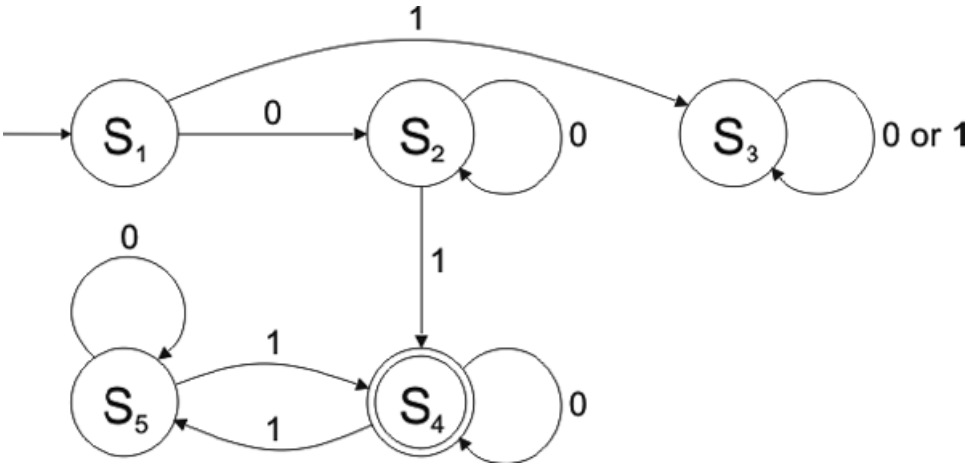
Q1. The diagram below shows a Finite State Automaton (FSA). The FSA has input alphabet {0, 1} and five states, S_1, S_2, S_3, S_4 and S_5.



(a) Complete the transition table below for the FSA in the diagram above.

Current State	S_1	S_1	S_2	S_2	S_3	S_3	S_4	S_4	S_5	S_5
Input Symbol	0	1	0	1	0	1				
Next State	S_2	S_3	S_2	S_4	S_3	S_3				

(1)

(b) The state S_4 is a special state. This is indicated by the double circle in the diagram. What does the double circle signify?

.....

..... **(1)**

(c) Write **Yes** or **No** in each row of the table below to indicate whether or not each of the four input strings would be accepted by the FSA in the diagram above.

Input String	**String Accepted? (Yes / No)**
101	
000	
010001101	
0100011011	

(2)

(d) Describe the language (set of strings) that the FSA will accept.

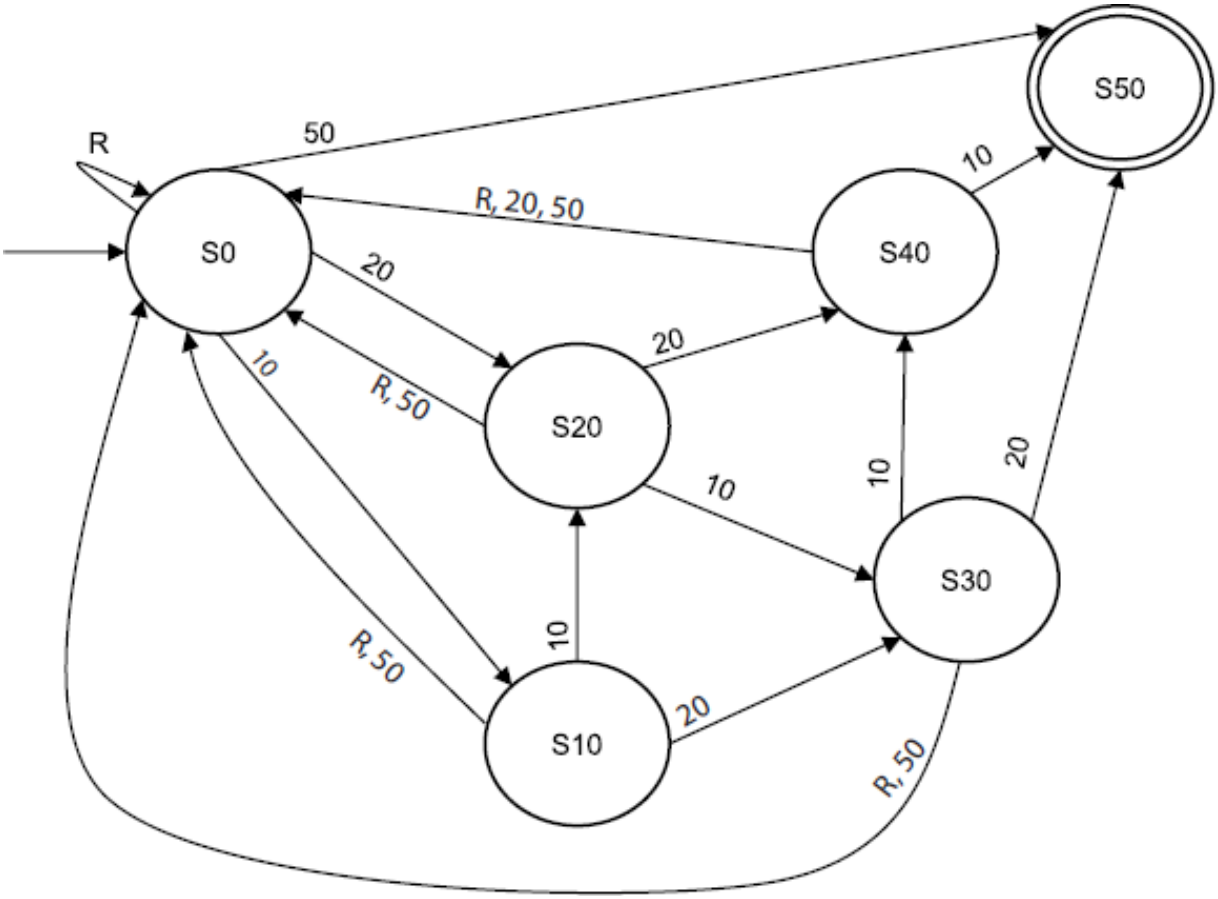
.....

