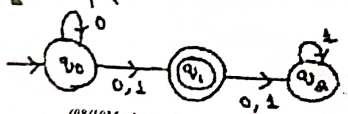
AUTOMATA THEORY AND COMPUTABILITY-18CS54

MODULE-1

Why study the Theory of Computation, Languages and Strings

1. a. Define the following terms: i) Alphabet ii) power of an alphabet iii) Strings Iv) Language v) DFSM
   (6 Marks June 12,Jan 15, 06 Marks Jun 19)
2. Write the DFA's for the following languages over $\Sigma = \{a,b\}$:
   i) The set of all strings ending with abb
   ii) The set of all strings not containing the substring aab *(08Marks-Dec10)*
   iii) L ={a w a| w'∈(a +b)*}
   iv) L ={w| |w| mod 3=0}
   v) The set of strings with exactly three a's. *(02Marks-Dec13-Jan14)*
   vi) The set of all strings ending with a and bb. *(03Marks-Jun-July14)*
   vii) The set of all strings not containing the substring aab. *(03Marks-Jun-July14)*
   viii) Set of all strings with exactly 3 consecutive a's *(03Marks-Jun-July14,May17)*
   ix) Set of all strings with atleast one 'a' and exactly two 'b's on ∑={a,b} *(04 Marks- Jan 15)*
   x) Set of all strings such that number of 1's is even and the number of 0's is a multiple of 3 on ∑={0,1} *(04Marks-Jan 15)*
   xi) Strings of a's and b's ending with bab. *(03 Marks- Jan 18)*
   xii) L ={ w ∈(01)*; w has 001as a substring}
   xiii) L ={ w ∈{a,b}*: w has even number of a's and even number of b's} *(08 Marks Jan 19*
3. Convert the following NFA to its equivalent DFA



(08/10Marks-Dec10, Jun-July14,06 Marks Jan 2018, 08 Marks Jan 19)

4. Define finite automata. What are the applications of finite automation? *(06Marks-Dec11,Jan16,Jan17)*
5. Define DFA.What are the difference between DFA ,NFAand ∈-NFA ? *(04Marks-Dec11,Dec13-Jan 14,Jan16,May17, 04 marks, Jan 2018)*
6. Design and DFA which accept strings of 0's and 1's which when interpreted as a

binary integer is multiple of 5. Also give the sequence of states that DFA is in while processing the input string: 1001011. *(10Marks-Dec 11)*

7. Design a DFA to accept the following language over the alphabet {0,1}
   i) L= {w |w is a even number } ii) L= { $(01)^i 1^{2j}$ |i ≥1, j ≥1}
   ii) The set of strings either start with 01 or end with 01. *(10Marks- June-July 09,Jan17)*
8. Consider the following ε-NFA. *(06M- June-July 09,Jan17)*

	ε	a	b	c
→ p	ϕ	{p}	{q}	{r}
q	{p}	{q}	{r}	ϕ
* s	{q}	{r}	ϕ	{p}

   Compute the ε-closure of each state ii) convert the automations to a DFA.
9. Prove that if D= (Q_D, ∑, δ_D, $\{q_0\}$, F_D) is the DFA constructed from NFA N=(Q_N,∑, δ_N, $\{q_N\}$, F_N) by subset construction then L(D)= L(N) *(08/06Marks- June- July 11,Jan 15)*
10. convert the following NFA to DFA:

δ	0	1
→* q0	q0	q0, q1
q1	q2	q2
* q2	ϕ	ϕ

(08 Marks June 12)

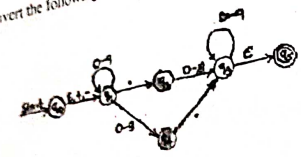
11. Design NFA or ∈-NFA for the following languages
    i) abc,abd,aacd {∑={a,b,c}}
    ii){ab,abc}* {∑={a,b,c}} *(06 Marks Dec13-Jan 14,Jan 16)*
    iii) L={$a^n b a b^n$ |n>=0}∪{$a b a^n$ |n>=0} with no more than 5 states *(03Marks-Jan 15)*
12. Design a DFA to read strings made up of letters "CHARIOT" and recognize these strings that contains the word "CAT" as a substring. *(08Marks-July 15)*
13. Draw a DFA to accept the language l={w| w has odd number of 1's and followed by even number of 0's}. Completely define DFA and transition function. *(06Marks-July 15)*
14. Draw a DFA to accept the language l={w| w is of even length and begins with 01. *(06Marks-Jan 16)*
15. Compute ε-closure of each state from the following ε - NFA :

