FORMAL LANGUAGE & AUTOMATA THEORY
(CSEN 3101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The smallest Finite State Automata, which accepts the language {W | length of W is divisible by 3} has
(a) 2 states (b) 3 states (c) 4 states (d) 5 states.

(ii) A language L is accepted by Finite State Automata if and only if it is
(a) Context-free (b) Context sensitive (c) recursive (d) regular.

(iii) Find the false statement if $\sum$: {a, b}
(i) L = $\{a^n b^m, m, n \geq 1\}$ is regular
(ii) L = {X, where number of a > number of b} is not regular
(iii) L = $\{a^n b^n, n \geq 1\}$ is regular
(a) (i) only (b) (iii) only (c) (ii) and (iii) (d) (i) and (iii).

(iv) Context Free Language (CFL) ∩ Context Sensitive Language (CSL) =?
(a) Regular Language (b) CSL (c) CFL (d) None of these.

(v) P, Q, R are three languages, if P and R are regular and if PQ = R then
(a) Q = R (b) Q = P (c) Both (a) and (b) (d) None of these.

(vi) Consider the grammar with following productions
$S \rightarrow aB \mid b \mid ab$
$Sa \rightarrow bdb \mid b$
What type of grammar is it?
(a) Context-free (b) Regular
(c) Context Sensitive (d) None of these.

(vii) $a^m b^n c^n \cap a^m b^m c^n$ = ? (where m, n ≥ 0)
(a) a^m, m ≥ 0 (b) $a^m c^n$, m, n ≥ 0 (c) $a^n b^n c^n$, n ≥ 0 (d) NULL.

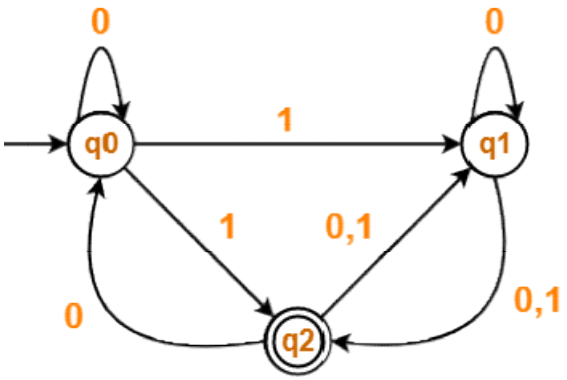
(viii) Which statement is correct or which statements are correct?
(i) Deterministic finite state automata is equally powerful as non-deterministic finite state automata
(ii) Deterministic Push down automata is equally powerful as non-deterministic push down automata
(iii) Deterministic Turing machine is equally powerful as non-deterministic Turing machine.
(a) (i) only (b) (i) and (iii) (c) (ii) and (iii) (d) none of these.

(ix) Let L_0 be the set of all languages accepted by a Push down automata (PDA_1) by the final state and L_1 be the set of all languages accepted by PDA_1 but by the empty stack then
(a) $L_0 = L_1$ (b) $L_0 \geq L_1$ (c) $L_0 < L_1$ (d) none of these.

(x) A Turing machine is more powerful than the finite state automata as for its
(a) Infinite tape length (b) Ability to rewind
(c) Ability to remember arbitrary length string (d) none of the above.

Group – B

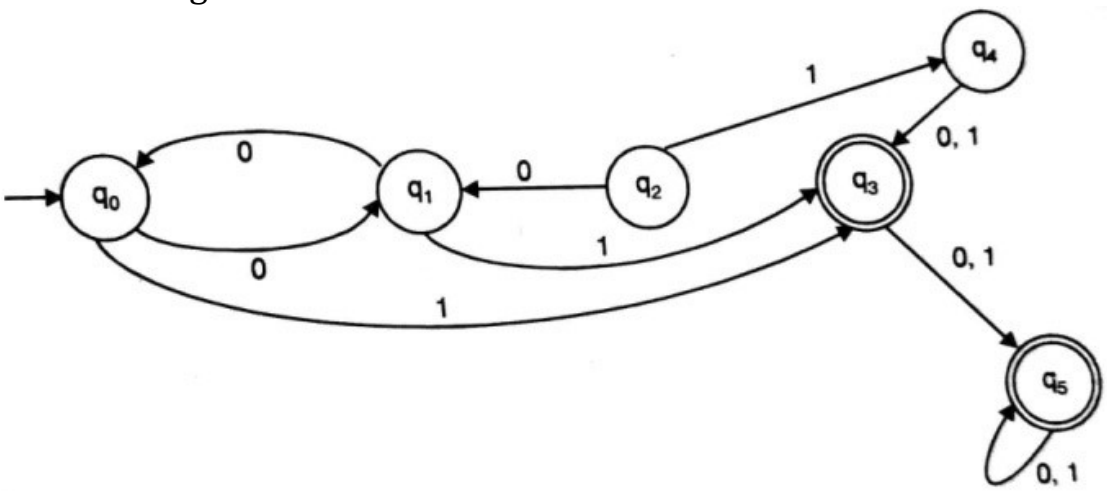
2. (a) Convert the following Non-Deterministic Finite Automata (NFA) to Deterministic Finite Automata (DFA)



