BITS Pilani, Dubai Campus
Dubai International Academic City, Dubai
I Semester 2010-11

Course	:	**CS C351 Theory of Computation**
Component	:	**Comprehensive Examination**
Year	:	**III Year CS**
Date	:	**30-12-2010**
Duration	:	**3 hrs**
Weightage	:	**40% (80 Marks)**
No. of Pages	:	**4 Pages**
No. of Section	:	**A & B**

Note:- Answer the **Section A** answers in **Blue** Answer book and the **Section B** in **Green** Answer Book.

Section A

1. What does the following Turing machine transition function meant for? Justify and prove your answer using a sample input string. (5 Marks)

Current state	Current symbol	Write	Move	New state
START	*	*	Right	GET1
GET1	0	0	None	HALT
GET1	1	x	Right	DROP1
GET1	y	1	Right	CHANGEY
DROP1	0	y	Left	FINDX
DROP1	1	1	Right	DROP1
DROP1	y	y	Right	DROP1
FINDX	1	1	Left	FINDX
FINDX	y	y	Left	FINDX
FINDX	x	x	Right	GET1
CHANGEY	0	0	Left	CHANGEX
CHANGEY	y	1	Right	CHANGEY
CHANGEX	1	1	Left	CHANGEX
CHANGEX	x	1	Left	CHANGEX
CHANGEX	*	*	None	HALT

2. Design a finite automaton for the language given below:

   L = {w | w contains equal number 0's and 1's}.

   Your design should include the state called for **reject state** to terminate the computation process if the input string does not satisfy the above language.

   (7.5 Marks)

