



B.E DEGREE EXAMINATIONS: MAY 2017

(Regulation 2015)

Fourth Semester

COMPUTER SCIENCE AND ENGINEERING

U15CST403 : Theory of Computation

COURSE OUTCOMES

- CO1: Explain automata theory as the basis of all computer science languages design.
 CO2: Construct automata for regular expression and perform minimization of automata.
 CO3: Perform simplification in grammars and build normalized grammars.
 CO4: Construct Push Down Automata for simple Applications.
 CO5: Construct Turing machine for simple applications.
 CO6: Explain undecidable problems and measure complexity.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Match the following:

CO2 [K₂]

List I	List II
A. Regular expression	i. Zero or one instance
B. Kleen closure	ii. $0^* 1 (0 1)^*$
C. ?	iii. Pattern matching construct
D. The set of strings over $\{0,1\}$ that have at least one 1.	iv. Zero or more instances

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

2. The set of strings over $\{0,1\}$ that have at most one 1.

CO2 [K₂]

- | | | | |
|----|-----------------------|----|--------------------|
| a) | $10^* 1 0^* 1 0^*$ | b) | $0^* 0^* 11 0^*$ |
| c) | $1 0^* 0^* 1 0^* 1$ | d) | $0^* 0^* 1 0^*$ |

3. Which of the following is regular language? CO2 [K₂]
- i) $\{0^n 1^n \mid n \geq 1\}$
 ii) $\{0^n 1^{2n} \mid n \geq 1\}$
 iii) $\{0^n 1^m \mid n \leq m\}$
 iv) $\{0^n 1^m \mid n, m \text{ are arbitrary}\}$
- a) iii only b) iv only
 c) ii & iii d) ii & iv
4. Suppose h is the homomorphism from the alphabet $\{0,1,2\}$ to the alphabet $\{a,b\}$ defined by CO1 [K₁]
 $h(0) = a; h(1) = ab; h(2) = ba$. Find $h(0120)$.
- a) aba b) aabbaa
 c) aabaa d) abbaa
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: CO4 [K₂]
- 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. The _____ languages are not exactly equal to the subset of the CFL’s that are not CO3 [K₂]
 inherently ambiguous.
- a) DPDA b) NFA
 c) NPDA d) Turing machine
7. Arrange the sequence of steps involved in the conversion of grammar to CNF CO3 [K₂]
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. Consider the given grammar production: $S \rightarrow aSa|bSb|a|b$; CO1 [K₂]
 The language generated by the above grammar over the alphabet {a,b} is the set of _____
- a) All palindromes b) Strings that begin and end with the same symbol
 c) All odd length palindromes d) All even length palindromes
9. 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 [K₂]
- 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
10. Which of the following is/are undecidable? CO6 [K₂]
1. G is a CFG. Is $L(G) = \Phi$?
 2. G is a CFG. Is $L(G) = \Sigma^*$?
 3. M is a Turing machine. Is $L(M)$ regular?
 4. A is a DFA and N is an NFA. Is $L(A) = L(N)$?
- a) 3 b) 3 and 4
 c) 1,2,3 d) 2,3

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11. Differentiate between NFA and DFA CO1 [K₁]
12. How will you find ϵ - closure of a state? CO1 [K₁]
13. Define Pumping lemma for regular languages. CO2 [K₁]
14. Give an example for ambiguous grammar. CO3 [K₁]
 Convert the following grammar to GNF:
15. $S \rightarrow AA | 0$ CO3 [K₂]
 $A \rightarrow SS | 1$
16. Define Deterministic Push Down Automata CO4 [K₂]
17. Define basic Turing machine. What are the actions that take place in a Turing machines? CO5 [K₂]
18. List out various techniques in designing Turing machines. CO5 [K₂]
19. How to prove that the Post Correspondence Problem is Undecidable CO6 [K₂]
20. Is it true that complement of a recursive language is recursive? Justify your answer CO6 [K₂]

Answer any FIVE Questions:-

PART C (5 x 14 = 70 Marks)

(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. i. Construct a DFA over $\Sigma=\{a,b\}$ accepting strings which have number of a's divisible by 2 and number of b's divisible by 3 (5) CO1 [K₃]

ii. Convert the following NFA to DFA:

	0	1
$\rightarrow p$	{p,q}	{p}
q	{r}	{r}
r	{s}	Φ
*s	{s}	{s}

(9)

22. i. What are the steps involved in checking whether a given language is regular or not? (4) CO2 [K₂]
(6) CO5 [K₂]

ii. Write short notes on Multi-tape Turing machine. (4) CO5 [K₂]

iii. Describe how a Turing machine can be encoded with 0 and 1 and give an example.

23. State Chomsky normal form and build a grammar in Chomsky normal form equivalent to the below grammar: CO3 [K₃]

$S \rightarrow ABC \mid BaB, A \rightarrow aA \mid BaC \mid aaa, B \rightarrow bBb \mid a \mid D, C \rightarrow CA \mid AC, D \rightarrow \epsilon$

24. i) Define pumping lemma for CFL's. Show that the language $\{0^n 1^n 2^n \mid n \geq 1\}$ is CFL or not. (6) CO3 [K₃]

ii) Convert the grammar $S \rightarrow AB, A \rightarrow BS \mid b, B \rightarrow SA \mid a$ into GNF. (8)

25. Construct a PDA by empty stack to accept the language, and construct an equivalent PDA to accept by final state. CO4 [K₃]

26. i) Design a Turing machine that computes $f(m+n) = m+n$, where $m, n \geq 0$ and simulate the action for the input 0100 (7) CO5 [K₂]

ii) Convert the following Regular Expression to Minimized Deterministic Finite Automata: RE: $(aab^* \mid ab)$ (7) CO2 [K₂]

27. Define the language L_u and check L_u is recursively enumerable? Justify your answer CO6 [K₂]
