised by the microprocessor and data stored from the input for processing and for the output for outputting.
- The *input and output sections* are where the processor receives information from external devices and communicates information to external devices.
- The *communications interface* is used to receive and transmit data on communication networks from or to other remote PLCs. It is concerned with such actions as device verification, data acquisition, synchronisation between user applications and connection management.

[+4M]

b) Simplify the Boolean Equation and draw the ladder diagram for the simplified equation. **4**

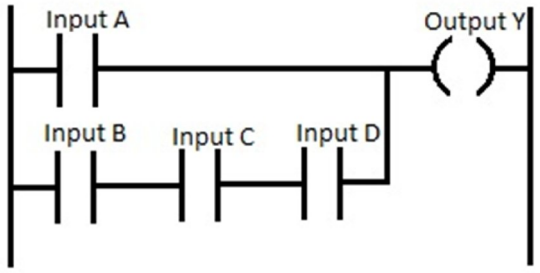
$$? = ? + ?.(? + ?.\overline{?} + ?.\overline{?}.?) + ?.?.?.?$$

$$? = ? + ?.? + ?.?.\overline{?} + \overline{?}.?.?.? + ?.?.?.?$$

$$? = ?(1 + ?) + (\overline{?}\,\overline{?} + ?).?.?.?$$

$$? = ? + ?.?.?$$

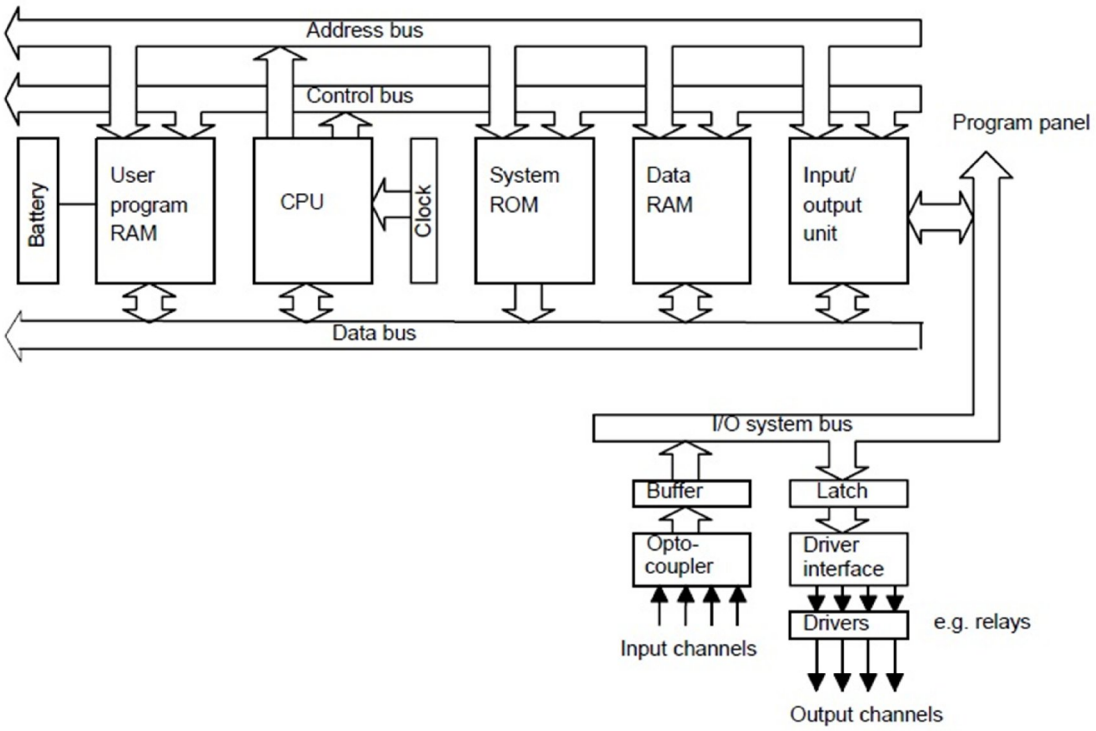
[+2M]



[+2M]

Fig.2. Ladder Diagram for 1.b

2) a) Explain the internal Architecture of PLC with neat block diagram. **7**



[+2M]

Fig.3. Internal Architecture of PLC

Fig.3. shows the basic internal architecture of a PLC. It consists of

The CPU

The internal structure of the CPU depends on the microprocessor concerned. In general they have:

An *arithmetic and logic unit* (ALU) which is responsible for data manipulation and carrying out arithmetic operations of addition and subtraction and logic operations of AND, OR, NOT and EXCLUSIVE-OR. Memory, termed *registers*, located within the microprocessor and used to store information involved in program execution. A *control unit* which is used to control the timing of operations.

