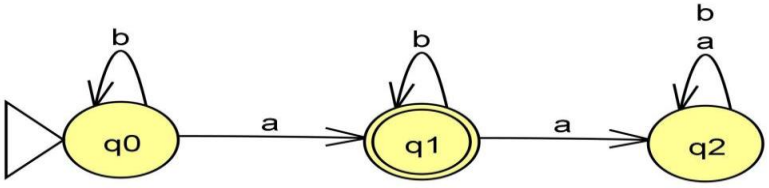
Answer the following questions:

Question 1: Choose the correct answer: **(10 Marks)**

1. If A= {1, 2, 3, 4, 5} and B = {5, 6, 7}, then | A− B| equals
   a. 4 b. 5 c. 7 d. 3
2. Select a bijective function:
   a. f: Z → Z: f (*x*) = *2 x*
   b. g: R →R: g(*x*) = x^2
   c. I: R →R: I(*x*) = *x*
   d. h: Z →{0, 1} : h(*x*) =*0* if *x* is even and *h(x) = 1* otherwise
3. If the function f is bijective, then f is invertible.
   a. True b. False
4. If |A| = 3 and |B| = 2, then |A x B| equals
   a. 6 b. 9 c. 4 d. 8
5. If a = c and b = d then (a, b) = (c, d)
   a. True b. False
6. Let A = {a, b, c}, if w is a string over A and |www|= 36, what is the length of w?
   a. 6 b. 12 c. 18 d. 36
7. If L = {aba, ba}, which of the following strings is NOT in L^*:
   a. aa b. bb c. ab d. All of the previous
8. Find L in L.{λ, a} = {λ, a, b, ab, ba, aba}
   a. L = {a, b}
   b. L = {λ, b, ab}
   c. L = {λ, a, b}
   d. L = {b, ab}
9. Let G = < {D,S} , {0,1,2,…,9} , P , S > , where P is:
   S → D 0 | D2 | D4 | D6 | D8
   D → λ |D0|D 1|D2|D3|D4|D5|D7| D8| D9
   Which of the following strings is NOT in L(G):
   a. 13 b. 22 c. 24 d. 28
10. Choose a *correct* grammar generating the language { *a, aaa, aaaaa, …,* a^{2n+1},…}
    a. S →a | aa S
    b. S →λ | a | aa S
    c. S → a | a S
    d. S → λ | a S
11. The language L = { $a^{n^2}: 1 \leq n \leq 4$} is regular.
    a. True b. False
12. Select a regular language:
    a. $\{1^n: n \geq 0, n \neq 1\}$
    b. $\{a^n\, b^p: n \neq p\}$
    c. $\{a^n\, b^m: n \geq m\}$
    d. $\{a^n\, b^n: n \geq 0\}$

13. Regular expressions are algebraic notations used to describe regular languages.
    a. True b. False
14. Choose a regular expression to describe the language {λ, a, b, ca, bc, cca, bcc, …, $c^n a, bc^n$, …}
    a. $\lambda + bc^*a$ c. $\lambda + ac^* + bc^*$
    b. $\lambda + c^*a + bc^*$ d. $\lambda + ac^* + cb^*$
15. Choose the correct language described by the regular expression $a^*(a + b)$
    a. {λ, a, b, aa, ab,, aaa, aab, …}
    b. {a, b, aa, ab, aaa, aab, …}
    c. {a, b, aa, ba, bb, ab, aaa, baa, …}
    d. { λ, a, b, aa, ba,, aaa, baa, …}
16. Let G = < { S} , {a } , P , S > , where P is: S → λ| aS , then G is a regular grammar.
    a. True b. False
17. The language L = { $a^n b^n c^n : n \geq 0$ } is context-free.
    a. True b. False
18. The concatenation of two context-free languages is context-free.
    a. True b. False
19. Two finite machines M_1 and M_2 are said to be **equivalent** if L (M_1) = L (M_2).
    a. True b. False
20. The language accepted by the following DFA is:
    a. {a} c. { $b^n ab^m : m, n \geq 0$}
    b. { $b^n ab^n : n \geq 0$} d. { $b^n ab^m a : m, n \geq 0$}



Question 2: **(10 Marks)**

1) Construct the following machines over the alphabet {0, 1}:
    1. DFA that accepts the language {00, 01}.
    2. DFA that accepts the language L ={ $01w : w \in \{0,1\}^*$}
    3. NFA that accepts the language L = {$u00v : u, v \in \{0,1\}^*$}
    4. NFA without λ-transition and with a single final state that accepts the language: $\{0\} \cup \{1^n : n \geq 1\}$
    5. A Mealy machine that produces an output 1 for any input.

Question 3:

1) Why the NFA is less efficient in recognizing strings than DFA? **(2 Marks)**
2) Consider the NFA given by the following table: **(4 Marks)**

		λ	a	b
Start	0	{1, 2}	{1}	ϕ
	1	ϕ	ϕ	{2}
Final	2	ϕ	{2}	ϕ

1. Find the lambda closure for all states.
2. Convert the machine into DFA and draw the graph for the resulting machine.

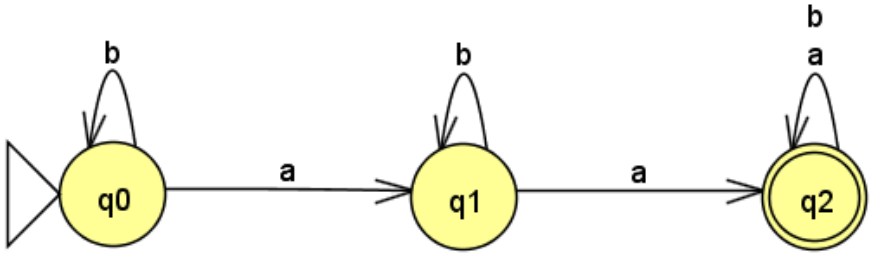
3) Construct NFA for the following regular expression using RE to FA algorithm: **(4 Marks)**

a*b c* + ac

Question 4:

1) Using Pumping lemma for regular languages, show that the language $\{a^n bc^n : n \geq 0\}$ is Not regular. **(3 Marks)**

2) Step by step find a regular expression describes the language accepted by the following automaton using FA to RE algorithm: **(4 Marks)**



3) Construct grammars for the following languages: **(3 Marks)**

a. L = { $ba^n b : n \geq 0$ }

b. M = {$a^n\ b\ c^n : n \geq 0$ }

Question 5:

1) Show that the function f(n) = n +1 , n ≥ 0 is *Turing Computable* where the number n is represented in binary form. **(3 Marks)**

2) Construct PDA to describe the language $\{a^{n+2}\ c\ b^n : n \geq 0\}$ **(4 Marks)**

3) Write regular expression to describe each of the following languages: **(3 Marks)**

a. L = $\{a^n b^m, n, m \geq 1\}$

b. M = { $a^n b^m, n \geq 2, m \geq 3\}$

c. The set of all strings over the alphabet {a, b} that begin and end with the same letter.

Good Luck