BITS, PILANI-DUBAI CAMPUS,
KNOWLEDGE VILLAGE, DUBAI.

COURSE: CS UC 351
COURSE TITLE: THEORY OF COMPUTATION **DATE: 15.1.2004**
DURATION: 3 HOURS **MAX. MARKS: 100**
WEIGHTAGE: 40 MARKS.

COMPREHENSIVE EXAMINATION

PART – A (10 * 2.5 = 25)

1. Assume that R = { (a,b), (b,c), (c,a) }be a relation of {a,b,c,}. Find R^4 ?
2. Show that for any n 0, 1+2+…+n = $(n^2 + n) / 2$.
3. What is L (((aUb)*a))?
4. What is the reflexive, transitive closure R* of R = {(a,b), (a,c), (a,d), (d,c),(d,e)}? Draw a directed graph representing R^*
5. Draw Deterministic Finite Automata to accept the following set of string over the alphabet {0,1 for all strings of length at most 5.
6. Explain why every NFA can be converted to an equivalent one that has a single final state.
7. Generate a meaningful language using the given G=(W, SIGMA, R, S), where

   W={S, A, N, V, P}$\cup$ SIGMA,

   SIGMA= {Jim, big, green, cheese, ate}

   R = {P→N, P→AP, S→PVP, A→big, A→green, N→cheese, N→Jim, V→ate}.
8. Give the exact definition for Push-Down Automata, Turing machine.
9. Show that S =>aabbaa, considering G whose production are S→aAS | a, A→SbA | SS | ba. And construct a derivation tree whose yield is aabbaa.
10. Give the definition for Class **P,** Class **NP** computability.

PART – B (5 * 15 = 75)

1. a) Assume that Language L ={0,1}*{10} of all strings of 0's and 1's that end in 10. The transition table of the above language is: (8+7)

state / input

	0	1
^	0	1
0	00	01
1	10	11
00	00	01
01	10	11
10	00	01
11	10	11

Draw the Transition Diagram and give the Transition equation delta =? , for the above

b) Design the transition table and transition diagram for the deterministic finite automaton M that accepts the language L(M)={w: w{a, b}* and w does not contain three consecutive b's} and is given by the

delta={(q_0,a, q_0),(q_0,b, q_0),(q_0,a, q_1),(q_1,b, q_0),(q_1,b, q_2),(q_2,a, q_2),(q_2,b,q0),(q_2,a, q_3), (q_3,a, q_3),(q_3,b, q_3),(q_3,b, q_0)} where K={q0,q1,q2,q3}, SIGMA={A,B}, s = q_0, F={ q_0, q_1, q_2, q_3}.

2. Construct a Non-deterministic finite automata and the Transition table from the transition equation given below: (10+5)

delta={(q_0,0,q_1),(q_0,1, q_5),(q_1,0, q_6),(q_1,1,q_2),(q_2,0, q_0),(q_2,1, q_2),(q_3,0, q_2),(q_3,1, q_6), (q_4,0, q_7),(q_4,1, q_5),(q_5,0, q_2),(q_5,1,q_6),(q_6,0, q_6),(q_6,1, q_4),(q_7,0, q_6),(q_7,1, q_2)},

where q_0 is the initial state and q_2 is the final state, and SIGMA={0,1}.

3. a) Consider the following productions:

   S→aB | bA (4+4+4+3)

   A→aS | bAA | a

   B→bS | aBB | b

   For the string ***aaabbabbba,*** find

   i) The leftmost derivation,

   ii) The rightmost derivation,

   iii) Parse tree.

   b) Show that the grammar S→a | abSb | aAb, A→bS | aAAb is Ambiguous.

4. a) Construct a Turing machine that perform the **copying** operation of the given string and so the Turing Machine is called as Copying Machine. Thus the given string is #abc# .

   b) What is meant by Extension of the Turing Machine? (10 + 5)

5. a) What is called as Halting problem of Turing Machines? (8+7)

   b) Give the four properties, that explain a L be an NP-complete Language.

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TEST – I (CLOSED BOOK)

MAXIMUM MARKS: 20 **DATE: 02.11.2003**
Time: 50 MINUTES **SUNDAY**

ANSWER ALL QUESTIONS:

1. Give the proof for the statement P(n) is $1+2+3+\ldots+n = n(n+1)/2$ by induction . (2)

2. Language L = {0,1}*{10}of all strings of 0's and 1's that end in 10. The Finite Automaton recognized Transition table for the above language : (2)

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 Language.

3. Design the deterministic finite automaton M that accepts the language (4)
L(M)={w:w∈{a,b}* and w does not contain three consecutive b's} and is given by the

δ={(q0,a,q0),(q0,b,q0),(q0,a,q1),(q1,b,q0),(q1,b,q2),(q2,a,q2),(q2,b,q0),(q2,a,q3), (q3,a,q3) ,(q3,b,q3),(q3,b,q0)}
where K={q0,q1,q2,q3}, Σ = {a,b}, s = q0, F = { q0,q1,q2,q3 }

4. Give the Proof for the Closure Properties of Context-Free Language. (4)

5. Give the derivation of the string (x1*x2+x1)*(x1+x2) in G, Considering the grammar G=(V, Σ, R,E) where V, Σ, and R are as follow: (4)
V={x1, x2, + , * , (,), T, F, E}
Σ = {x1, x2, +, *, (,) }
R = { E →E + T, E → T, T→ T*F, T→ F, F → (E), F→ X1, F→ X2 }
The symbols E,T, and F are abbreviation for expression, Terms, and factor respectively.