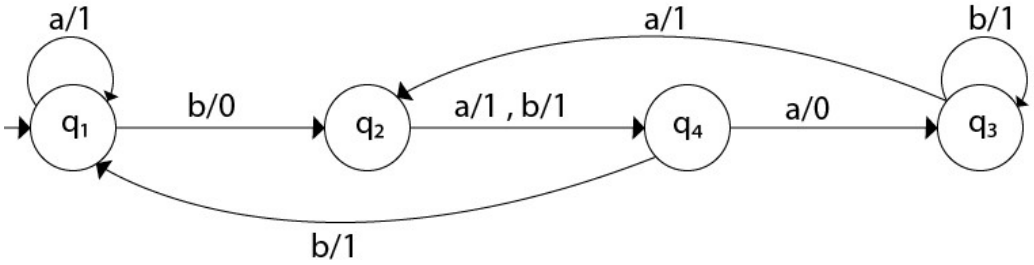
(b) Construct a DFA that accepts all possible strings over the input symbols {0, 1} that **do not** contain 011 as substring.

6 + 6 = 12

3. (a) Minimise the given DFA.



(b) Convert the following Mealy machine into an equivalent Moore machine.

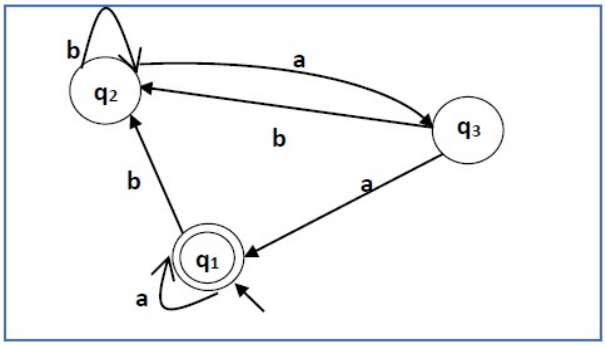


6 + 6 = 12

Group – C

4. (a) What will be the regular expression of the Finite State Automata (FSA) that will accept all the binary strings (i.e. ∑: {0, 1}) that start with even number of zeros and end with odd number of ones?

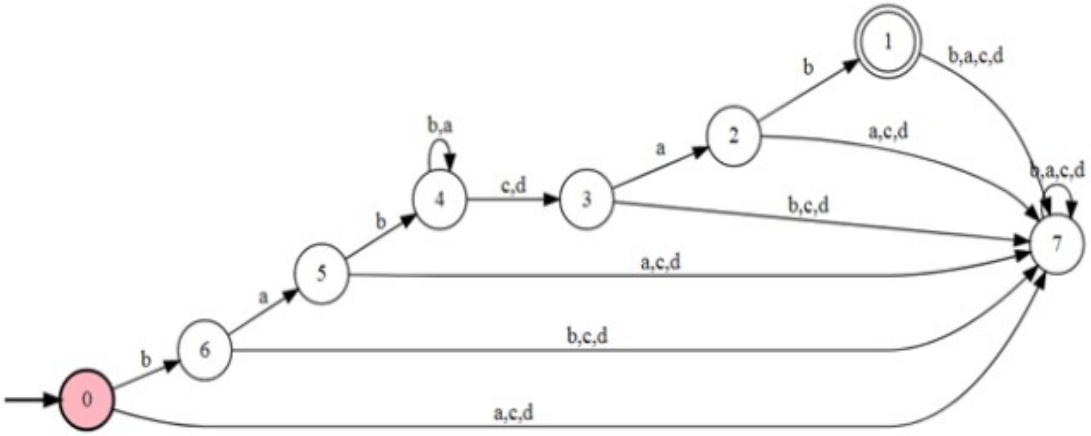
(b) Find out the regular expression for the following Finite State Automata (FSA).



4 + 8 = 12

5. (a) Prove that there does not exist any Finite State Automata (FSA) that will accept the following language
L: a^p | p is a prime number.

(b) Find out the regular grammar for the following FSA.



6 + 6 = 12

Group – D

6. (a) Design a PDA that will accept the language L, such that {L: $a^n b^n$ | n ≥ 0} over the input alphabets ∑: {a, b}.

(b) Show that there does not exist any PDA that will accept the language,
L: $a^n b^n c^n | n \geq 0$

7 + 5 = 12

7. (a) Design the CFG for the following languages:
$a^n bc^n | n \geq 0$
$0^m 1^n | n > m, m \geq 0$

(b) Simplify the following CFG as much as possible
$S \rightarrow DAa$
$A \rightarrow b$
$B \rightarrow a$
$D \rightarrow Ɛ$ (Ɛ represents NULL).

(4 × 2) + 4 = 12

Group – E

8. (a) Design a Turing machine that will accept the language L, such that
{L: $a^n bc^n | n > 0$}, over the input alphabets (i.e. ∑: {a, b, c}).

(b) There exists a Turing machine M that accepts the language L. Can we infer that - L is a recursive language? Justify your answer.

8 + 4 = 12

9. (a) Write short note on the following topics
(i) Turing machine halting problem
(ii) Multi-tape Turing machine.

(b) Design a Turing machine that generates the one's complement of any given binary input string (i.e. ∑: {0, 1}).

(4 × 2) + 4 = 12

Department & Section	Submission link:
CSE	https://classroom.google.com/c/Mjc5NDY3ODk3NzEx/a/Mjc2ODM1ODgyMzI1/details