.....

..... **(2)**

Q2. The diagram below shows the state transition diagram of a finite state machine (FSM) used to control a vending machine.

The vending machine dispenses a drink when a customer has inserted exactly 50 pence. A transaction is cancelled and coins returned to the customer if more than 50 pence is inserted or the reject button (R) is pressed. The vending machine accepts 10, 20 and 50 pence coins. Only one type of drink is available.
The only acceptable inputs for the FSM are 10, 20, 50 and R.



(a) An FSM can be represented as a state transition diagram or as a state transition table. The table below is an incomplete state transition table for part of the diagram above.

Complete the missing sections of the four rows of the table below.

Original state	Input	New state
S0	10	S10
S0		
S0		
S0		

(3)

(b) There are different ways that a customer can provide **exactly three** inputs that will result in the vending machine dispensing a drink. Three possible permutations are "20, 10, 20", "10, R, 50" and "10, 50, 50".

List **four** other possible permutations of **exactly three** inputs that will be accepted by the FSM shown in the diagram above.

.....

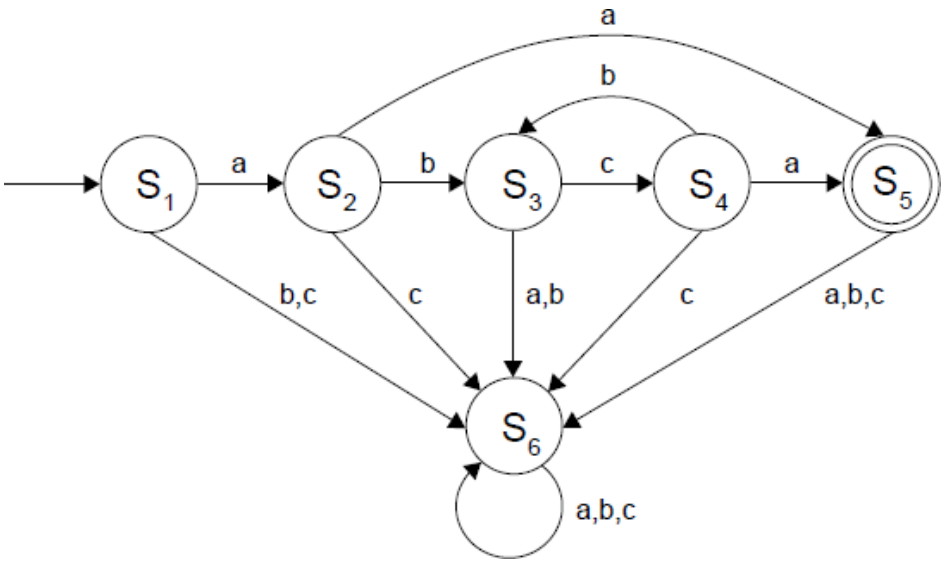
.....

