Register Number:……..

KUMARAGURU
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B.E. DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Fourth Semester

COMPUTER SCIENCE AND ENGINEERING

U18CST4003: Theory of Computation

COURSE OUTCOMES

CO1: Design or convert an automaton for any given problem and experiment and document using JFLAP tool.
CO2: List the various closure properties of languages in Chomsky hierarchy.
CO3: Construct Context Free Grammars to generate strings from a context free language and convert them into normal forms.
CO4: Identify the hierarchy of formal languages, grammars and machines.
CO5: Distinguish between computability and non-computability; decidability and undecidability.

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Match List I (Regular expression) with List II (sample string) CO3 [K_2]

List I	List II
A. S→aSbb | bSaa | ab	i. abbaba
B. S→aaa | bbb | Sa | Sb	ii. aabbaaaa
C. S→ SS | aa | bb	iii. ababaabb
D. S→ ab | ba | aSa | bSb	iv. bbbaa

	A	B	C	D
a)	ii	i	iii	iv
b)	iii	iv	ii	i
c)	ii	iv	iii	i
d)	iii	i	ii	iv

2. Sequence the order in which minimization of DFA takes place. CO1 [K_2]
   1. For each unmarked pair, identify the dependencies and mark accordingly.
   2. Initialize all the entries as unmarked and with no dependencies for the remaining states and mark all pairs consisting of final and non-final states.
   3. Delete all dead states and inaccessible states.
   4. Combine all unmarked pairs of states.

   a) 3-2-1-4 b) 1-3-2-4

c) 3-4-2-1 d) 4-1-3-2

3. Which of the following statements are true? CO2 [K_2]
   1)Homomorphism of a regular language is not regular
   2)Reversal of the regular language is regular
   3) Difference between two regular language is regular
   a) 2 and 3 b) 1 only
   c) 1 and 2 d) 1 and 3

4. Which of the following are not regular sets? CO2 [K_2]
   i) {xcy |x,y Є {a,b}*}
   ii) {$a^n b^{2m}$ | n>=0, m>=0}
   iii) {$a^n b^m$ | n=2m}
   iv) {$a^n b^n c^n$| n>0}
   a) iii only b) iv only
   c) iii & iv d) ii & iv

5. The following item consists of two statements, one labeled as the "Assertion (A)" and the other as "Reason (R)". You are to examine those two statements carefully and select the answers to these items using the codes given below: CO3 [K_2]
   Assertion (A): A context free language L(A) is accepted by a DPDA if and only if there is a single computation from the initial configuration until an accepting one for all strings belonging to L(A).
   Reason (R): All languages accepted by NPDA can also be accepted by a DPDA
   a) Both A and R are Individually true, and R is the correct explanation of A
   b) Both A and R are Individually true, but R is not the correct explanation of A
   c) A is true but R is false
   d) A is false but R is true

6. A context free language L is said to be _____ if all its grammars are ambiguous. CO3 [K_1]
   a) ambiguous b) inherently ambiguous
   c) context sensitive d) regular

7. Arrange the sequence of steps involved in the conversion of grammar to CNF CO4 [K_2]
   1. Eliminate unit production.
   2. Eliminate useless symbols
   3. Cascade the productions
   4. Eliminate Null production
   a) 2-3-4-1 b) 1-3-2-4
   c) 3-4-2-1 d) 4-1-2-3

8. Which of the following relates to Chomsky hierarchy? CO4 [K_1]
   a) CFL < CSL < Unrestricted < Regular b) CSL < Unrestricted < CFL < Regular
   c) Regular < CFL < CSL < Unrestricted d) Unrestricted < CFL < Regular < CSL

9. If L is recursive, then its complement is CO4 [K_1]
   a) recursively enumerable b) context free
   c) regular d) Recursive

10. The following item consists of two statements, one labeled as the "Assertion (A)" and the other as "Reason (R)". You are to examine those two statements carefully and select the answers to these items using the codes given below: CO5 [K_2]

Assertion (A): Multi tape Turing machine can simulate real time computers.

