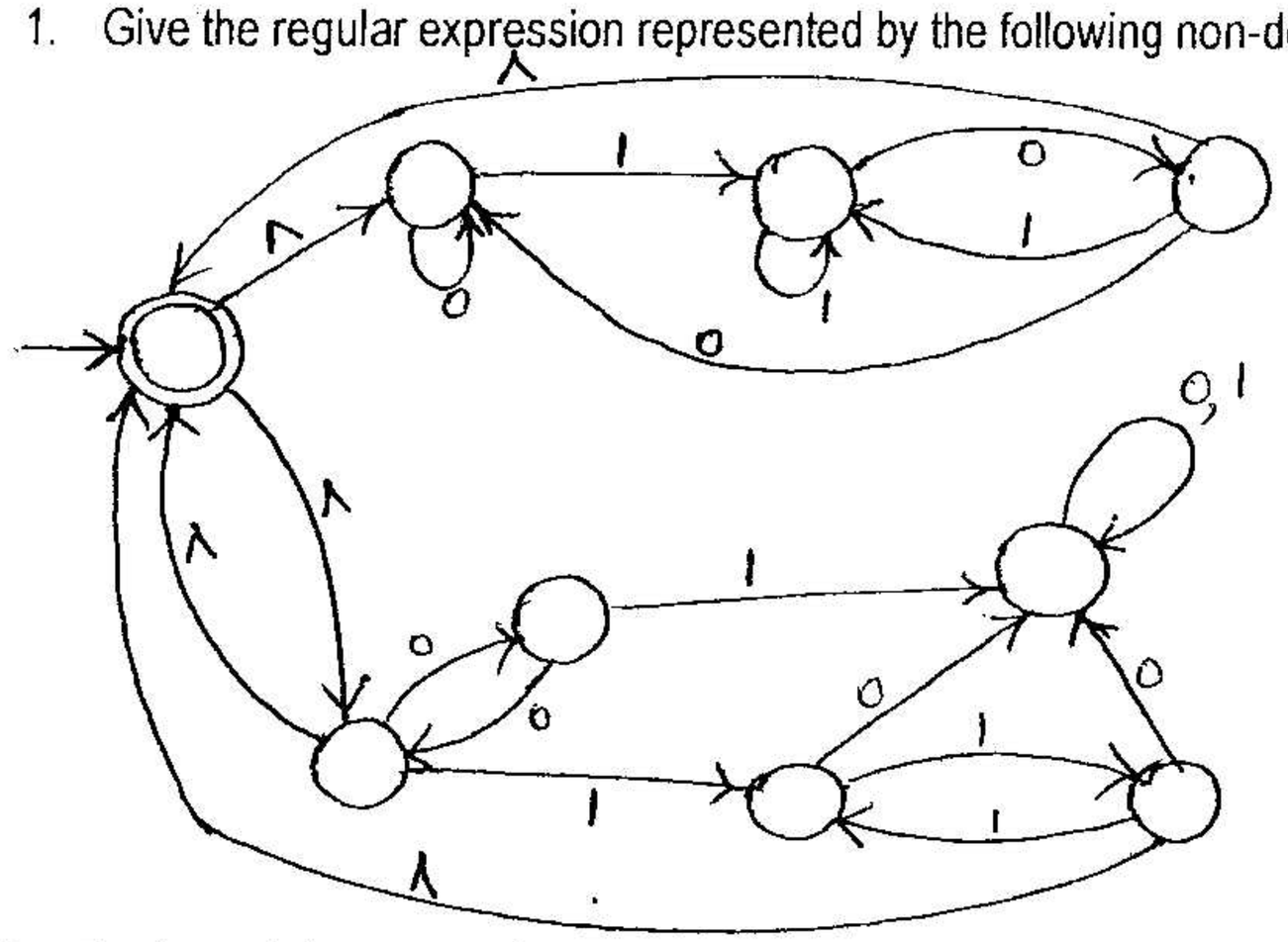
BITS, PILANI-DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
I – SEMESTER 2009-2010

COURSE NO. & NAME	:	**CS C351 THEORY OF COMPUTATION**
YEAR	:	**III YEAR COMPUTER SCIENCE**
COMPONENT	:	COMPREHENSIVE EXMANITAION **(CLOSED BOOK)**
DATE	:	**27-12-2009, SUNDAY**
DURATION	:	3 HRS.
WEIGHTAGE	:	40 % (80 MARKS)
Pages	:	**2 pages**

Note: Answer the questions sequentially. Start answering all the questions in a fresh page.
The number pages: **2 Pages.**