	ε	a	b
->p	{r}	{q}	{p,r}
q	Φ	{p}	Φ

r	{p,q}	{r}	{p}
*S	{p}	{p}	{p}

(04Marks-Dec10)

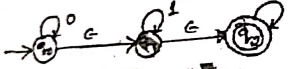
16. Convert the following ε-NFA to DFA using "Subset construction Scheme" *(08Marks- Dec 08-Jan09,Jan 16)*



17. Consider the following ε-NFA:

	ε	a	B	C
→p	ϕ	{p}	{q}	{r}
Q	{p}	{q}	{r}	ϕ
*r	{q}	{r}	ϕ	{p}

i)Compute the ε-closure of each state/
ii)Give all the strings of length 3 or less accepted by the automation
iii)Convert the automation to a DFA *(10/08Marks- Dec. 09- Jan. 10,Jun-Jul2014)*



18. For a given ε-NFA, compute the following :
a) Compute ε-closure of each state
b) Give the set of all strings of length 3 or less accepted by the automation.
c) Convert the automation to DFA. *(10 Marks June12)*

δ	∈	Q	b
→p	{r}	{q}	{p, r}
q	ϕ	{p}	ϕ
*r	{p, q}	{r}	{p}

19. Consider the following ε-NFA

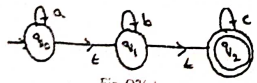


Fig. Q2(a)

i) Compute ECLOSURE of each state
ii) Convert above ε-NFA to DFA. *(08 Marks Dec13-Jan14)*

20. a) Convert the following ∈-NFA to DFA

δ	∈	a	b	c
→p	{q, r}	ϕ	{q}	{r}
*q	ϕ	{p}	{r}	{p, q}
r	ϕ	ϕ	ϕ	ϕ

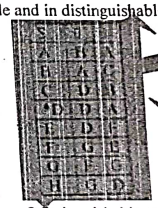
(05 Marks Jan15)

21. Define the following terms with example a) Alphabet b) Power of an alphabet c) Concatenation d) Languages *04 Marks Jan18*

22. Convert the following NDFSM to its equivalent DFSM *(09 Marks- Jan 18)*

23. Draw a DFSM to accept the language,
L={w∈{a,b}*: ¥x,y∈(a,b}*((w=xabbaay)v(w=bzbzy))} *(03 Marks- Jan 18)*

24. Define distinguishable and in distinguishable states. Minimize the following DFSM



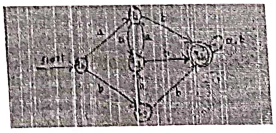
(09 Marks- Jan 18)

*i)*draw the table of distinguishable and in distinguishable states for tha automata
ii) construct minimum state equivalent of automata

25. Define DFSM. Design a DFSM to accept the decimal strings which are divisible by 3 *(06Marks Jul 18)*

26. With a neat diagram, explain a hierarchy of language classes in automata theory. *(04Marks Dec. 17-Jul 18)*

27. Minimize the following finite automata. *(06Marks Jul 18)*

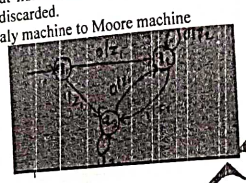


28. Construct the mealy machine for the following *(06Marks Jul 18)*

i) Design a mealy machine for a binary input sequence, Such that, if it has a substring 101, the machine outputs A, if input has substring 110, the machine outputs B, otherwise it outputs C.

ii) Design mealy machine that takes binary number as input and produces 2's complement of that number as output. Assume the string is read from LSB to MSB and carry is discarded. *(04Marks Jul 18)*