3. Convert the regular expression into finite automaton. (7.5Marks)

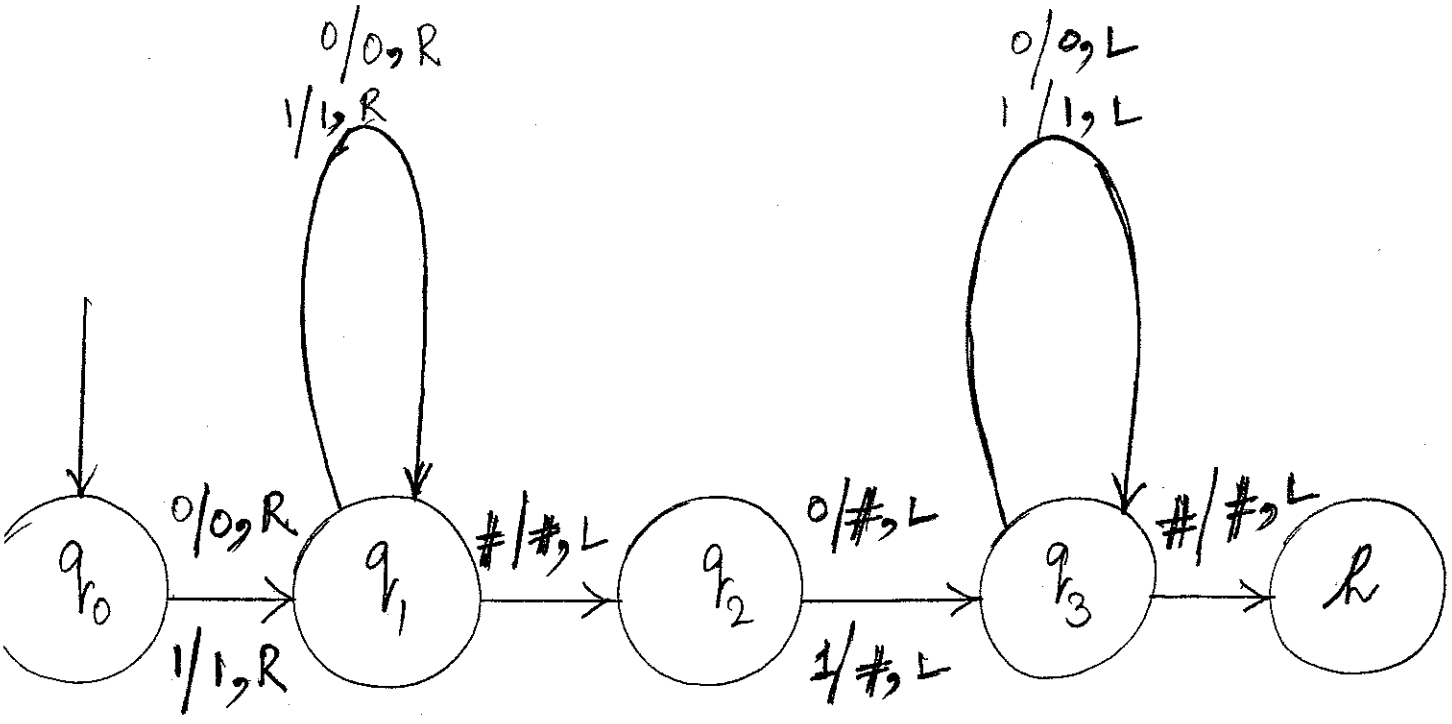
   (0 + 11 + 01)*0*(01)*

4. Design a finite automata and a Turing Machine that reads binary strings and performs the following actions. If the input represents an odd number, subtracts one to the number. If the input represents an even number, add one to the number. For example, for input "101" the output should be "100" and for input "1010" the output should be "1011". (10 Marks)

5. What do you mean by P and NP Completeness? (3 Marks)

6. What does the following transition diagram represent? Justify your answer with proper configuration history. (7 Marks)

   Where P is the halt state.



Section B

1. Convert the following CFG to PDA.

   S -> aAA

   A -> aS | bS | a

   Give the definition and transition functions of PDA. Check with a string. (5 Marks)

2. Let G = (V, ∑, R, Expr) be a CFG with variables

   V = { Expr, Factor, Term}, and terminals.

   ∑ = { CONSTANT, IDENTIFIER, PLUS, TIMES, LPAREN, RPAREN} and rules:

   Expr -> Term | Expr PLUS Term

   Term -> Factor | Term Times Factor

   Factor -> IDENTIFIER | CONSTANT | LPAREN Expr RPAREN

   Here are regular expression for the terminals:

   CONSTANT = (0 U 1 U...U 9) $^{+}$

   IDENTIFIER = (a U b U...U z U A U B U... U Z) *

   PLUS = +

   TIMES = *

   LPAREN = (

   RPAREN =)

   White space between terminals is ignored.

   For each string below, show that it is generated by G by showing a derivation or explain why it is not generated by G. (3*5=15Marks)

   a. 2*a+b

   b. (aardvark+2)*antelope

   c. 2x+3*(y+z)

3. Specify CFG for the language. (10 Marks)

   L = { x ∈ {a,b,c}* : x contains an equal number of two different characters}.

4. Let G = (V, ∑, R, Expr) be the following grammar: (5 Marks)

   STMT → ASSIGN | If Then | If Then Else

   If Then → if condition then STMT

   If Then Else→ if condition then STMT else stmt

ASSIGN → a:= 1

$\sum$ = {if, condition then, else, a:=1}

V = {STMT, If Then, If Then Else, ASSIGN}

Check whether the grammar is ambiguous or not for the sentence "if condition then if condition then a:= 1 else a:=1.

5. PDA P = ({q0,q1,q2,q3,f}, {a,b}, {Z0,A,B}, δ, q0, Z0, {f}) has the following rules defining δ. (5 Marks)

$\delta(q0, a, Z0) = (q1, AAZ0)$

$\delta(q0, b, Z0) = (q2, BZ0)$

$\delta(q0, \in, Z0) = (f, \in)$

$\delta(q1, a, A) = (q1, AAA)$

$\delta(q1, b, A) = (q1, \in)$

$\delta(q1, \in, Z0) = (q0, Z0)$

$\delta(q2, a, B) = (q3, \in)$

$\delta(q2, b, B) = (q2, BB)$

$\delta(q2, \in, Z0) = (q0, Z0)$

$\delta(q3, \in, B) = (q2, \in)$

$\delta(q3, \in, Z0) = (q1, AZ0)$

Give an execution trace (sequence of ID's) showing that string **bab** is in L(P).