1. Give the regular expression represented by the following non-deterministic finite state automaton. (5 Marks)



2. Design a finite automaton that will control an elevator that serves three floors in a residential building. Your design must describe the states of the machine, intuitively present its operating strategy. (5 Marks)

3. Design finite automata that will accept the sets represented by the following regular expressions:
   (i) $[0\text{-}9]^+ \backslash . [0\text{-}9]^+$
   (ii) $[a\text{-}z]^+ \backslash ([0\text{-}9]^+ \backslash)$ { hint: to simplify the regular expression, [0-9] := [0,1,2,3,4,….,9]
   [a-z] := [a,b,c,d,….,z]
   . matches any symbol and $\backslash \alpha$ matches α
   $a^+ := aa^*$ and $a? := (a \mid \varepsilon)$

(5 + 5 Marks)

4. Consider a language, $L \subseteq \{ 0,1\}^*$ of all strings w containing an even number of 0's where |w| is a multiples of 3. (eg. 011101 $\in$ L, but 1001 $\notin$ L). Draw the state diagram of a DFA that accepts L. (5 Marks)

5. Give a context-free grammar for the language $L= \{ a^n b^m : n \neq 2m\}$. Is your grammar ambiguous? (5 Marks)

6. Convert [00 + 11 + (01 + 10) (00 + 11)*(01 + 10)]* to a Finite Automaton. (5 Marks)

7. Construct non-deterministic pushdown automata to accept the following languages:

   (i) $\{10^n1^n \mid n>0\} \cup \{110^n1^{2n} \mid n>0\}$

   (ii) $\{1^n0^n \mid n>0\}$ (10 + 5 Marks)

8. Give both a context-free grammar and a pushdown automaton for the following language, $L_2 = \{a^{2i}b^{3i} : i > 0\}$ $\Sigma = \{a; b\}$. Provide a short description of what the variables and rules in your CFG represent, and a short and clear description of how the PDA works with the sample input string. (10 Marks)

9. Consider a TM, M= (K, Σ,δ, s, H), where K=(s,y,n), Σ={a,b,␣}, H={y,n} and δ is defined as follows:

q	σ	$\delta(q,\sigma)$
s	a	(s, a)
s	␣	$(s, ␣)$
s	▷	$(s, \rightarrow)$

   Explain what the TM will do as per the transition function. (4 Marks)

10. If the CGF grammar production rules are as follows:

    (i) $M \rightarrow M + T$

    (ii) $M \rightarrow T$

    (iii) $T \rightarrow T * a$

    (iv) $T \rightarrow a$

    Give its rightmost derivation and the bottom-up parse for the string **a + a * a $**. (6 Marks)

11. Design a Turing Machine to perform the concatenating the two strings; for example, if **#BITS#** and **#Pilani#** are the two strings, the TM performs the combination of these two strings together and after concatenation the output generated from the TM will be **#BitsPilani#**. (5 Marks)

12. Explain the Hard problems (NP-Complete) and Easy problem (in P)? (5 Marks)

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I-SEMESTER 2009-2010

COURSE	:	**CS C351 THEORY OF COMPUTATION**
COMPONENT	:	**TEST -2 (OPEN BOOK)**
DATE	:	**10-12-2009, Thursday**
DURATION	:	**50 MINS.**
MAX. MARKS	:	**40 MARKS**
NO. OF PAGES	:	**2 PAGES**

Note: 1. Answer all the questions.
2. Only hand written class notes and text book are allowed.

1. Let M = (K, Σ, T, Δ, s, F), where K={s,q,f}, Σ={a,b}, Γ = {a,b,c}, F={f} and Δ is listed below:
   i. ((s,e,e),(q,c))
   ii. ((q,a,c), (q,ac))
   iii. ((q,a,a), (q,aa))
   iv. ((q,a,b), (q,e))
   v. ((q,b,c), (q,bc))
   vi. ((q,b,b), (q,bb))
   vii. ((q,b,a), (q,e))
   viii. ((q,e,c), (f,e))

   Give the table that shows the operations of the machine for the input string abbbabaa. The table must have the following: stack content, state, unread input status, and the transition used at each operation. (4 Marks)

2. Consider the grammar, G = (V, S, R, S) with V={X, m,n,p}, Σ={m,n,p}, R={ X→mXm, X → nXn, X → p} which helps us to generate the language $\{sps^R: s \in \{m,n\}^*\}$.
   Give the detailed definition of the push down automaton for the above mentioned grammar, which uses two states {s1, s2} to accept the language mentioned above. And, also check whether the input string mnnnpnnnm is accepted by the PDA or not? (4 + 4 Marks)

