Q1: Consider the following deterministic finite state automaton (DFSA) with state transition table shown below:

1. Draw the state diagram of DFSA.
2. Explain the component of DFSA.
3. What are the conditions of DFSA.
4. Determine the output state function by arrow. 
   \[ w = 1(101)*1(1001)*(0+1)1 \]

<table>
<thead>
<tr>
<th>Input Symbols (w)</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
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</thead>
<tbody>
<tr>
<td>0</td>
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<td>S4</td>
<td>S1</td>
<td>S5</td>
<td>S6</td>
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<td>1</td>
<td>S2</td>
<td>S3</td>
<td>S4</td>
<td>S7</td>
<td>S9</td>
<td>S4</td>
<td>S8</td>
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</tbody>
</table>

(14 marks)

Q2: (Chose two only)

A- Prove the statement is true by using mathematical induction:
   \[ P(n): a + ar + ar^2 + \ldots + ar^{n-1} = a \left(1 - r^n\right) / 1 - r \quad \text{where} \quad r \neq 1 \]
   (7 marks)

B- 1. A computer must hire 25 programmers to handle systems programming task and 40 programmers for applications programming of those hired, 10 will be expected to perform tasks of each type. How many programmers must be hired.
   2. Given \(2x - 3, 3y - 1) = (5, 5). Find \(x \) and \(y\). 
   (7 marks)

C- Sketch the graph of function: \(f(x) = x^3 - 3x + 2\)  
(7 marks)

Q3: A- Consider the algebraic expression: \((4a + b/3)/(5 - 2a b)^3\)

1. Draw the corresponding ORT.
2. Rewrite the expression into prefix and postfix polish notation form.
   (7 marks)

B- Let \(V = \{V_1, V_2, V_3, V_4, V_5, V_6\}, E = \{e_1, e_2, e_3, e_4, e_5, e_6, e_7, e_8, e_9\}\).
   \[ E = \{(V_1, V_2), (V_2, V_3), (V_3, V_4), (V_4, V_5), (V_5, V_6), (V_6, V_1), (V_1, V_5), (V_5, V_3), (V_5, V_2)\} \]

1. Draw the graph.
2. Find the sequence of graph (in part one) according to:
   Trail, path, walk and not that
3. Find the minimum path of graph (in part one) between \(V_1\) and \(V_6\).  
(7 marks)

Q4: A- Find all partition of \(x = \{a, b, c, d\}\).

Note: first that each partition of \(x\) contains either 1, 2, 3, or 4 distinct sets.
   (7 marks)

B- Compute:
   \(A = \{a, b, c, d\}, B = \{d, e, f\}, C = \{g, h\}, U = \{a, b, c, d, e, f, g, h\}\)

1. \(A - B\)  2. \(|A \cap B \cap C|\)  3. \(A^c\)  4. \(A \cup B \cap C\).  
(7 marks)
Q5: (Chose two only)

A- Let $X=\{1, 2, 3, 4\}$, $R$ a relation on $X$, $a \ R \ b \iff a \neq b$, $\forall \ a, b \in X$, Find:
1- $R$ in ordered pairs.
2- $R$ by coordinate.
3- $R^{-1}$ by matrix form.
4- $R^C$ by graph form.
5- $R \circ (R \circ R^{-1})$  

(7 marks)

B- Let $Z=\{1, 2, 3\}$, for all part ($R$ is a relation), determine which from this properties of
relation:
(reflexive, symmetric, transitive, irreflexive, antisymmetric and equivalence relation)

1- If $R=\{(1,1), (1,2), (1,3), (2,2), (2,1), (2,3), (3,3), (3,1), (3,2)\}$
2- If $R=\{(1,1), (2,2), (3,3)\}$
3- If $R=\{(1,2), (2,1), (1,3), (2,3), (3,1)\}$
4- If $(2, 2) \not\in R$, $2 \in A$, then $R=\{(2,1), (2,3), (3,3)\}$
5- If $R=\{(1,2), (2,3), (1,3)\}$
6- If $R=\{(1,2), (2,1)\}$

(7 marks)

C- Define the following with example: (Chose six only)

Bipartite graph, Incidence matrix, Tree, FSM, Corollary, Subset, Universal set.

(7 marks)

Good luck