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I-SEMESTER 2010-11

Course	:	**CS C351 Theory of Computation**
Component	:	**Test – 2 (Open Book)**
Duration	:	**50 mins**
Date	:	**12-12-2010**
Weightage (%)	:	**20 % (40 Marks)**
Year	:	**III Year Computer Science**
No. of Pages	:	**02 Pages**

Note: Make necessary assumption wherever it is required. Start answering the answers in a fresh page.
Only Text Book, Class notes and Photocopy of the Turing Machine slides are allowed.

1. Construct a PDA for the CFG given below: (10 Marks)

   I → a | b | Ia | Ib | I0 | I1

   E → I | E*E | E+E | (E)

2. For the given CFG grammar trace the Shift-Reduce parsing of the input string:
   x - 2 * y $.
   (10 Marks)

   S = E$

   E = E+T | E-T | T

   T = T* F | T / F | F

   F = num | id

3. Design a Turing Machine to check well balanced structure of Parenthesis, using the set of transition function defined below for the input string **$ ((( )) ( )) $.** Give the Transition diagram and the table. **$** represent the blank space. (10 Marks)

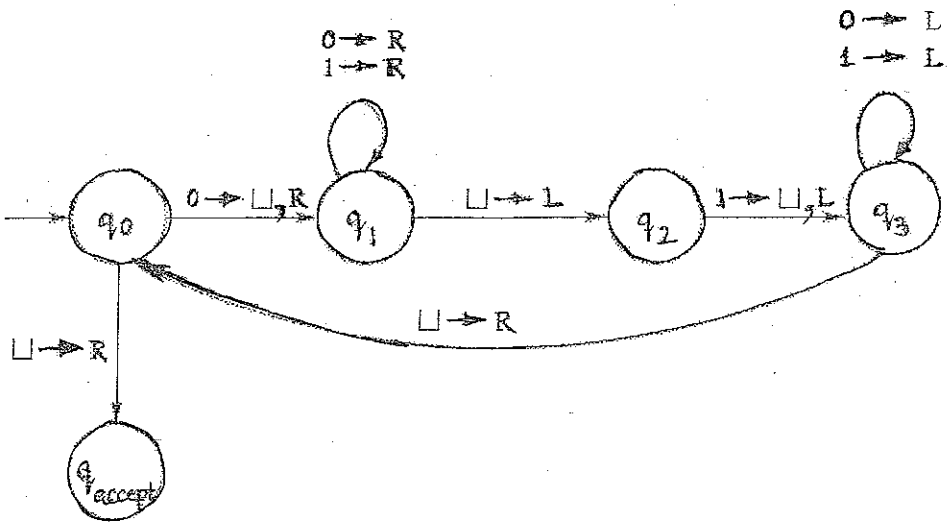
   (J0, **(**) = (J1,X,R); (J0, Y) = (J0, Y, R); (J0, **$**) = (J3, **$** L);

   (J1, **(**) = (J1, **(**, R); (J1, **)**) = (J2, Y, L); (J1, Y) = (J1, Y, R);

   (J2, **(**) = (J2, **(**, L); (J2, X) = (J0, X, R); . (J2, Y) = (J2, Y, L) ;

   (J3, X) = (J3, X, L); (J3, Y) = (J3, Y, L); (J3, **$**) = (Accept)

4. Consider the formal description of a Turing Machine M, where Q = {q_0, q_1, q_2, q_3, q_{accept}, q_{reject}}; Σ = { 0, 1}; Φ = { 0, 1, ⊔}. Assume that any unspecified transition go to qreject. Write out the accepting computation history of M on input ⊔**0**0011 ⊔10011 ⊔ and also describe the behavior represented in this computation history in words. Finally redraw the Turing Machine diagram with the q_{reject} state by placing it in a proper position in the transition diagram. (10 Marks)



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I-Semester 2010-11

Course Number	:	**CS C351**
Course Name	:	**Theory of Computation**
Year	:	**III Year CS**
Component	:	**Test – 1 (Closed Book)**
Weightage / marks	:	**25 % / 50 Marks**
Date	:	**31-10-2010**

Note: answer all the questions.