The buses

The buses are the paths used for communication within the PLC. The information is transmitted in binary form, i.e. as a group of *bits* with a bit being a binary digit of 1 or 0, i.e. on/off states. The term *word* is used for the group of bits constituting some information. Thus an 8-bit word might be the binary number 00100110. Each of the bits is communicated simultaneously along its own parallel wire. The system has four buses: The *data bus* carries the data used in the processing carried out by the CPU. A microprocessor termed as being 8-bit has an internal data bus which can handle 8-bit numbers. It can thus perform operations between 8-bit numbers and deliver results as 8-bit values. 2 The *address bus* is used to carry the addresses of memory locations. So that each word can be located in the memory, every memory location is given a unique *address*. Just like houses in a town are each given a distinct address so that they can be located, so each word location is given an address so that data stored at a particular location can be accessed by the CPU either to read data located there or put, i.e. write, data there. It is the address bus which carries the information indicating which address is to be accessed. If the address bus consists of 8 lines, the number of 8-bit words, and hence number of distinct addresses, is 28 = 256. With 16 address lines, 65 536 addresses are possible. The *control bus* carries the signals used by the CPU for control, e.g. to inform memory devices whether they are to receive data from an input or output data and to carry timing signals used to synchronie actions. The *system bus* is used for communications between the input/output ports and the input/output unit.

Memory

There are several memory elements in a PLC system:

System *read-only-memory* (*ROM)* to give permanent storage for the operating system and fixed data used by the CPU. *Random-access memory (RAM)* for the user's program. *Random-access memory (RAM)* for data. This is where information is stored on the status of input and output devices and the values of timers and counters and other internal devices. The data RAM is sometimes referred to as a *data table* or *register table*. Part of this memory, i.e. a block of addresses, will be set aside for input and output addresses and the states of those inputs and outputs. Part will be set aside for preset data and part for storing counter values, timer values, etc.

Possibly, as a bolt-on extra module, *erasable and programmable read-only-memory (EPROM)* for ROMs that can be programmed and then the program made permanent.

Input/output unit

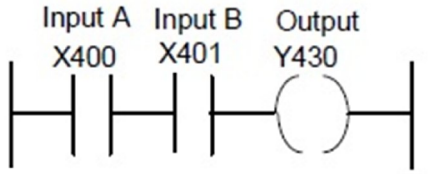
The input/output unit provides the interface between the system and the outside world, allowing for connections to be made through input/output channels to input devices such as sensors and output devices such as motors and solenoids. **[+5M]**

b) Using Mitsubishi notations draw a ladder diagram for a two input AND gate and write the Instruction list. **3**

Truth Table for AND Gate

Inputs		Outputs
A(X400)	B(X401)	(Y430)
0	0	0
0	1	0
1	0	0
1	1	1

[+1M]



[+1M]

Fig.4. Two input AND Gate

The instruction List for two input AND gate using Mitsubishi Notations is as follows:

LD X400
AND X401
OUT Y430 **[+1M]**

3) With relevant diagrams, explain the operation of absolute encoder with incremental encoder. **10**

The term *encoder* is used for a device that provides a digital output as a result of angular or linear displacement. An *increment encoder* detects changes in angular or linear displacement from some datum position, while an *absolute encoder* gives the actual angular or linear position. Fig.5. shows the basic form of an *incremental encoder* for the measurement of angular displacement. A beam of light, from perhaps a light-emitting diode (LED), passes through slots in a disc and is detected by a light sensor, e.g. a photodiode or phototransistor. When the disc rotates, the light beam is alternately transmitted and stopped and so a pulsed output is produced from the light sensor. The number of pulses is proportional to the angle through which the disc has rotated, the resolution being proportional to the number of slots on a disc. With 60 slots then, since one revolution is a rotation of 360^o, a movement from one slot to the next is a rotation of 6^o. By using offset slots it is possible to have over a thousand slots for one revolution and so much higher resolution.