.....

.....

(4)
(Total 7 marks)

Q3. The diagram below shows a Finite State Automaton (FSA). The FSA has input alphabet {a, b, c} and six states, S_1, S_2, S_3, S_4, S_5 and S_6.



(a) Complete the empty cells in the **part of the transition table shown** below for the FSA in the diagram.

Current State	S_1	S_1	S_1	S_2	S_2	S_2	S_3	S_3	S_3
Input Symbol	a	b	c	a	b	c			
Next State	S_2	S_6	S_6	S_5	S_3	S_6			

(1)

(b) Give the name of the state that the FSA will end up in when processing the string `abcb`.

.....

(1)

(c) Describe the purpose of state S_6.

.....

.....

(1)

Q4. A hotel provides a safety deposit box in guest rooms. The safety deposit box has a keypad with twelve buttons, as shown in **Figure 1**.

Figure 1

1	2	3
4	5	6
7	8	9
C	0	E

The safety deposit box operates as follows:

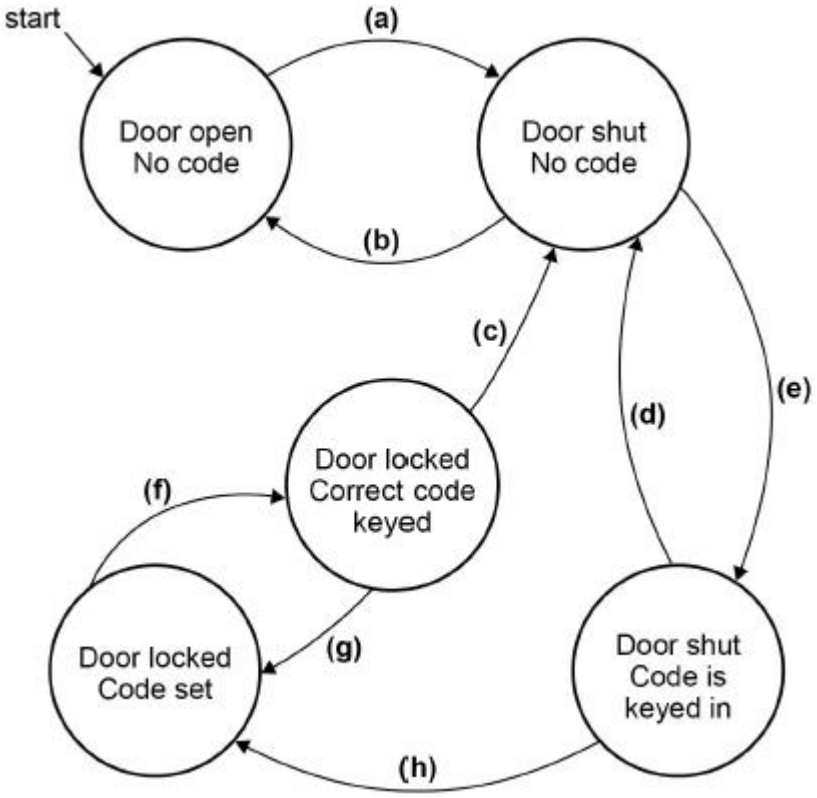
The buttons with digits 0 to 9 enable the guest to set their own code. Button C cancels any digits entered. Button E is the Enter key.

- To close the safety deposit box:
  - push the door shut
  - key in a new 4-digit code (guest's choice)
  - press the Enter key (this sets the code and locks the door).
- To open the safety deposit box:
  - key in the correct 4-digit code (previously chosen by the guest)
  - press the Enter key (this also deletes the stored code)
  - pull open the door.
- Pressing the keypad has no effect, except when keying in a code.

Figure 2 shows a partially complete state transition diagram that represents the operation of the safety deposit box. The events are labelled **(a)** to **(h)**.

Note the state transition diagram does not show what happens if an incorrect code is keyed in.

Figure 2



In the table below indicate which label(s), **(a)** to **(h)**, represent(s) which event. Two labels have to be assigned to some of the events.

Complete the table by filling in the unshaded cells with the correct labels from **Figure 2**. A label **must** only be used once.

Event	**Label(s): (a) to (h)**
Correct code keyed	
Door pulled open	
Door pushed shut	
New code keyed	
Press C	
Press E	

(Total 4 marks)