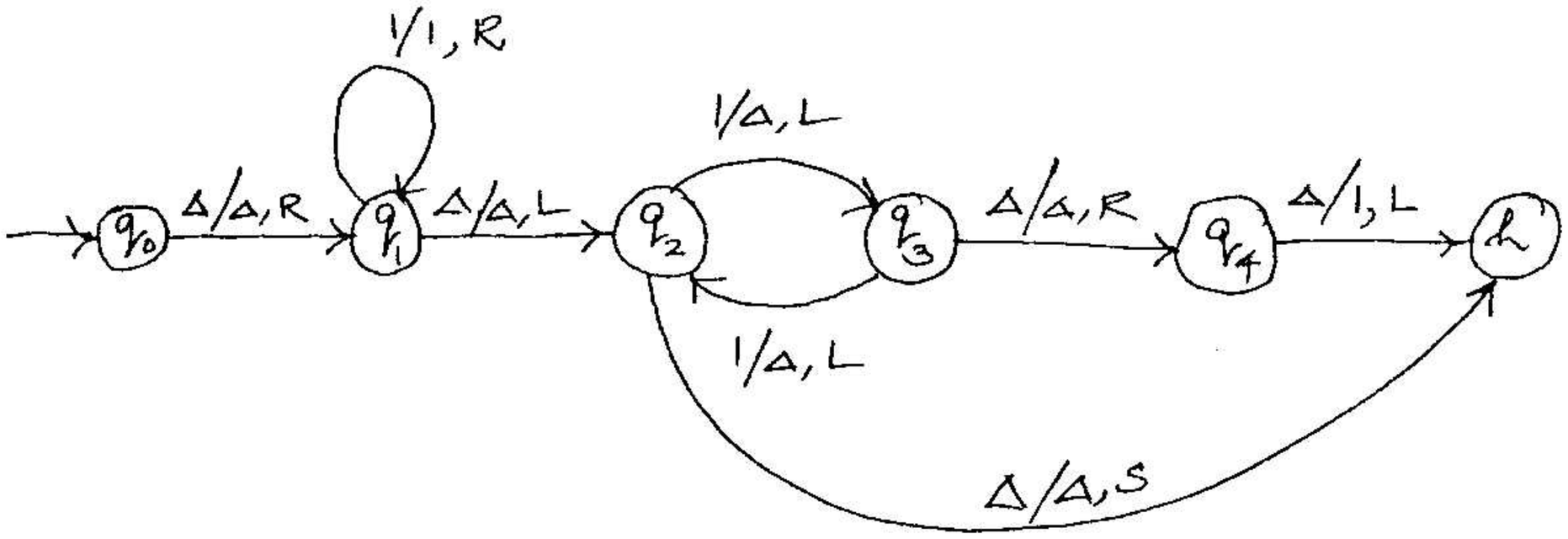
3. Consider a Turing Machine which has states q0, q1, q2,….,q6 and the alphabet Σ={y, T, F, #}, where T is represent even parity, and F represent odd parity; s=q0, and δ is given below: (4 + 2 + 2 Marks)

q	σ	δ(q, σ)
q0	#	(q1, L)
q1	y	(q2, #)
q1	#	(q4, R)
q2	#	(q3, L)
q3	y	(q0, #)
q3	#	(q6, R)
q4	#	(q5, T)
q5	T	(h, R)
q5	F	(h, R)
q6	#	(q5, F)

Check whether following stings are accepted by the TM or not?
(i) #yyyyy# (ii) #yy#
And Draw the transition diagram for the TM.