The *absolute encoder* differs from the incremental encoder in having a pattern of slots which uniquely defines each angular position. With the form shown in Fig.6., the rotating disc has four concentric circles of slots and four sensors to detect the light pulses. The slots are arranged in such a way that the sequential output from the sensors is a number in the binary code, each such number corresponding to a particular angular position. With 4 tracks there will be 4 bits and so the number of positions that can be detected is $2^4 = 16$, i.e. a resolution of $360/16 = 22.5^o$. Typical encoders tend to have up to 10 or 12 tracks. The number of bits in the binary number will be equal to the number of tracks. Thus with 10 tracks there will be 10 bits

and so the number of positions that can be detected is 2^{10}, i.e. 1024, a resolution of 360/1024 = 0.35^{o}. **[+4M]**

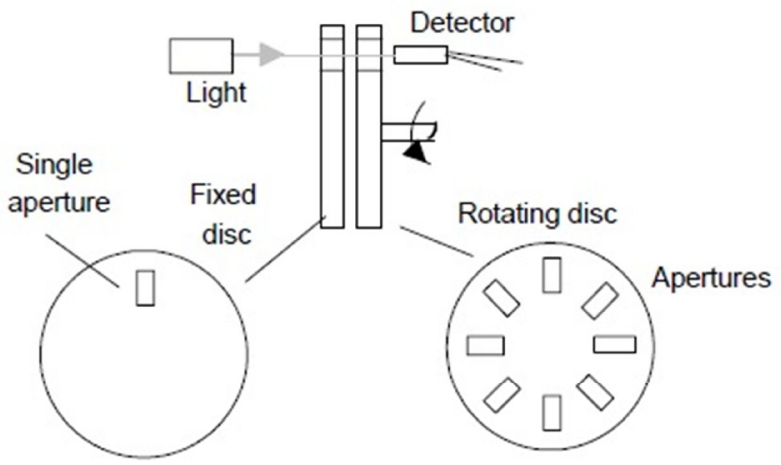
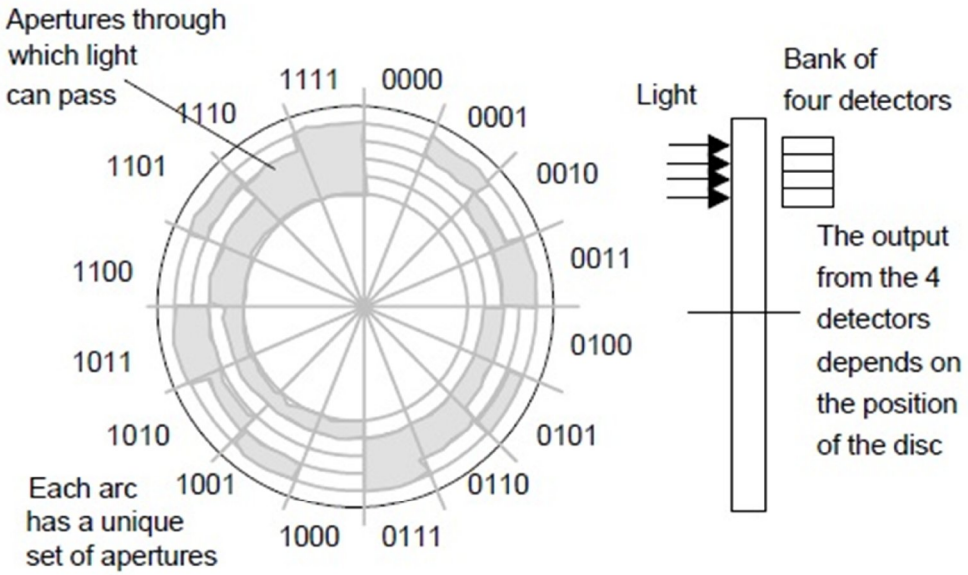


Fig.5. Incremental Encoder **[+2M]**



[+2M]

Fig.6. Absolute Encoder

Note that though the normal form of binary code is shown in the figure, in practice a modified form of binary code called the Gray code is generally used. This code, unlike normal binary, has only one bit changing in moving from one number to the next. Thus we have the sequence 0000, 0001, 0011, 0010, 0011, 0111, 0101, 0100, 1100, 1101, 1111.

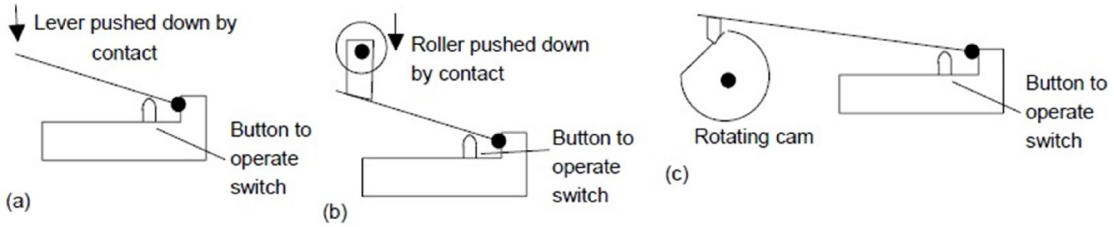
The Truth table for Binary to Gray Code conversion is as follows.