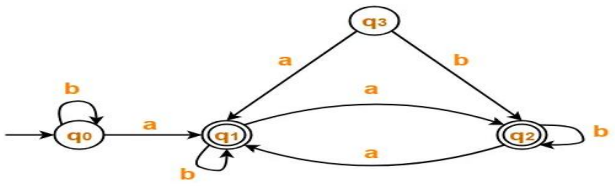
Reason (R): Multi tape Turing machine is powerful than single tape Turing machine

a) Both A and R are Individually true, and R is the correct explanation of A
b) Both A and R are Individually true, but R is not the correct explanation of A
c) A is true but R is false
d) A is false but R is true

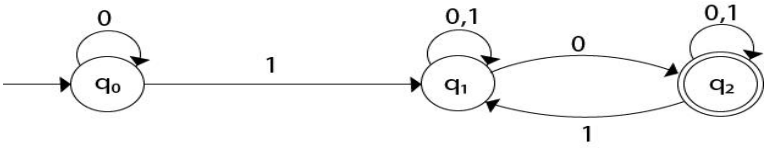
Answer any TEN Questions:-
PART B (10 x 4 = 40 Marks)
(Answer not more than 80 words)

11. Translate the regular expression (a+b)*abb to ϵ-NFA. CO1 [K_2]

12. Minimize the given DFA using table filling algorithm. CO1 [K_3]



13. Give the regular expression equivalent for the given automata. CO1 [K_3]



14. Write the regular expression to represent strings containing atleast one a or atleast one b over the alphabet {a,b,c}. With the above, conclude if regular languages are closed under union. CO2 [K_3]

15. List the closure properties of regular languages. CO2 [K_1]

16. Show that the given CFG is ambiguous. CO3 [K_2]
S→ aSbS | bSaS | ϵ

17. Construct a PDA equivalent to the following CFG. CO3 [K_3]

S→aAA A→aS|bS | a

18. Outline grammar with the 4-tuple notation. Write a CFG to represent set of all odd palindromes over ={0,1}. CO3 [K_3]

19. Tell about context sensitive and context free grammars in the Chomsky hierarchy. CO4 [K_1]

20. Prove that L_d is not a recursively enumerable language. CO4 [K_2]

21. Encode the given Turing Machine. CO5 [K_3]

M = ({q1, q2, q3 } , {0,1}, {0,1,B}, δ, q1, B, {q2})

δ is given by,

- δ(q1, 1) = (q3, 0, R)

- δ(q3, 0) = (q1, 1, R)
- δ(q3, 1) = (q2, 0, R)
- δ(q3, B) = (q3, 1, L)

22. Verify whether the instance of PCP with the two lists has a solution? CO5 [K2]

wi	List A	List B
1	1	111
2	10111	10
3	10	0

Answer any FIVE Questions:-
PART C (5 x 10 = 50 Marks)
(Answer not more than 250 words)

23. Prove that If $D = (Q_D, \sum, \delta_D, \{q_0\}, F_D)$ is the DFA constructed from the NFA $N = (Q_N, \sum, \delta_N, q_0, F_N)$ by the subset construction, then $L(D) = L(N)$. 10 CO1 [K2]

24. Construct a DFA equivalent to the given NFA. 10 CO1 [K3]

State / Input	0	1
→p	{p,q}	{p}
q	Φ	{r}
*r	{p,r}	{q}

25. a) Perform the below operations. 8 CO2 [K3]
   a) Construct a DFA to accept set of strings over alphabet {0,1} with odd number of 0's.
   b) Construct a DFA to accept set of strings over alphabet {0,1} with odd number of 1's.
   c) Perform intersection of the above two mentioned language.
   d) Conclude if the intersection of two regular languages is regular or not?

   b) Suppose h is the homomorphism from the alphabet {0,1,} to the alphabet {a,b} defined by h(0) = a; h(1) = ab; Find h (010). 2 CO2 [K2]

26. Convert the following CFG into CNF 10 CO3 [K3]

   S → ASA | aB, A → B | S, B → b | ε

27. a) Summarize multi-tape Turing Machine. 4 CO4 [K2]

   b) Design a Turing Machine for the language $L = \{a^n b^n c^n \mid n \geq 1\}$. 6 CO4 [K3]

28. a) State and Prove Rice's theorem. 8 CO5 [K2]

   b) What is meant by diagonalization language? 2 CO5 [K2]

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