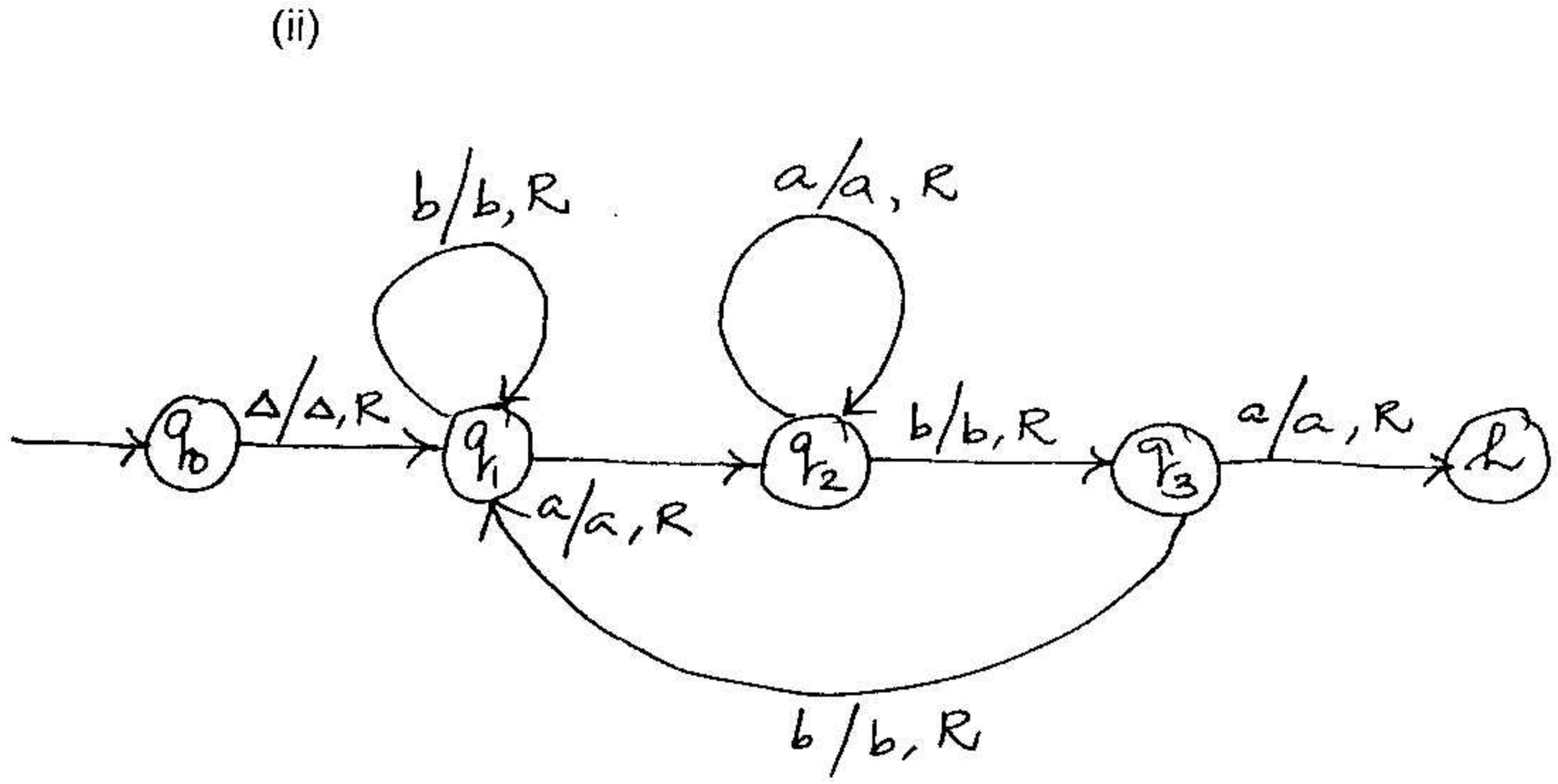
4. Let the CFG production rules are: $E \rightarrow TE'$ $E' \rightarrow +TE'$ $E' \rightarrow e$
   $T \rightarrow FT'$ $T' \rightarrow *FT'$ $T \rightarrow e$ $F \rightarrow (E)$ $F \rightarrow Xn$
   $N \rightarrow 1$ $N \rightarrow 2$
   Give the PDA transition functions using the CGF grammar production rules. Also perform top-down parsing for the input string **x1 * (x2) $,** if the states of the PDA are K = { p, q, q_x, q_1, q_2, q_+, q_*, $q_)$, $q_($, $q_\$$}. (5 + 5 Marks)

5. What does the following TMs designs represents and explain.
   (i)



Where S represents Stop and Δ is the blank symbol. (3 Marks)

(ii)



where Δ is the blank symbol.

(a) Give the definition of the above shown TM. (1 Mark)
(b) What is the language accepted by the TM. (3 Marks)
(c) Give the equivalent FA. (3 Marks)

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BITS, PILANI – DUBAI
Dubai International Academic City, Dubai
I – SEMESTER 2009-10

Course	:	**CS C351 THEORY OF COMPUTATION**
Component	:	**Test – I**
Nature of the component	:	**Closed Book**
Date and day	:	**18-10-2009, Sunday**
Duration	:	**50 mins.**
No. of Pages	:	**2 pages**
Max. Marks	:	**50 Marks**

Note: 1. Answer all the questions. 2. Draw the diagram neatly.