Binary				Gray Code			
A	**B**	**C**	**D**	**A**	**B**	**C**	**D**
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	1
0	0	1	1	0	0	1	0
0	1	0	0	0	1	1	0
0	1	0	1	0	1	1	1
0	1	1	0	0	1	0	1
0	1	1	1	0	1	0	0
1	0	0	0	1	1	0	0
1	0	0	1	1	1	0	1
1	0	1	0	1	1	1	1
1	0	1	1	1	1	1	0
1	1	0	0	1	0	1	0
1	1	0	1	1	0	1	1
1	1	1	0	1	0	0	1
1	1	1	1	1	0	0	0

[+2M]

4) a) What are limit switches? Explain different types of limit switches. **5**

The term *limit switch* is used for a switch which is used to detect the presence or passage of a moving part. It can be actuated by a cam, roller or lever. Figure 7 shows different types of limit switches. The cam (Figure 7(c)) can be rotated at a constant rate and so switch the switch on and off for particular time intervals. **[+2M]**



[+5M]

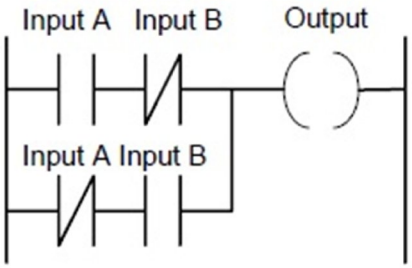
Fig.7.Limit switches actuated by, (a)lever, (b) roller, (c) Cam

b) Explain a two input Exclusive OR gate with Ladder diagram and Functional Block. **5**

The OR gate gives an output when either or both of the inputs are 1. Sometimes there is, however, a need for a gate that gives an output when either of the inputs is 1 but not when both are 1, i.e. has the truth table: **[+1M]**

Inputs		Output
A	B	
0	0	0
0	1	1
1	0	1
1	1	0

[+1M]



[+1M]

Fig.8. Ladder Diagram for XOR gate.

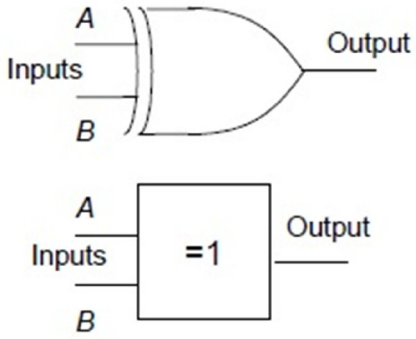
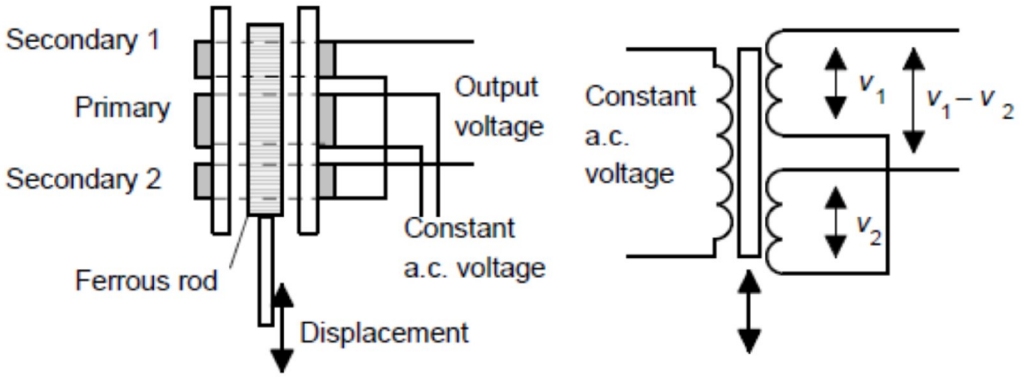


Fig.9. Circuit Symbol and Functional Block Diagram of XOR Gate **[+2M]**

5) a) Explain with necessary diagrams, the LVDT for measuring the position of an object. **7**

The *linear variable differential transformer (LVDT)* is the displacement sensor, this giving a voltage output related to the position of a ferrous rod. The LVDT consists of three symmetrically placed coils through which the ferrous rod moves (Figure.10).

