Register Number: …………………….

B.E. DEGREE EXAMINATIONS: NOV/DEC 2010

Fifth Semester

COMPUTER SCIENCE AND ENGINEERING

U07CS503: Theory of Computation

Time: Three Hours   **Maximum Marks: 100**

Answer All the Questions:-

PART A (10 x 1 = 10 Marks)

1. Given an arbitrary NFA with N states, the maximum number of states in an equivalent minimized DFA is at least

   a) N^2 b) 2N   c) 2^N d) N!

2. Which of the following regular expression identities are true?

   a) (r*)* = r*   b) (r*s*)* = (r*+s*)*   c) (r+s)* = r* + s*   d) r* + s* = r*s*

3. _____ can reach two different states from a given state with the state input.

   a) DFA   b) NFA   c) PDA   d) TM

4. If L0 is a CFL and L1 is a Regular language, then

   a) L0 – L1 is not CFL   b) L0 Λ L1 is CFL   c) ~ L1 Λ ~ L1 is CFL   d) ~ L1 is regular

5. Which of the following languages over {a,b,c} is accepted by DPDA?

   a) {wcw^R | w ε {a,b}*}   b) {ww^R | w ε {a,b,c}*}

   c) {a^{n}b^{n}c^n | n ≥ 0}   d) {w | w is a palindrome over {a,b,c}}

6. A CFG is accepted by _____

   a) NFA   b) DFA   c) PDA   d) TM

7. A FSM can be considered to be a _____ of finite tape length without rewinding capability and unidirectional tape movement

   a) Turing machine   b) PDA   c) NDPDA   d) both a & b

8. Instantaneous description of _____ contains current state of the automaton, unread part of input, stack contents

   a) LBA   b) DFA   c) PDA   d) TM

9. A/An _____ is a turing machine that can simulate an arbitrary Turing machine on arbitrary input

   a) LBA   b) one tape TM   c) universal TM   d) both a & c

10. It is undecidable when _____

   a) an arbitrary Turing Machine halts on all inputs

   b) a Turing Machine prints a specific letter

   c) an arbitrary Turing Machine halts after 10 steps

   d) a Turing Machine computes product of 2 numbers

PART B (10 x 2 = 20 Marks)

11. Define proof by contradiction.

12. Define DFA formally.

13. Write regular expression for all strings of even length over the alphabet set (0,1)*.

14. Define homomorphism. Are regular languages closed under homomorphism?

15. Write CFG for defining palindrome over $\Sigma = \{a,b\}$.

16. Define an ambiguous grammar. Give an example.

17. "Intersection of a CFL and a *Regular* language is a --------". Give your answer and justify.

18. Show that $L = \{a^n b^n c^n / n \geq 0\}$ is not context-free using pumping lemma.

19. Define recursively enumerable language.

20. Does the following instance of PCP have a solution?

Index	w_i	x_i
1	1	11
2	11	10
3	011	1

PART C (5 x 14 = 70 Marks)

21. a) (i) Prove that "If x is the sum of the squares of four positive integers, then $2^x \geq x^2$".   (7)

   (ii) For all $n \geq 0$, Prove $\sum_{i=1}^{n} i^2 = \dfrac{n(n+1)(2n+1)}{6}$ by induction.   (7)

(OR)

   b) Convert to a DFA the following NFA. (*p* is the start state and *s* is the end state)

	0	1
p	{p,q}	{p}
q	{r}	{r}
r	{s}	Φ
s	{s}	{s}

22. a) (i) Prove that "Regular languages are closed under Intersection". (4)

(ii) Construct a DFA to recognize odd number of 1's in an alphabet set {0, 1}. Derive the regular expression for the same. (10)

(OR)

b) (i) Minimize the following DFA (10)

	0	1
A	B	F
B	G	C
C	A	C
D	C	G
E	H	F
F	C	G
G	G	E
H	G	C

(ii) Prove that the following language is not regular using pumping lemma

$L = \{a^n b^k: n > k \text{ and } n \neq 0\}$ (4)

23. a) (i) Prove the following theorem:

If $L = N(P_N)$ for some PDA $P_N = (Q, \Sigma, \Gamma, \delta_N, q_0, Z_0)$, then there is a PDA P_F such that $L = L(P_F)$. (7)

(ii) Construct PDA for the following CFG. Check for a string of acceptance (7)

$S \rightarrow a \mid aS \mid bSS \mid SSb \mid SbS$

(OR)

b) (i) Design a PDA by empty stack to accept the language $\{0^n 1^n \mid n \geq 1\}$. Construct an equivalent PDA to accept by final state. (8)

(ii) Consider the grammar

$S \rightarrow AB / C$ $A \rightarrow aAb / ab$ $B \rightarrow cBd / cd$

$C \rightarrow aCd / aDd$ $D \rightarrow bDc / bc$

Draw the parse tree for the string "*aabbccdd*" and also give the left most and right most derivation. (6)

24. a) Define CNF and GNF. Construct the CNF & GNF for the following grammar and explain the steps

$$S \rightarrow aAa \mid bBb \mid \varepsilon$$
$$A \rightarrow C \mid a$$
$$B \rightarrow C \mid b$$
$$C \rightarrow CDE \mid \varepsilon$$
$$D \rightarrow A \mid B \mid ab$$

(OR)

b) Design a Turing Machine for computing $f(m,n) = m - n$ (Proper subtraction) and check with an example.

25. a) (i) Show that the language L_d is neither recursive nor recursively enumerable. (7)

(ii) Describe how a Turing Machine can be encoded with 0 and 1 and give an example.

(7)

(OR)

b) Prove the following

(i) "If L1 and L2 are recursive languages, then L1 U L2 is recursive language". (7)

(ii) "If both a language L and its complement are recursively enumerable, then L is recursive". (7)

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