29. Convert the following mealy machine to Moore machine



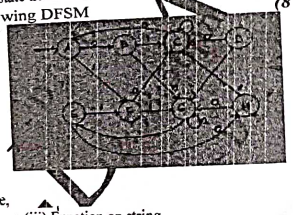
30. Design a deterministic finite sate machine for the following language over Σ ={a,b}

i) L = {W:|W| mod 3>|W| mod 2} *(10 MarksJune 19)*

ii) L = {w: w ends either with ab or ba} *(7 MarksJune 19)*

31. Write a note on finite state transducers *(8 Marks Jan 19)*

32. Minimize the following DFSM

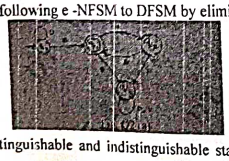


33. Explain with example,
(i) Strings (ii) Language (iii) Function on string *(6 Marks Jan 20)*

34. Discuss standard operations on Languages with example *(4 Marks Jan 20)*

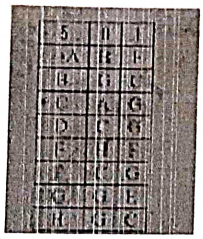
35. Construct DFSM for the following languages *(10 Marks Jan 20)*
(i) L={w∈{a,b}*|w contains no more than one b}
(ii) L = { w∈{a,b}* |w contains Even number of a's and odd number of b' s}
Give the transition Table and show that aabaa is accepted.

36. Convert the following e -NFSM to DFSM by eliminating ∈ -transition



(10 Marks Jan 20)

37. Define distinguishable and indistinguishable states. Minimize the number of states in DFSM. *(10 Marks Jan 20)*



MODULE-2

Regular Expressions, Regular Languages And Non Regular Languages

1. Define regular expression. Write the regular expression for the following languages:
i) L = {$a^n b^m$| n ≤ 4, m≥2}
ii) Strings of 0's and 1's having no two consecutive zeros
iii)strings of 0's and 1's whose lengths are multiples of 3. *(06Marks-Dec 10,Jan 16,Jan17,May17)*

2. Obtain an ε-NFA for the regular expression $a^*+b^*+c^*$ *(04Marks- Dec12,Jan17)*

3. Write regular expression for
i) L= { $a^n b^m$ | n≥ and m≥1}
ii) L= { $a^{2n} b^{2m}$ | n≥0, m≥0}. *(06Marks- June-July 11,Jan 16)*

4. Convert the following DFA to a regular expression using the state elimination technique

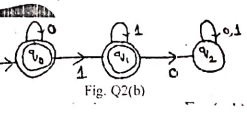


Fig. Q2(b)

(07 Marks Dec13-Jan14)

5. Convert the regular expression (0+1)*1(0+1) to an NFA. *(06 Marks Jun-Jul14,Jan 16)*

6. Define regular expression and also write the regular expression for the following language
i) L={w∈{a,b}*| w has exactly one pair of consecutive a's}
ii) Set of all strings not ending in substring 'ab' over Σ={a,b} *(05 Marks Jan15)*

7. Prove that if L=L(A) for some DFA A, then there is a regular expression R such that L=L(R) *(06 Marks Jan15,July15)*

8. Obtain the regular expression for the following DFA using state elimination technique

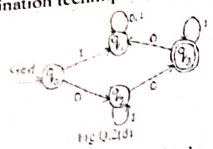


Fig Q.2(d) *(03 Marks Jan15)*

9. For the following DFA. Obtain regular expression $R_{ij}^{(0)}$ and $R_{ij}^{(1)}$. Simplify the regular expression as much as possible

States	0	1
→q 1	q 2	q 1
q 2	q 3	q 1
*q 3	q 3	q 2

(09 Marks July15, 09 Marks Jan15)

10. Construct NFA for the regular expression V=(0.1+10)* *(05 Marks July15)*

11. Show that if L is regular language, then complement of L denoted by L is also regular *(04Marks-Dec 11)*

12. If L_1 and L_2 are regular languages then prove that family of regular language are closed Under L1 – L2. *(06Marks- Dec 08-Jan09)*