6. Construct a Parse Tree for (-- ((4x2 – y2) + 8xy)), for the grammar G=(V, Σ , R,S), where V={ S, (,), 4, 8, +, -, x, y}, and Σ ={ 4,8,x,y, (,) } and
R={S→ -S, S → ((S)), S→ (S), S→ 4S, S→ x S, S→ y S, S→ x, S→ y, S→ S-S, S→ 8S, S→ S+S}
(4)

9. Let L1 and L2 be two DCFL's. Then L1 UNION L2 is guaranteed to be:

i) Empty ii) Regular iii)Deterministic Context_Free iv)context-free

v)none of the above.

10. M1 is a DFA such that L(M1) = {w: w {a,b}* and w contains an even number of a's and an even number of b's}.

ADFA = {<M,w>:m is a DFA, w {a,b}*, and M accepts w}
A DFA = {<M>:M is a DFA and M accepts a}
EDFA = {<M>:M is a DFA and L(M) = SII}
ALLDFA = {<M>:M is a DFA and L(M) = {a,b}*}
EQDFA = {<M1,M2>: M1,M2 are DFAs AND l(M1) = L(M2)}
Is <M1> ALLDFA?

i) Yes ii) No

11. Assuming the constraint of the above problem, is <M1,M1>$\in$ EQDFA?

i) Yes ii) No

12. Consider the Language FINITE DFA = {<M>:M is a DFA and L(M)is finite}. FINITE DFA is:

i) not co-recursively enumerable ii) recursively enumerable

iii) co-recursively enumerable iv) recursive v) none of the above.

13. A deterministic finite automaton is a simple Language Recognition Device

i) Yes ii) No

14. A context free grammar G is a quadruple (V,SIGMA,R,S) where V is an alphabet SIGMA is a subset of V, R is a finite subset of (V-SIGMA)*v*, S is an element of V-SIGMA.

i) Yes ii) No

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QUIZ (CLOSED BOOK)

MAXIMUM MARKS: 10 **DATE: 22.12.2003**
Time: 30 MINUTES

ANSWER ALL QUESTIONS:

1. Let L1 = {e,a} and L2 = {a,b}. M = (L2*)(L1). M is :

   i) {e,a} ii) {a,b} iii) {e,b} iv) {a,b}* v)None of the above

2. The String ***abbab*** is a member of the Language represented by which of the following regular expressions? (sigma = {a,b})

   i) (a∪b) ii) b(a∪b)* iii) abbab iv) ϕ v) (ab)+(bb)+(ba)+b

3. Let A= {a,b,c,d,e}. How many elements are there in A x A.

   i) 1 ii) 25 iii) 5 iv) 32

4. Let M = (K,SIGMA,DELTA,s, F) be an NFA , where
   K = {q0,q1,q2}, SIGMA = {a,b,c,d},
   DELTA={(q0,a,q0),(q0,e,q1),(q1,b,q1), (q1,c,q1),(q1,e,q2),(q2,d,q2)}
   S = q0, F = {q0,q1,q2}.
   The regular language corresponds to the language accepted by M is :

   i) (abcd)* ii)a*b*c*d* iii)(a∪b ∪ c d)* iv) a*(b∪c)*d* v) none of above

5. Assume that symbols in upper case (S,A,B etc.) are non-terminals, and that symbols in lower case (a,b,c, etc.) are terminals. Which of the following is a context-free rule?

   i) SA→B ii) SA→S iii) b→SA iv) S→aS

6. Assume that symbols in upper case (S,A,B etc.) are non-terminals, and that symbols in lower case (a,b,c, etc.) are terminals. Which of the following is a NOT context-free rule?
   i) S→B ii) S→S iii) b→SA iv) S→aS

7. How many derivations does the string ***ab*** have in G

   i) 0 ii) 2 iii) 1 iv) 3

8. Let L1 and L2 be two DCFL's. Then L1L2 is guaranteed to be:

   i) Empty ii) Regular iii)Deterministic Context_Free iv)context-free

   v)none of the above.

15. The tabular representation of the transition function can be represented in a graphical model or diagram, called as :

i) Device Diagram ii) Machine Diagram iii)State Diagram iv) Standard diagram .

16. A Non-Deterministic Finite automaton can be much more convenient device to design than a deterministic finite automata.

i) Yes ii) No

17. In a non-deterministic finite automaton, Δ is :

i) Deterministic state ii) Transition relation iii) Transfer function

18. For each Non-deterministic finite automata there is an equivalent deterministic finite automaton.

i) Yes ii) No

19. The Class of language accepted by finite automata is closed under a)Union, b)concatenation, c)Kleene star, d)complementation, e)intersection.

i) a, c, d, e ii) b, d, e iii) a, b, d, e iv) a, b, c, d, e

20. The Context free languages are closed under union, concatenation, Kleene star, Intersection.

i) Yes ii) No

CM.MADHAJAGAM