[+1M]



[+3M]

Fig. 10.LVDT

When an alternating current is applied to the primary coil, alternating voltages, *v*1 and *v*2, are induced in the two secondary coils. When the ferrous rod core is centered between the two secondary coils, the voltages induced in them are equal. The outputs from the two secondary coils are connected so that their combined output is the difference between the two voltages, i.e. *v*1 – *v*2. With the rod central, the two alternating voltages are equal and so there is no output voltage. When the rod is displaced from its central position there is more of the rod in one secondary coil than the other. As a result the size of the alternating voltage induced in one coil is greater than that in the other. The difference between the two secondary coil voltages, i.e. the output, thus depends on the position of the ferrous rod. The output from the LVDT is an alternating voltage. This is usually converted to an analogue d.c. voltage and amplified before inputting to the analogue channel of a PLC.

[+3M]

b) Write the instruction List for the ladder diagram shown in Fig.5.b. **3**

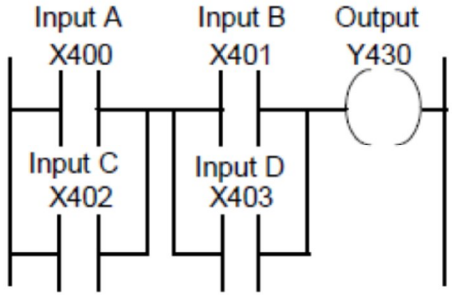


Fig.5.b. Figure for question 5. b)

LD X400
OR X402
LD X401
OR X403
ANB
OUT Y430

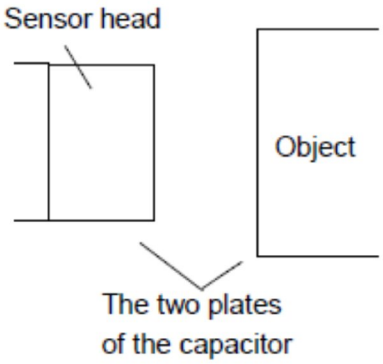
[+3M]

6) a) Explain the operation of capacitive proximity switch. **4**

A proximity switch that can be used with metallic and non-metallic objects is the *capacitive proximity switch*. The capacitance of a pair of plates separated by some distance depends on the separation, the smaller the separation the higher the capacitance. The sensor of the capacitive proximity switch is just one of the plates of the capacitor, the other plate being the metal object whose proximity is to be detected (Figure11). Thus the proximity of the object is detected by a change in capacitance. The sensor can also be used to detect non-metallic objects since the capacitance of a capacitor depends on the dielectric between its plates. In this case the plates are the sensor and the earth and the non-metallic object is the dielectric. The change in capacitance can be used to activate an electronic switch circuit and so give an on−off device.

Capacitive proximity switches can be used to detect objects when they are typically between 4 and 60 mm from the sensor head.

[+2M]



[+2M]