13. Let ∑= {a,b}. Show that the language $L = \{w \in \Sigma^* | n_a(w) < n_b(w)\}$ is not regular *(05Marks- Jan 15)*

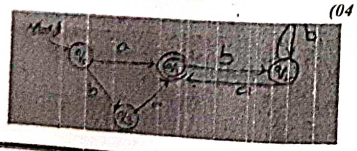
14. If L and M are regular languages prove that L∩M is also regular. *(03 Marks June 12,Jan17)*

15. Show that $L=\{A^{n^2} \mid n \geq 0\}$ is not regular. *(05 Marks July15)*

16. What is Homomorphism? Explain with an example. *(04 Marks Jan 16)*

17. Give regular expression for the following languages on ∑={a,b,c}
    i) All strings containing exactly one a
    ii) All strings containing no more than 3 a's
    iii) All strings contain at least one occurrence of each symbol in ∑ *(03 Marks Jan 18)*

18. Let L be the language accepted by the following finite state machine *(04 Marks Jan 18)*



Indicate for each of the following regular expressions, whether it correctly describes L
i) (aU ba)bb*a
ii) (εU b)a(bb*a)*
iii) baU ab*a
iv) (aU ba)(bb*a)*

19. Prove that the following language in not regular $L=\{0^n1^n \mid n>0\}$ *(05 Marks Jan 18, 8 Marks Jun 19)*

20. If L1 and L2 are regular languages then prove that L1 U L2, L1.L2,L1* are regular languages. *(05 Marks Jan 18)*

21. Define regular expression. obtain a regular expression for the following languages
    i)$L=\{a^nb^m \mid m+n \text{ is even}\}$
    ii) $L=\{a^nb^m \mid m>=1, n>=1, nm>=3\}$
    iv) $L=\{w: |w| \bmod 3=0 \text{ where } w \in (a,b)^*\}$ *(08 Marks Jul 18)*

22. Design an NDFSM that accept the language L(aa*(a+b)) *(04 Marks Jul 18)*

23. Convert the regular expression (0+1)*1(0+1)to NDFSM *(04 Marks Jul 18)*

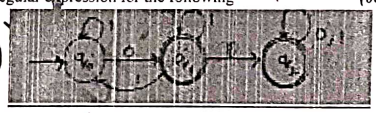
24. If the regular grammars define exactly the regular language, then prove that the class of languages that can be defined with regular grammars is exactly the regular languages *(04 Marks Jul 18)*

25. Prove that the regular languages are closed under complement, intersection, difference, reverse and letter substitution. *(08 Marks Jul 18)*

26. State and prove pumping theorem for regular language. *(04 Marks Jul 18, Jun 19, 08 Marks Jan 19)*

27. Define the regular expression and write regular expression for the following languages *(08 Marks Jan 19)*
    i)$L=\{a^{2n}b^{2m+1} \mid n>=0, m>=0\}$
    i)$L=\{a^nb^m \mid m>=1, n>=1, nm>=3\}$

28. Obtain the regular expression for the following *(08 Marks Jan 19)*



29. Define regular grammar. Design regular grammar for the following languages
    i) Strings of a's and b's with atleast one a
    ii) Strings of a's and b's having strings without ending with ab
    iii) Strings of 0's and 1's with 3 consecutive 0's *(08 Marks Jan 19)*

30. Define Regular expression. Write RE for the following: *(10 Marks Jan 20)*
    (i) Language of all strings of 0's and 1's that have odd number of 1's.

(ii) Language of all strings of 0's and l's that has at least one pair of consecutive 0's.
(iii) The Language of all strings of 0's and 1 's that have no pair's of consecutive 0's.