1. Construct a Finite State machine for the language {c*b{a| b| c}*| e} using 3 states and also give the definition of the machine(where e is **null**). (5 Marks)
2. Construct a FSM for **robot** application and using the the events (inputs) and their states are given below: (5 Marks)

Event	State
turnOn	Activated * ←
turnOff	Deactivated (Idle)
stop	Stopped
walk	Walking
run	Running
raiseLeftArm	LeftArmRaised
lowerLeftArm	LeftArmLowered
lowerLeftArm	LeftArmLowered
raiseRightArm	RightArmRaised
lowerRightArm	RightArmLowered
turnHead	HeadTurned(direction)
speak	Talking(text)

3. Give the Transition diagram for mod-4 counter. It is defined that the state transition takes place only if the input is 1. Give the finite state machine definition. (5 Marks)

4. Give the Finite Automaton for the regular expression

$$(((0 * 1)+ \bullet (0 * 1)^* * (0 * 1)^* \bullet (0 * 1)+) \#)^*,$$

where {0, 1, •, #} are alphabets. (10 Marks)

5. Let G = (V, S, R, Expr) be the CFG with

V={ Expr, Variable, Constant, Letter, Digit} (5 +5 Marks)

S ={ 0,1,…., 9, a, b, …., z, +, * }

And rules are

Expr → Variable | Constant | Expr + Expr | Expr * Expr

Variable → Letter | Variable Letter | Variable Digit

Constant → Digit | Constant Digit

Letter → a | b | . . . | z

Digit → 0 | 1 | . . . | 9

(a) Is this grammar is Ambiguous, if so, demonstrate it by drawing two different parse tress that generate the string **x + 12 * y**.

(b) Write an unambiguous grammar that generates the same language as G. You can just write the rules. If a variable in your grammar has the same rules as a variable in the grammar above, you can write V → same as G.

6. Draw the Transition diagram for the regular expression (ab)*(aba)*, represent the transition diagram using 3 states. (5 Marks)

7. Give the finite automata for the following: (4 + 3 + 3 Marks)
   (a) Accepts strings which are any of ART or ARTS or ARTIST or ABLE.
   (b) Accepts CAT or DOG alone.
   (c) Accepts strings consisting of only 0 or more repetitions of 15211.

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A

I SEMESTER 2009-10
COURSE: CS C351 -THEORY OF COMPUTATION
QUIZ – 2

DATE: ----------
MAX. MARKS: 16

MARKS

NAME:_____ **IDNO.:** _____

1. Construct a PDA accepting $\{w^n v^m w^n \mid N(n), N(m) >= 1\}$ by a null store, using two states. Check whether the transition function generated accepts the input string **wvvwvwwwvv** (7 marks)

2. If A = ({q0, q1, q2}, {l,m,n}, {l,m, Z0}, δ, q0, z0, {q2}) is a PDA, where delta is defined as (3 Marks)

d(q0,l,z0) = {(q0, lz0)}, d(q0,m.z0)={(q0,mz0)}
d(q0,l,l) = {(q0, ll)}, d(q0, m,l) = {(q0, ml)}
d(q0, l,m) = {(q0, lm)}, d(q0,m,m) = {(q0,mm)}
d(q0,z,a) = {(q1, l)}, d(q0,z,m)= {(q1,m)}
d(q0, z, z0)= {(q1, z0} d(q1,l,l) = d(q1,m,m)= {(q1, null)}
d(q1, null, z0) = {(q2, z0)}
Check whether the input string **llmmlmlm** is accepted by the PDA or not.

3. Construct a PDA equivalent to the following CFG (4 Marks)
X→ 1AA, A→ 1X | 0X | 1 | 0. Test whether 101^5 is in N(A)

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A

I SEMESTER 2009-10
COURSE: CS C351 -THEORY OF COMPUTATION
QUIZ – 1

DATE: ----------
MAX. MARKS: 16 MARKS

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

1. Construct a Finite Automaton for the transition function given below. And also give its definition

DFA transition function:

δ	∅	→A	B	C	D	BC	AC	*BCD
0	∅	BC	BC	D	∅	BCD	BCD	BC
1	∅	AC	∅	∅	BC	∅	AC	BC

2. Draw the Finite Automata to accept the following sets of strings over the alphabet{0,1}:
   a) All strings that contain the substring 0101

   b) All strings that don't contain the substring 110

3. What does the given transition diagram represent?