BITS, Pilani – Dubai

Dubai International Academic City, Dubai

I Semester 2008-09

Course Number	:	**CS C351**
Course Name	:	**Theory of Computation**
Department	:	III Year Computer Science
Nature of Component	:	Closed Book
Date and Day	:	**05-10-2008, Sunday**
Duration	:	50 mins
Weightage (%)	:	25% (25 Marks)
No. of Pages	:	2 Pages

Note: 1. Answer all Questions.
2. Start answering the questions in a fresh page.

1. If Language L = {0, 1}*{10} of all strings of 0's and 1's that end in 10 and the finite automaton is recognized by the Transition table given below for the above mentioned language: (2 Mark)

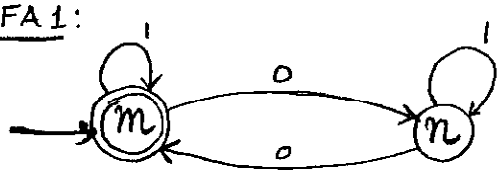
State | input

	0	1
→ ^	0	1
0	00	01
1	10	11
00	00	01
01	10	11
10	00	01
✓ **11**	10	11

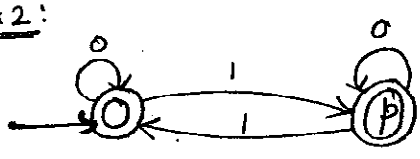
Give the Transition Diagram for the above described language.

2. State the Deterministic Finite Automaton (DFA) Equivalence Algorithm and mention that how to check whether the two given DFA's are equivalent. (2 Marks)
3. If DFA1 and DFA2 are given, show the product of the two DFA's and state whether the two DFAs are equivalent. (3 Marks)

DFA 1:



DFA 2:



4. Under what condition DFA states can be merged, explain it with an example. (2 Marks)
5. Build a Finite State machine to accept the words ***"cab", "cob", "cat", "cot"***, but no others from the alphabet L = { a, b, c, t, o }. (3 Marks)

6. Construct the transition table and transition system for the given transition equation:

δ = { (q0,a,q1), (q0,b,q0), (q1,a,q0), (q1,b,q2), (q2,a,q3), (q2,b,q1), (q3,a,q3), (q3,b,q0), (q4,a,q3), (q4,b,q5), (q5,a,q6), (q5, b,q4), (q6,a,q5), (q6,b,q6), (q7,a,q6), (q7,b,q3) } and Σ = {a,b}, K={q0,q11,q2,q3,q4,q5,q6,q7}, s=q0, F={q3} (2 Marks)

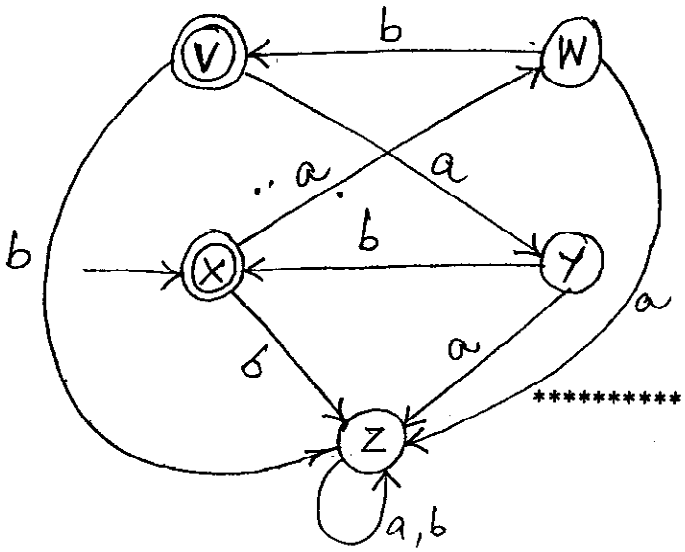
7. For the formal definition of machine M given below construct the non-deterministic finite state machine. (3 Marks)

States = {Start, Deposited, Removed, Violated}, input I = {D, R}, initial state = Start, F= {Deposited, Removed}, and the **transition equation** is:

f (Start, D) = Deposited, f(Start, R) = Violated, f(Deposited, D) = Deposited, f(Deposited, R) = Removed, f(Removed, D) = Deposited, f(Removed, R) = Violated, f(Violated, x) = Violated for x in I.