31. Prove with an example that the class of language can be defined with regular grammar is exactly the regular language. *(10 Marks Jan 20)*
32. Using Kleen's theorem, prove that any language that can be defined with a Regular expression can be accepted by some FSM. *(10 Marks Jan 20)*
33. State and prove pumping lemma for regular language and show that the language L = {a^n P is a prime number} is not regular. *(10 Marks Jan 20)*

MODULE-3

Context –Free Grammars And Push Down Automata

1. a.Define context free grammar. Write the grammar for the following languages:
   i)L= { 0^{n+2} 1^n | n≥1} ii) L={ a^n b^m|m>n and n>0} *(07Marks- Dec 10,Jan17,May17)*
2. Consider the grammar G with following productions E-> +EE|*EE|-EE|x|y. Find LMD,RMD and write parse tree for the string +*-xyxy. *(06 Marks Dec13-Jan14,Jan17)*
3. Show that the following grammar is ambiguous.
   S->SbS
   S->a *(04Marks- Jan 15)*
4. Obtain the grammer to generate the following languages:
   *i)*L={w:na(w)mod 2=0 where w∈(a,b)*}
   ii) L={w: w is a palindrome, where w∈(a,b)*}
   iii)L=a^nb^{2n}|n>=1 *(06Marks-July15)*
5. Show that the following grammer is ambiguous:
   S→a|Sa bSS|SSb|SbS. *(05Marks-July15)*
6. What is an instantaneous description of PDA? Obtain a PDA to accept the following language by final state:
   L={a^nb^{2n}|n≥1, ∑={a,b}}
   Draw the transition diagram for PDA. Also, show the moves made by PDA for the string: aabbbb *(12Marks-Dec 11,May17)*
7. For the following grammer construct a PDA
   S → aABB | aAA
   A → aBB | a
   B → bBB | A
   C → a.
8. Define a PDA. Discuss about the languages accepted by a PDA. Design a nondeterministic PDA for the Language L= {0^n1^n| n≥1} *(8Marks- Dec 08-Jan09,Jan 16) (12Marks- Dec. 09-Jan. 10,July 15)*
9. Define PDA. Design PDA for the language L= {wCw^R, w∈ (a+b)*}. Show that ID's for the string abcba and also write the transition diagram *(12M Dec 12,Jan 16,08 M Jul 18)*

10. Define PDA. Design PDA to accept the following language by final state L={w | w∈ (a, b)* ,$N_a(w) = N_b(w)$}
11. Draw the graphical representation of PDA. Also, show the moves made by the PDA for the string abbaba. *(12 Marks May-June 10,Jan17)*
12. Convert the following CFG TO PDA.
    S→ $aABB|aAA$
    A→ $aBB|a$
    B→ $bBB|A$
    C→ a *(08/10 Marks May-June 10,Jun-Jul 14)*
13. Define a PDA. Design a PDA for the Language L= {ww^r | w ∈(a+b)* and w^r is the reverse of w}.Draw the transition diagram for the constructed PDA. Write ID's for the string aabbaa and 'abbbba' *(10Marks- Jun-Jul 14,Jan 15,10 Marks Jan 18)*
14. Convert the following CFG to a PDA that accepts the same language by empty stack.
    E → E + E | E * E | (E) | I
    I → Ia | Ib | I0 | I1 | a | b *(05Marks- Jan 15)*
15. Define a deterministic PDA (DPDA) . Also, design a DPDA along with transition diagram for the following language L={a^nb^{2n}|n>=0} *(07Marks- Jan 15)*
16. Explain the PDA with two stacks. *(05Marks- July 15)*
17. Define grammar, derivation, sentential form and give one example for each *(03Marks, Jan 18)*
18. What is CNF? Obtain the following grammar in CNF *(09 Marks, Jan 18)*
    S → ASB|ε
    A → aAS|a
    B → SbS|A|bb
19. Let G be the grammar *(04 Marks, Jan 18)*
    S→aB|bA
    A→a|aS|bAA
    B→b|bS|aBB For the string aaabbabbba find a
    i)leftmost derivation ii)rightmost derivation iii) parse tree
20. Explain the following terms *(03 Marks, Jan 18)*
    i) Pushdown automata
    ii) Languages of a PDA
    iii) Instantaneous description of a PDA
21. Convert the following CFG to PDA *(03 Marks, Jan 1, 04 marks Jul 18)*
    S → aABB | aAA
    A → aBB | a
    B → bBB | A
    C → a.
22. What is ambiguity? Show that the following grammar is ambiguous