Fig.11 Capacitive Proximity Switch

b) Write a note on remote input output connection to PLC **6**

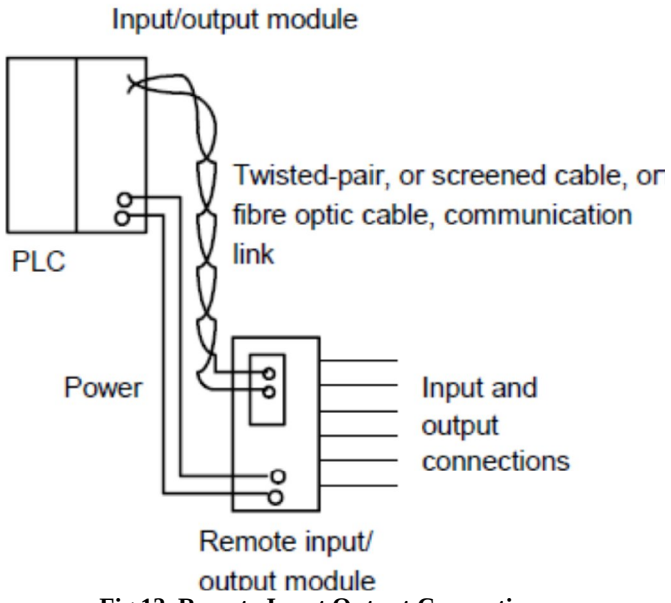


Fig.12. Remote Input Output Connection

When there are many inputs or outputs located considerable distances away from the PLC, while it would be possible to run cables from each such device to the PLC a more economical solution is to use input/output modules in the vicinity of the inputs and outputs and use just a single core cable to connect each, over the long distances, to the PLC instead of the multicore cable that would be needed without such distant I/O modules (Fig.12) In some situations a number of PLCs may be linked together with a master PLC unit sending and receiving input/output data from the other units. The distant PLCs do not contain the control program since all the control processing is carried out by the master PLC. The cables used for communicating data between remote input/output modules and a central PLC, remote PLCs and the master PLC are typically *twisted-pair cabling*, often routed through grounded steel conduit in order to reduce electrical 'noise'. *Coaxial cable* enables higher data rates to be transmitted and does not require the shielding of steel conduit. *Fiber-optic cabling* has the advantage of resistance to noise, small size and flexibility and is now becoming more widely used.

7) a) Explain half adder using ladder diagram and functional block diagram. **8**

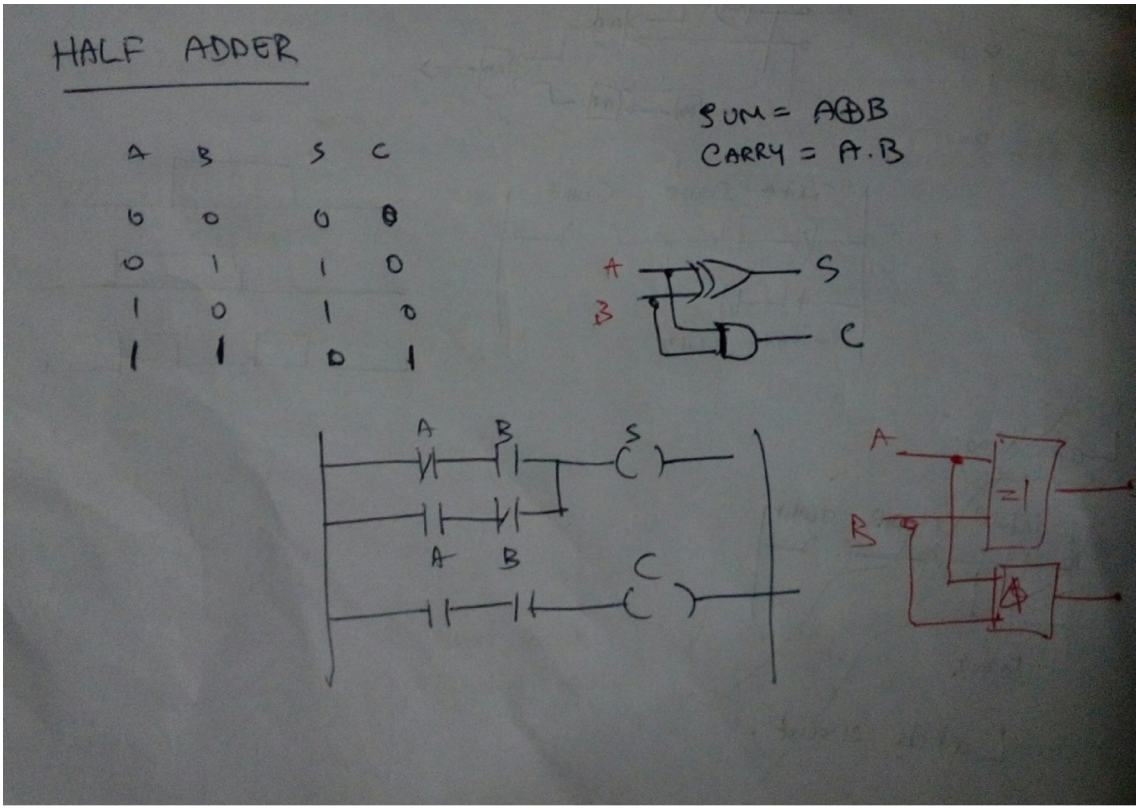


Fig.13 Half adder

b) Draw a neat diagram of reed switch and label the parts. **2**

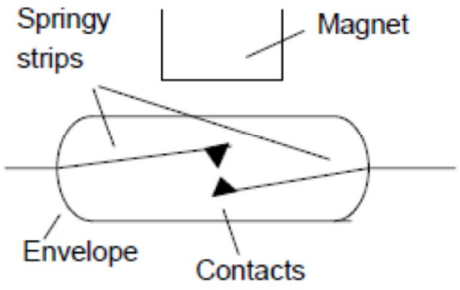


Fig.14 Reed Switch