Design a binary up/down mod 5 counter using state machines and draw the circuit. If the input \( c = 1 \) then count down, and if \( c = 0 \) then count up. Use don't cares for unused states. Use D flip-flops for the state memory. For full credit, show the derivation of all logic expressions used for implementing this counter.
Given the function $F(A,B,C,D,E)$ defined by the following maxterm expression. Answer the following questions.

$$F = \prod_{ABCDE} M(1,3,4,6,7,12,22,23,30) + dc(5,8,16)$$

a) Determine the **minimal** POS expression for $F$.

b) Determine the **minimal** SOP expression for $F$. 
Design a state machine which will detect a 1011 sequence. The state machine should output a 1 only when the sequence has been detected. Use Mealy-type outputs (make the outputs functions of the current state and input.) Include in your design the state transition diagram, state table, logic equations for the flip-flop inputs and the state machine output. You may use any type of flip-flop to implement the sequential network.
X = 3FEAB020h, Y = BE0FA400h, where X and Y are both in IEEE single precision floating-point format.

a) Give $Z = X - Y$, as a hexadecimal number in IEEE single precision floating-point format.

b) Give $Q = X / Y$ in binary floating-point format, showing 8 significant digits in the significand.
Write a VHDL program for a 4-bit modulo-16 counter circuit with the count sequence 7,6,5,4,3,2,1,0,8,9,10,11,12,13,14,15,7,...
(a) What is computational intelligence (CI) and how does it impact the field of adaptive devices, circuits and systems?

(b) Explain the stalling effect in the fitness function. How does one overcome the stalling effect? Mention at least two methods.
(c) Describe the concept of General Disjunction Decomposition (GDD) for Evolvable Hardware. Provide diagrams and tables where necessary.
(i) Determine whether the following functions are strictly convex, convex, strictly concave or concave:

\[(a) \quad f(x) = e^x\]
\[(b) \quad f(x) = -8x^2\]
\[(c) \quad f(x_1, x_2) = 3x_1^3 - 6x_2^2\]

(ii) Mention eight different ways in which optimization problems can be classified.
(iii) Below is a finite state machine for an individual in an EP algorithm. Using a 6-bit string for each state, derive the EP string representation if state A is the active state, and the active inputs at States A, B, C and D are ‘1’, ‘0’, ‘1’, and ‘0’, respectively. Clearly state the bit assignments you have chosen for the states and outputs.

6-bit string representation:
- First bit – state activation (‘0’ inactive & ‘1’ active).
- Second bit – input symbol
- Third and fourth bits – next state
- Last two bits – output symbol
(a) What is Approximate Dynamic Programming? Describe with equation(s) and a diagram.

(b) What are Adaptive Critic Designs (ACDs)? Give six examples of ACD family members and describe DHP approach in detail (development and training methodology).
(a) Describe the Mean-Variance Optimization Algorithm.

(b) Apply backward dynamic programming to find the shortest path from node 1 to 11.
<This empty page is given for showing work/derivation for problem CA 19>
(i) What is reinforcement learning?

(ii) Describe four elements of reinforcement learning.
(iii) Give an example of a problem where reinforcement learning is the most applicable approach. Explain why so.