S→aB|bA
A→a|aS|bAA

B→b|aS|aBB

23. Define CFG. Obtain the grammar to generate the language $L=\{w|n_a(w)=n_b(w)\}$ *(04 Marks, Jul 18)*

24. Obtain the CFG To PDA *(04 Marks, Jul 18)*
f(q0,a,Z)=(q0,AZ)
f(q0,a,A)=(q0,A)
f(q0,b,A)=(q1, ε)
f(q1, ε,Z)=(q2, ε)

25. Define grammar. Write the CFG for the following language *(08 Marks, Jul 19)*
i) $L=\{ a^ib^j \mid i=j+1\}$
ii) $L=\{w \mid w\in (a, b)^*, N_a(w) = N_b(w)\}$

26. What is inherent ambiguity? S T the language given is inherently ambiguous. *(08 Marks, Jul 19)*
$L=\{a^nb^nc^m \mid n,m>=0\}U\{a^nb^mc^n \mid n,m>=0\}$

27. Define PDA. Design PDA for the language $\{a^nb^n \mid n,m>=0\}$ *(06 Marks, Jul 19)*

28. Convert the following language from CFG to PDA $L=\{ww^R \mid w\in\{0,1\}^*\}$ *(06 Marks, Jul 19)*

29. Convert thefollowing CFG to CNF E->E+T|T*E|(E)|id. *(04 Marks, Jul 19)*

30. Define CFG. Design a CFG for the language *(08 Marks, Jan 19)*
i) $L=\{0^m1^m2^n \mid n>+0,m>=0\}$
ii) $L=\{a^ib^j \mid i\neq j, i>=0, j>=0\}$
iii) $L=\{a^nn^{n-3} \mid n>=3\}$

31. Consider the grammar G with production *(08 Marks, Jan 19)*
S->AbB
A->a|ε
B->aB|bB|a

32. Define context Free Grammar. Construct CFG for the following languages:
(i) Balanced parantheses.
(ii) L = {w∈{a,b}* w contains substring ab} and derive two strings for each language along with parse tree. *(10 Marks, Jan 20)*

33. Explain deterministic PDA and construct DPDA for language given and give the trace fort the string abbaab and aabbabb.
$L=\{a^nb^ma^mb^n \mid m,n > 0 \text{ and } n \# m\}$ *(10 Marks, Jan 20)*

34. Discuss Chomsky normal form and Greibach normal form. Convert the following Grammar to Chomsky Normal form, *(10 Marks, Jan 20)*
S --> aACa
A-->B|a

B →C
C --> cC|ε

35. Explain Non deterministic PDA and construct an NPDA for the language
$L = \{ww^R \mid w\in\{a,b\}^*\}$ *(10 Marks, Jan 20)*
Give the transition diagram and show the trace for a string abaaba

MODULE-4

Context Free and Non Context Free Languages, Turing Machines

1. what is an unit production? Begin with the grammar:
S → ABC | BaB
A → aA | BaC |aaa
B → bBb | a | D
C → CA | AC
D → ε
i) Eliminate ε-productions
ii) Eliminate any unit productions in the resulting grammar
iii) Eliminate any useless symbols in the resulting grammar
(10Marks-Dec 11,Jun-Jul-14,Jan17)

2. If L_1 and L_2 are context free languages then prove that family of context free languages are closed under Union and concatenation operations *(06Marks-Dec 08-Jan09,Jan 16)*

3. Prove that context free languages are closed under union,concatenation and star operation *(04/08Marks- Dec 12,July 15)*

4. Define CNF. Convert the following CFG to CNF.
S → ASB | ε , A → aAS | a , B → SbS | A | bb
(10MJune-July 09,Jan 16)

5. Consider the grammer
S→ASB
A→aAS/a
B→SbS/bb
a) Eliminate useless symbols
b) Eliminate ε - productions
c) Eliminate unit productions
d) Put the grammar into CNF *(10 Marks June 12,Jan 16)*