8. Design a Finite State Machine for the following problem definition: Consider the behavior and associated events of a gate at a train crossing. Suppose that there is a road crossing railway track, and a gate that opens and closes over the road. When a train approaches the crossing, the gate should close. More than one train can be crossing area at once, for example, a convoy of trains, each with a single engine and no cars. When the last train has left and the area is empty of trains, the gate should open. The gate could be in one of four states: **open, closed, opening,** and **closing**. The relevant events are: **cg** and **og** which are commands to close and open the gate, respectively; and **o-o** and **c-c** indicating from sensor input that the gate has completed opening (and thus changed from the opening to the opened state), and that the gate has completed closing, respectively. The initial state is closed and there are no stop states. The Finite state machine accepts the **cg** and **og** commands in all its states; thus, for example, the gate may be commanded to close while it is opening. (5 Marks)

9. Minimize the given finite automaton. (3 Marks)



BITS, Pilani – Dubai

Dubai International Academic City, Dubai

I Semester 2008-09

Course Number	:	**CS C351**
Course Name	:	**Theory of Computation**
Department	:	III Year Computer Science
Nature of Component	:	Open Book
Date and Day	:	**16-11-2008, Sunday**
Duration	:	50 mins
Weightage (%)	:	20% (20 Marks)
No. of Pages	:	2 Pages

Note: 1. Answer all Questions.
2. Start answering the questions in a fresh page.

1. Here is an ambiguous CFG: (6 Marks)

   $A \rightarrow aA \mid bA \mid Aa \mid e$

   (a) Describe informally the language of this grammar.

   (b) Give an example of a terminal string that has two leftmost derivations. Show those leftmost derivations.

   (c) Draw the derivation tree for the terminal string you gave in (b).

   (d) Convert this grammar to a PDA that accepts by empty stack. You may either specify the PDA formally, as a 7-tuple with δ given by a list of rules, or as a transition diagram. In the latter case, assume Z0 is the start symbol.

   (e) Modify your answer to (c) so acceptance is by final state.

   (f) Give an unambiguous grammar for the same language.

2. Let G = ({ S, A, B, a, b}, { a, b}, S, P) (5 Marks)

   Where P consist of:

   a) S→ AB, A→ ab, B→ b

   b) S→AB, S→ aA, A→a, B→ba

   c) S→ AB, S→ AA, A→ aB, A→ ab, B→ b

   d) S→ AA, S→B, A→ aaA, A→aa, B→ bB, B→b

   e) S→ AB, A→ aAb, B→ bBa, A → a , B → b

   Find the languages generated by G.

3. A Turing Machine with a tape alphabet 0, 1, and blanks; that accepts strings of {0,1}* as input by replacing all 0's on the tape with 1's and 1's as blank spaces. The states of the TM are q_0, q_1, q_{accept}, q_{reject}. There will be a change in the initial state to next state or next to the initial state whenever there is a 1 as input and when the number of 1's in the given input is is in odd length and only blank spaces are there it move to q_{reject} state. If the

number of 1's is even length then a blank space occurs to enters into the accepting state. Using the above description give a Turing Machine that decides string containing even numbers of 1's. (5 Marks)

4. Let M be the Turing Machine (K, Σ, δ, s, {h}), where K = {q_0, q_1,q_2, q_3, q_4, h}, S= {a, b, ␣ , ▶ }, and s=q_0, and δ is given by the following table.

q,	σ	δ(q, σ)
q_0	a	(q_2 , →)
q_0	b	(q_3 , a)
q_0	␣	(h, ␣)
q_0	▶	(q_0 , →)
q_1	a	(q_2 , →)
q_1	b	(q_2 , →)
q_1	␣	(q_2 , →)
q_1	▶	(q_1 , →)
q_2	a	(q_1 , b)
q_2	b	(q_3 , a)
q_2	␣	(h , ␣)
q_2	▶	(q_2 , →)
q_3	a	(q_4 , →)
q_3	b	(q_4 , →)
q_3	␣	(q_4 , →)
q_3	▶	(q_3 , →)
q_4	a	(q_2 , →)
q_4	b	(q_4 , →)
q_4	␣	(h , ␣)
q_4	▶	(q_4 , →)

Start from the configuration (q_0, ▶aaabbbaa). Give the Turing machine design and transition sequence for the input string. (4 Marks)