1. Find a derivation tree of a*b+a*b given that a*b+a*b is in L(G), where G is given by S→S + S | S* S,

   S → a | b. (5 Marks)

2. In both cases below, a transition table is given for a PDA with initial state q0 and accepting state q2. Describe in each case the language that is accepted. (15 Marks)

Move Number	State	Input	Stack Symbol	Move(s)
1	q0	a	Z0	(q1, aZ0)
2	q0	b	Z0	(q1, bZ0)
3	q1	a	a	(q1, a), (q2,a)
4	q1	b	a	(q1,a)
5	q1	a	b	(q1,b)
6	q1	b	b	(q1,b), (q2,b)

Move Number	State	Input	Stack Symbol	Move(s)
1	q0	a	Z0	(q0, XZ0)
2	q0	b	Z0	(q0, XZ0)
3	q0	a	X	(q0, XX)
4	q0	b	X	(q0, XX)
5	q0	c	X	(q1, X)
6	q0	c	Z0	(q1, Z0)
7	q1	a	X	(q1, null)
8	q1	b	X	(q1, null)
9	q1	null	Z0	(q2, Z0)

3. Check whether the given Context-Free Grammar is ambiguous or not for the input string $a^2b^2a^2$. (5 Marks)

   Production rules are: S → aAS | a ,

   A → SbA | SS |ba.

4. Write a deterministic finite automaton to recognize each of the following languages.

   a. L1 = {w∈{a,b} * | each *a* in w is immediately preceded and immediately followed by a *b*}

   (Use 5 states)

   b. L2 = { w∈{a,b} * | w has both *ab* and *ba* as substrings}.(Use 6 states)

   (2 * 5 = 10 marks)

5. Design a nondeterministic finite automaton for the following language. (5 marks)

   L = { x ∈ {0,1} * | x has 101 as a substring.(Use 4 states)

6. Write a Context Free Grammar for the following languages. (2 * 5 = 10 marks)

   a. L accepts strings on the alphabet {a, b, c}, where number of c's equals the sum of the number of 'a's and 'b's.

   b. L = { a^nb^m | 2n <=m<=3n}

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BITS, Pilani – Dubai
Dubai International Academic City, Dubai
I – Semester 2010-11
Quiz – II

Course: Theory of computation Year: III year CS

Id. No: _____ Name: _____

Section: _____ Duration: 20 mins

Date: 22-11-2010 Weightage: 7 % (Marks: 14 Marks)

1. Construct a CFG grammar accepting $\{a^n b^m a^n \mid m, n >= 1\}$ by null store. The transition functions are $\delta(q_0, a, z_0) = \{ (q_0, aZ_0)\}$
   $\delta (q_0, a, a) = \{(q0, aa)\}$
   $\delta (q_0, b, a) = \{(q1, a)\}$
   $\delta (q_1, b, a) = \{(q1, a)\}$
   $\delta (q_1, a, a) = \{(q1, null)\}$
   $\delta (q_1, null, Z_0) = \{(q1, null)\}$

2. Construct a PDA for the CFG given below for the language L of all balanced strings involving two types of brackets, "{ }" and "[ ]". The language L is generated by the CFG with production:
   S → SS | [S] | {S} | null

Answers:

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I- SEMESTER 2010-11

A

Name: _____ Date: 06 Sept 2010

Id. No.: _____ **Section:** I / II

Course: **CS C351 Theory of Computation** **III Year CS** QUIZ - I

Marks: 16 Marks (8 %)

1. Draw Deterministic Finite Automata to accept the following sets of strings over the alphabet {0,1}: 4 Marks

   (i) All strings ending in "1101" using 5 states.

   (ii) All strings that start with 0 and has odd length or start with 1 and has even length, using 3 states. 4 Marks

2. All strings that contains an even number of 0s or exactly two 1s. (6 states)

4 Marks

3. Generate the given (a1*b2+a1)*(a1+b2) using the CFG Grammar production rules, and also give the CFG definition for this problem. 4 Marks

Production rules are:

E → E+T..... Rule 1

E → T .....Rule 2

T → T * F ..... Rule 3

T → F ..... Rule 4

F → (E) ..... Rule 5

F → a1 ..... Rule 6

F → b2 ..... Rule 7