6. What are unit production? Eliminate unit productions from the following grammar:
S → Aa|B. B → A|bb. A → a| bc|B. *(07 Marks Dec13-Jan14)*

7. Begin with a grammar

S → aAa | bBb | ∈

A → C | a

B → C | b

C → CDE | ∈

D → A | B | ab

i) Eliminate ∈- productions

ii) Eliminate any unit production in the resulting grammar.

iii) Eliminate any useless production in the resulting grammar. ***(08 Marks Jan15)***

8. Define Chomsky Normal Form (CNF).Also, convert the following CFG to CNF:

S → AB | a

A → aab

B → Ac ***(06 Marks Jan15)***

9. Show that the language L={X∈{0,1}*||X| is a perfect square} is not context free. ***(06 Marks Jan15)***

10. Simplify the grammer by eliminating useless productions.

S→AB

A→a

B→C|b

C→D

D→E|bC

F→d|Ab ***(06 Marks July15)***

11. Show that the language $L=\{a^n b^n c^n \mid n\geq 0\}$ is not context free. ***(04 Marks Jan16, 08 marks Jul 18, Jun 19)***

12. Define turing machine, Explain with a diagram, general structure of multitape turing machine. ***(06Marks-Dec 10,May17,Jan17)***

13. Design a turing machine to accept the language $L = \{0^n 1^n \mid n \geq 1\}$. Write its transition diagram and give instantaneous description for the input 0011. ***(14Marks-Dec 10,Jan17,May17,08 Marks jul 18)***

14. Design a Turing machine to accept the set of all palindromes over {0,1}*. Also, indicate the moves made by Turing machine for the string: 1001. ***(12Marks-Dec 11,Jan 15)***

15. Explain with neat diagram the working of a turning machine model ***(06Marks-Dec 08-Jan09,Jan17,May17)***

16. Explain the general structure of multi tape and non deterministic turing machines and show that these are equivalent to basic turing machine. ***(08Marks- Dec.09-Jan.10,Jan 15,Jan 16)***

17. Define turing machine and multitape turing machine. Show that the language accepted by these Machines are same. ***(08Marks Dec 12, 08M- June-July 09, 10 Marks June 12)***

18. Design a turing machine to accept the language $L=\{ a^n b^n c^n \mid n\geq 1\}$. Given the graphical representation for the TM obtained ***(12/10Marks Dec 12,July 15,11 Marks Jan 18)***

b. Design a turning machine that performs the following function:

$q_0 w \mid * q_f ww$ for any w ∈ {1}* ***(10 Marks May-June 10,Jan 16)***

19. Design a Turing machine to accept the set of all palindromes over {a,b}*. Also, indicate the moves made by Turing machine for the string: aba. ***(14Marks-Jun-Jul 14)***

20. Explain the programming techniques for turing machine. ***(10Marks-Jun-Jul 15)***

21. If L1 and L2 are context free languages then prove that L1 U L2, L1.L2, L1* are context free languages. ***(05 Marks Jan 18, 8 Marks Jun 19)***

22. Give a decision procedure to answer each of the following question

i) Given a regular expression α and a PAD M, the language accepted by M a subset of the language generated by α

ii) Given a context free grammar G and two strings S1 and S2, does G generate S1S2?

iii) Given a context free grammar G ,does G generates any even length string S1S2?

iv) Given a regular grammar G, is L(G) context free? ***(12 Marks Jan 18)***

23. Explain with neat diagram,the working of Turing Machine model ***(5 Marks Jan 18, 04 Marks Jul 18, Jun 19)***

24. Briefly explain the techniques for the TM construction ***(04 Marks Jul 18)***

25. Design a Turing machine that accepts the language $L=\{a^n b^n c^n \mid n>0\}$. ***(05 Marks Jul 19)***

26. Write a note on multitape machine. ***(03 Marks Jul 19)***

27. State and prove pumping lemma for context free languages. ST $L=\{a^n b^n c^n \mid n\geq 0\}$ is not context free. ***(08 Marks Jan 19)***