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I SEMESTER 2008-09
COURSE: CS C351 -THEORY OF COMPUTATION
QUIZ – 1

DATE: ----------
MAX. MARKS: 5 MARKS

NAME:_____ **ID. NO.:** _____

1. Draw Deterministic Finite Automata to accept the following sets of strings over the alphabet {0,1}:G

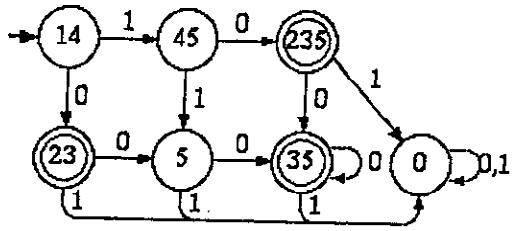
   i) All strings whose binary interpretation is divisible by 5.

   Ans:

   ii) All strings ending in 1101.
   Ans:

   iii) All strings that contain the substring 0101
   Ans:

2. Minimize the given DFA and check whether they satisfy the same language.



Ans:-

3. Draw the state diagram to the DFA M = (Q, S, d, q0, F), where Q={ A,B,C,D,E}, S={0,1}, q0 = A, F = { B,C,D,E} and d is specified by the table:

d	A	B	C	D	E
0	A	C	E	B	D
1	B	D	A	C	E

Then for the input string 1001, give the corresponding computation of automaton M, and say whether the computation is accepting or rejecting (Remember, the computation of a DFA on input *w* is the sequence of states the automaton goes through when reading *w*.

Ans:

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I – SEMESTER 2008-09
III YEAR COMPUTER SCIENCE **(5 Marks)**
COURSE: THEORY OF COMPUTATION, CS C351
QUIZ-2

DATE: ----------

Name: _____ **Id. No.:** _____

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1. Given the CFG G = ({S, A, B, C}, {a, b}, P, S), give the proper production rules using all the variables defined by the grammar, so that the following strings can be derived by using the production rules. Using the production rules check that all strings are in the language. (1 Mark)

Ans: with Productions

S -> AB | BC
A -> BA | a
B -> CC | b
C -> AB | a
Strings are: (i) aaaaaa
(Ii) bbababbab

2. Given the production rule of a CFG as
E->T, T->(F) | F , F->a | E ; check that the string (((a))) can be derived from the rules and also give the Parse tree for the given string. (1 Marks)

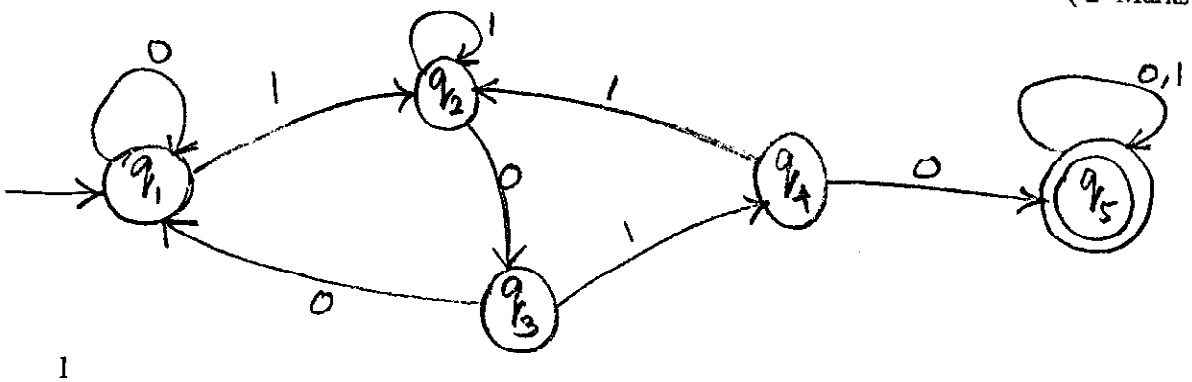
3. Give the transition table for PDA recognizing the language of all odd-length palindrome over {a, b}; if the states of PDA are {q0, q1, q2}, and the final state is {q2} and required string to be checked is **aba** and also give the sequences of moves for the same given input string. (2 + 1 Marks)

BITS, Pilani- Dubai
Dubai International Academic City, Dubai
I Semester 2008-09

Course	:	**CS C351 THEORY OF COMPUTATION**
Year	:	III Year Computer Science
Component	:	Comprehensive Exam
Date	:	06-01-2009
Weightage	:	40 % (40 Marks)
Duration	:	180 mins
No. of Pages	:	2 Pages

Note:-
1. Answer all the Questions and give the proper assumption wherever required.

