b. Convert the following grammar into Greibach normal form

$$A_1 \rightarrow A_2 A_3$$
$$A_2 \rightarrow A_3 A_1 \mid b$$
$$A_3 \rightarrow A_1 A_2 \mid a$$

10. a. Design a push down automata for the language $L = \left\{ ww^R \mid w \in \{0,1\}^* \right\}$.

(OR)

b. Derive the equivalent context tree grammar for the following push down automata.

$PDA = \left\{ \{q_0, q_1\}, \{0,1\}, \{z_0, x\}, \delta, q_0, z_0, \phi \right\}$ where δ is given as,

$$\delta(q_0, 0, z_0) = (q_0, x z_0)$$
$$\delta(q_0, 0, 0) = (q_0, xx)$$
$$\delta(q_0, 1, 0) = (q_1, \in)$$
$$\delta(q_1, 1, 0) = (q_1, \in)$$
$$\delta(q_1, \in, z_0) = (q_1, \in)$$

11. a. Construct a Turing machine for the language $L = \{a^n b^n c^n \mid n \geq 1\}$.

(OR)

b. Design a Turing machine to perform multiplication operation.

12. a. Prove that post correspondence problem is undecidable.

(OR)

b. Explain in detail about the following with example
   (i) NP complete problem
   (ii) NP hard problem

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B.Tech. DEGREE EXAMINATION, MAY 2019
1st to 7th Semester

15CS301 – THEORY OF COMPUTATION
(For the candidates admitted during the academic year 2015 - 2016 to 2017 - 2018)

Note:
(i) **Part - A** should be answered in OMR sheet within first 45 minutes and OMR sheet should be handed over to hall invigilator at the end of 45th minute.
(ii) **Part - B** and **Part - C** should be answered in answer booklet.

Time: Three Hours   Max. Marks: 100

PART – A (20 × 1 = 20 Marks)
Answer ALL Questions

1. A language is regular if and only is
   (A) Accepted by DFA   (B) Accepted by PDA
   (C) Accepted by LBA   (D) Accepted by Turing machine

2. Let the class of language accepted by finite state machine be L_1 and the class of languages represented by regular expression be L_2 then
   (A) $L_1 < L_2$ (B) $L_1 >= L_2$
   (C) $L_1 \cup L_2 = `*`$ (D) $L_1 = L_2$

3. Which of the following is true?
   (A) Every subset of a regular set is regular   (B) Every finite subset of non-regular set is regular
   (C) The union of two non regular set is not regular   (D) Infinite union of finite set is regular

4. Which of the following is not a regular expression.
   (A) $\left[(a+b)^* (aa+bb) \right]^*$
   (B) $\left[(0+1) - (0b+a1)^* (a+b) \right]^*$
   (C) $(01+11+10)^*$
   (D) $(1+2+0)^* (1+2)^*$

5. Context sensitive grammar are
   (A) Type 0 language   (B) Type 1 language
   (C) Type 2 language   (D) Type 3 language

6. Connect hierarchical relationship among context free, right linear and context sensitive language is
   (A) Context free C right linear C context sensitive   (B) Context fee C context sensitive C right linear
   (C) Context sensitive C right linear C context free   (D) Right linear C context free C context sensitive

7. Which of the following CFG's can't be simulated by an FSM?
   (A) $S \rightarrow Sa \mid b$ (B) $S \rightarrow aSb \mid ab$
   (C) $S \rightarrow abX, X \rightarrow cY, Y \rightarrow d \mid aX$ (D) $S \rightarrow OS \mid Y, Y \rightarrow OY \mid O$

8. The context free languages are closed for
   - (i) Intersection
   - (ii) Union
   - (iii) Complementation
   - (iv) Kleene star
   - (A) (i) and (iv)
   - (B) (i) and (iii)
   - (C) (ii) and (iv)
   - (D) (ii) and (iii)

9. Which of the following is true?
   - (A) Power of deterministic automata is equivalent to power of non-deterministic pushdown automata
   - (B) Power of deterministic pushdown automata is not equivalent to power of non-deterministic push down automata
   - (C) Power or Turing machine is equivalent to power of non-deterministic pushdown automata
   - (D) Power of deterministic and non-deterministic finite automata are not equivalent