28. Explain turing machine module ***(08 Marks Jan 19)***

29. Design a turing machine to accept the language $L=\{0^n 1^n 2^n \mid n\geq 1\}$. ***(08 Marks Jan 19)***

30. Design a turing machine to accept the strings of a's and b's ending with ab or ba. (08 ***Marks Jan 19)***

31. State pumping Lemma for context free language. ***(10 Marks Jan 20)***

32. Define Turing Machine. Design TM to accept the language $L = \{a^n b^n c^n \mid n >= 1\}$. Draw the transition diagram and show the moves made by TM for the string aabbcc. (***10 Marks Jan 20)***

33. Explain with neat diagram the working of TM and design a TM to accept all set of palidrom over {1,0}*. Also show the transition diagram and instantaneous description on string "10101". ***(14 Marks Jan 20)***

34. Discuss the relationship between the deterministic context free language and the languages that are not inherently ambigs ***(06 Marks Jan 20)***

MODULE-5

Variants of Turing Machine

1. Post's correspondence problem ***(05Marks-Dec 10, Dec 08/Jan09, Dec 2012, June-July 2009, May-June 2010, June 2012,Dec13-Jan 2014,Jun-Jul 14,Jan 15, July 15,Jan 16,Jan 17,May 17, Jun 19, 04 Marks Jan 2019)***
2. Recursive languages and Halting problem of TM ***(05Marks-Dec11,Dec. 09 Jan. 10, June-July 2009, June-July 2011,Dec-Jan 2014, Jun-Jul 14,Jun-Jul 15,Jan 17)***

3. Write a detailed note on halting problem of Turing Machine *(06 Marks-June 13, Jun 19)*
4. Write short notes on Multi Tape Turing M/C. *(05 Marks-Dec13-Jan14,Jun-Jul 14)*
5. Recursive language and its relationship with RE and non RE languages. *(04 Marks-Jan 15)*
   (05 Marks-July 15)
6. Universal Languages *(05 Marks-July 15)*
7. Recursively enumerable language. *(05 Marks-Jan 16)*
8. Applications of Regular Expressions *(05 Marks-Jan 16)*
9. Applications of CFG *(05 Marks-Jan 16)*
10. Chomsky Hierarchy *(16 Marks-Jan 18, jul 18)*
11. Write short notes on
    a. Multi-tape turing machine
    b. Non-deterministic turing machine
    c. Linear bounded automata *(16 Marks-Jan 18,jul 18)*
12. Write short notes on
    a. Undecidable languages
    b. Halting problem of turing machine
    c. The post correspondence problem
13. Obtain a TM to recognize the language $L=\{0^n 1^{2^n} | n>=1\}$ (08 *Marks-Jul 16)*
14. With example, explain the quantum computation (04 *Marks-Jul 16)*
15. Various types of turing machine (06 *Marks-Jul 19)*
16. Write a short note on (16 *Marks-Jul 19)*
    i) Growth rate of function
    ii) Church turning thesis
    iii) Linear bounded automata (06 *Marks-Jan 19)*
17. Explain the following
    i) Non-deterministic Turing machine
    ii) Multi Tape Turing machine (06 *Marks-Jan 19)*
18. Define the following
    i) Recursive enumerable language
    ii) Decidable language (06 *Marks-Jan 19)*
19. What is halting problem of TM? (06 *Marks-Jan 19)*
20. Define the following
    i) Quantum computer
    ii) Class NP (04 *Marks-Jan 19)*
21. Explain church turing thesis *(10 Marks Jan 20)*
35. With a neat diagram, explain variants of Turing Machines. *(10 Marks Jan 20)*
36. Explain with example,
    (i) Decidability (ii) Decidable languages (iii) Undecidable language.
37. Discuss Halting problem and post correspondence problem with respect to TM. *(10 Marks Jan 20)*
38. Define non-deterministic TM and prove that there in a deterministic TM 'NV T(M)= T (M1). *(10 Marks Jan 20)*