1. What is the language generated by G = ({a, b, S, T, e}, {a, b}, S, P) if P is altered to:
   $S \rightarrow T$, $S \rightarrow bSb$, $T \rightarrow aT$, $T \rightarrow e$. (1 Mark)
2. Make a grammar generating $\{ a^n b^{2n} \mid n >= 0 \}$ and also give the definition of generated grammar. (2 Marks)
3. For each of the following regular expression give two strings that are members of the language it represents and give two that are not:
   (i) a^*b^*
   (ii) $a(ba)^*a$ (2 Marks)
4. Give a regular expression for decimal digits. (2 Marks)
5. Construct a NFA N1 from the grammar G = ({ a,b,S, T, U}, { a, b}, S, P) where
   $S \rightarrow a \mid b \mid aT \mid aU \mid bT \mid bU$, $T \rightarrow a$, $U \rightarrow b$ (3 Marks)
   Give the proper states equivalent to the grammar given above. (Use only 4 states)
6. Let G = ({ a,b,c, S }, { a, b, c }, S, P), where P consists of
   $S \rightarrow abS \mid bcS \mid bbS \mid a \mid cb$. Construct derivation trees for
   i) bcbba ii) bbbcbba iii) bcabbbbbcb (3 Marks)
7. Give the FA that recognizes the language is the set of all strings $0^*1(00^*1)^*1(0U1)^*$, that contains 11 as a substring. Your FA should have only 3 states. (3 Marks)
8. What the language recognized by the machine given below and also what is the substring does this machine will represent? (2 Marks)



9. Design Turing Machine with tape alphabet 0,1, and Blank that given a string $\{0, 1\}^*$ as input replaces all 0's on the tape with 1's and otherwise leaves the input unchanged, and a TM that decides string containing even number of 1's (your machine should contain 4 states in the state diagram). (4 Marks)

10. Give the state transition diagram for a pushdown automaton that recognizes the language $L=\{ a^i b^j c^k \mid i, j >= 0,\ k=2i-j\}$, example: abc, abb, aabccc L, but aaabc, bcc L. (3 Marks)

11. Prove that the following CFG is Ambiguous: $S \rightarrow aSbT \mid T$,

$T \rightarrow aT \mid bT \mid e$. (2 Marks)

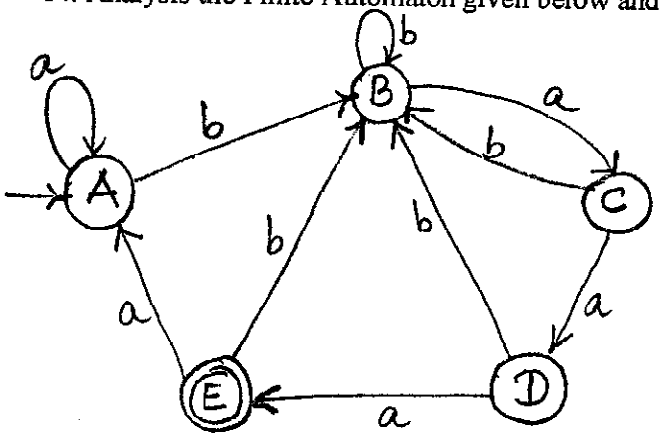
12. Construct and check the bottom-up parser for the language L(G)$, where G is the grammar, and the Production rules are:

$S \rightarrow S+T,\quad S \rightarrow T,\quad T \rightarrow T*a,\quad T \rightarrow a$

The string for the Bottom-up parsing is **a + a * a$.** (3 Marks)

13. Construct a PDA that traces the moves of the machine for three input strings: abcba, ab, and acaa. In this a,b,c are the set of alphabets, q0, q1, and q2 are the states and the stack alphabets are a, b, X_0. Give the transition table and also the transition diagram that helps to check whether the three given input strings are accepted or not. (4 Marks)

14. Analysis the Finite Automaton given below and give what does the machine accepts? (2 Marks)



15. Construct a Turing Machine that performs the *n mod 3* arithmetic operations.(4 Marks) and explain it.