10. A context free grammar G is in Chomsky normal form if every production is of the form
    - (A) A→BC, A→A
    - (B) A→BC, A→a
    - (C) A→aAB, A→a
    - (D) A→BCa, A→A

11. In Chomsky normal form a string of length n will need _____ number of derivation steps.
    - (A) 2n−1
    - (B) 2n+1
    - (C) 2n
    - (D) $2n^2$

12. Which of the following language is accepted by pushdown automata?
    - (A) Context sensitive language
    - (B) Context free language
    - (C) Regular language
    - (D) Unrestricted language

13. Next move function δ of pushdown automata $PDA = (Q, \Sigma, \Gamma, \delta, q_0, z_0, F)$ is mapping of
    - (A) $\delta : Q \times \Sigma \rightarrow Q \times \Gamma$
    - (B) $\delta : Q \times \Sigma \times \Gamma \rightarrow Q \times \Gamma$
    - (C) $\delta : Q \times \Gamma \rightarrow Q \times \Sigma \times \{L,R\}$
    - (D) $\delta : Q \times \Sigma \rightarrow Q \times \Gamma \times \{L,R\}$

14. A language L is called recursive is
    - (A) ∃ a Turing machine M for L
    - (B) We can construct a Turing machine which always have halts
    - (C) The TM never halts
    - (D) We cant construct a TM

15. According to pumping lemma for regular language, if we select a string w such that w = xyz. Which of the following portion cannot be an empty string.
    - (A) x
    - (B) y
    - (C) z
    - (D) xz

16. The production of the form A→B, where A and B are non terminals is called
    - (A) Null production
    - (B) Unit production
    - (C) Chomsky normal form
    - (D) Greibach normal form

17. A pushdown automata is said to be _____ if it has atmost one transition around all configurations.
    - (A) Finite
    - (B) Non regular
    - (C) Non deterministic
    - (D) Deterministic

18. A Turing machine that is able to simulate over Turing machines
    - (A) Nested Turing machine
    - (B) Universal Turing machine
    - (C) Counter machine
    - (D) Halting machine

19. Set or language accepted by Turing machine.
    - (A) Recursively enumerable language
    - (B) Recursive language
    - (C) Regular language
    - (D) Non regular language

20. Which of the following problem is not NP-hard?
    - (A) Hamiltonian circuit problem
    - (B) The 0/1 Knapsack problem
    - (C) Finding BI-connected component of a graph
    - (D) The graph coloring

PART – B (5 × 4 = 20 Marks)
Answer ANY FIVE Questions

21. Construct DFA for the language L over {a,b}, which contains all string that does not start with 'ab'.

22. Using pumping lemma, prove $L = \{a^n b^n \mid n \geq 1\}$ is not regular language.

23. List different types of grammar with example.

24. Is non deterministic push down automata more powerful than deterministic push down automata? Justify.

25. Design a turing machine that accepts the language of odd integers, written in binary and given instantaneous description for input '1111'.

26. Prove that multitape Turing machine and single tape Turing machine are equivalent.

27. Differentiate recursive and recursive enumerable language.

PART – C (5 × 12 = 60 Marks)
Answer ALL Questions

28. a. Construct minimized DFA for the regular expression $"ab(a+b)^{*}"$.

    (OR)

    b. Find regular expression for the following DFA using R_{ij}^{k} formula.
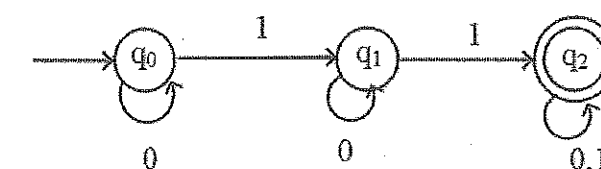
29. a. Convert the following context free grammar to Chomsky normal form
    $S \rightarrow ABA \mid BaA \mid A$
    $A \rightarrow Ba \mid S \mid \epsilon$
    $B \rightarrow Ba \mid b \mid ca$
    $C \rightarrow Ca$
    $D \rightarrow DaD \mid a$

    (OR)