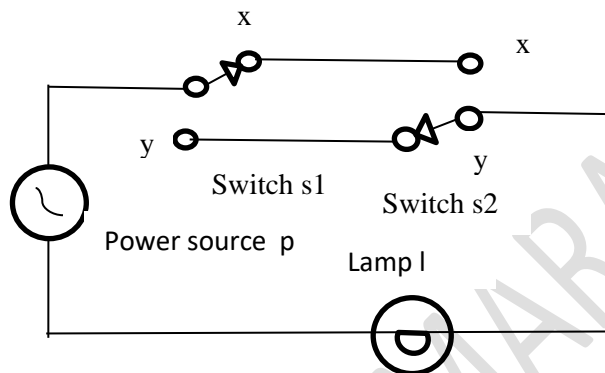


1.

- (a) Explain how to derive a Boolean expression from a given truth table.
 (b) In residential electrical wiring. The following circuit has been used to operate a light in a staircase.



As in the above circuit, two switches S1 and S2 are installed at the bottom and the top of the staircase to operate the lamp L. The lamp turned on by using the switch S1 at the bottom of the staircase can be turned off by using the switch S2 at the top of the staircase. Further, the lamp turned on by using switch S2 at the top of the staircase can also be turned off by the same switch.

Assume that the connections to positions X and Y of a switch in the above circuit are represented by the truth values 1 and 0 respectively and the turned on and turned off states of the lamp L are represented by the truth values 1 and 0 respectively.

- (i) Construct a truth table to represent the functionality of the above circuit.
 (ii) Derive a Boolean expression to represent the truth table obtained in section (i) above.
 (iii) What is the logic gate which is equivalent to the functionality of the Boolean expression obtained in section (ii) above?
 (iv) Construct a logic circuit for the Boolean expression obtained in section (ii) above with NOT, AND and OR gates only.

2.

An air craft is equipped with a quality control system with sensors that functions in accordance with temperature of engine, pressure and rotation speed of piston shaft.

A warning built in pilot's cabin is on when there is a risk and the risk levels are given below.

- When internal temperature is above 400 degrees centigrade **and**
- Internal pressure is above 1.5Mpa **or** rotation speed of the piston shaft is less than 4000.

In a dangerous situation,

1. When the internal temperature is greater than 400°C, 'A' temperature sensor is switched on automatically.
2. When the internal pressure is greater than 1.5Mpa, 'B' sensor is switched on automatically.
3. When the rotation speed of the shaft is less than 4000, 'C' sensor is switched on automatically.

Following table shows the input control system of the security alarm bulb and the relevant Boolean value.

Input	Condition/Process	Boolean Value
A	Internal temperature is above 400 °C.	1
B	Internal pressure is above 1.5 MP.	1
C	Rotation speed of the shaft drops is greater than 4000.	1
A	Internal temperature is below 400 °C.	0
B	Internal pressure is below 1.5 MP.	0
C	Rotation speed of the shaft is less than 4000.	0

- (a) Design the logic circuit by using a combination of only AND, OR, NOT gates only to implement the above control system.
- (b) Construct a truth table to represent the functionality of the above circuit.
- (c) Write a Boolean expression (not simplified) for the final output to represent the truth table.
- (d) Simplify the expression obtained in the above part (c) using the Boolean laws or Karnaugh map.
- (e) State with A, B and C, under what condition of the engine, the security alarm bulb is lit? (There may be several possibilities).
