2009 Paper 2 Question 2

Digital Electronics

(a) With the aid of a suitable diagram, explain *set-up time*, *hold time* and *propagation delay* for a positive edge triggered D-type flip-flop. [6 marks]

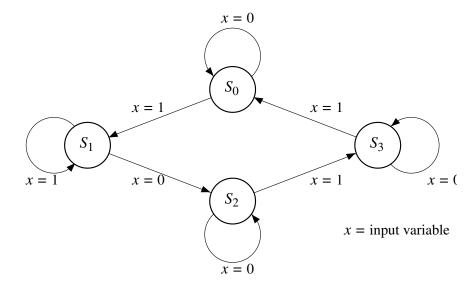(b) The controller of a car wash machine is designed to produce the following sequence of steps.

Water spray (W)	Sponge (S)	Heater (H)
0	0	0
1	0	0
1	1	0
0	0	1
0	0	0

The sequence starts at $W = S = H = 0$ following the pressing of a button B: i.e. $B = 1$ if pressed, $B = 0$ otherwise.

If B is pressed while the heater is on ($H = 1$) then return to the step with the heater off ($H = 0$) and water spray on ($W = 1$) and sponge on ($S = 1$). Otherwise B has no effect until the entire sequence of steps is complete.

Draw a state diagram for the system. [6 marks]

(c) Consider the following state diagram

and the state assignment $S_0 = 00$, $S_1 = 01$, $S_2 = 10$ and $S_3 = 11$. Write down the state table. Assuming the use of D-type flip-flops for the state registers, derive the minimised Boolean expressions for the next-state functions. Note that state $= (Q_1, Q_0)$ where Q_n is the output from flip-flop n. [8 marks]