JHARKHAND Rai University
RANCHI

# PRACTICE SET
## End Semester Examination, Spring- 2026

**Program: BCA**
**Semester: VI**
**Subject: Theory of Computation**
**Subject Code: 3CCC304**

**Course Outcome:**
On the completion of the Course, the students will be able to:

| Course Outcomes | Description |
|---|---|
| CO1 | Design and analyze finite automata (DFA & NDFA), perform conversions, and apply them to solve real-time problems. |
| CO2 | Apply regular expressions to define languages, use algebraic laws, and prove language regularity using pumping lemma. |
| CO3 | Construct and convert grammars, distinguish between types in Chomsky hierarchy, and apply normal forms to CFGs |
| CO4 | Explain the concept of Pushdown Automata, differentiate between DPDA and NPDA, and apply parsing techniques. |
| CO5 | Understand Turing Machines, classify languages based on decidability, and identify complexity classes like P, NP, NP-Complete, and NP-Hard |

### UNIT I
### Section A (10 marks)

1. Describe DFA and its components with suitable example. Explain the difference between DFA and NDFA. (CO1, Understand, LOT)
2. Explain NDFA. Convert a given NDFA M= (Q, ∑, 8, q0, F} to the equivalent DFA where q0=p and F={R} to DFA. (CO1, Apply, LOT)

| State | a | b |
|---|---|---|
| p | {p} | {p,q} |

| | | |
|---|---|---|
| **q** | **{r}** | **{r}** |
| **r** | **{q}** | **{q}** |

3. Give the transition diagram for the given NFA M= {Q, ∑, 8, q0, F} where Q = {a, b, c, d} q0= a and f={d}. Find whether the string 100101 will be accepted by it or not. Also convert the given NFA to DFA. (CO1, Analyze, HOT)

| State | Input-0 | Input -1 |
|---|---|---|
| a | {b,d} | {c,d} |
| b | {b} | {d} |
| c | {d} | {c} |
| d | - | - |

4. Explain mealy machine with its components. Convert given Moore machine to Mealy machine. (CO1, Understand, LOT).

| State | Input | | output |
|---|---|---|---|
| | a | b | |
| A | A | B | 0 |
| B | B | B | 1 |

5. Convert NDFA {{P, Q, R, Q1, R1, R2, S}, {a, ε}, P, {Q, R}} with ε-moves to DFA and explain steps. (CO1, Analyze, HOT)

6. Minimize the given DFA (CO1, Apply, LOT)

| | a | ε |
|---|---|---|
| →P | - | {Q, R} |
| Q | Q1 | - |
| R | R1 | S |
| Q1 | Q | - |
| R1 | R2 | - |
| R2 | R | - |

| | | |
|---|---|---|
| S | - | - |

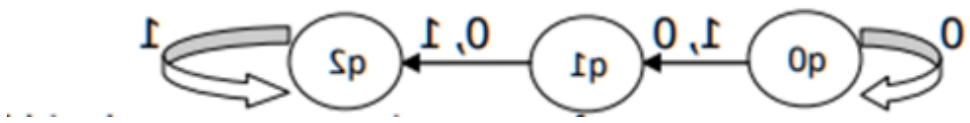
| δ | a | b |
|---|---|---|
| A | B | A |
| B | A | C |
| C | D | B |
| D | D | A |
| E | D | F |

**Section B (20 marks)**

7. Explain Mealy and Moore machine with its components. Convert the given Mealy machine to Moore machine. (CO1, Apply, LOT)

| | Input=0 | | Input=1 | |
|---|---|---|---|---|
| Present State | Next State | Output | Next State | Output |
| q0 | q1 | 0 | q2 | 0 |
| q1 | q1 | 0 | q2 | 1 |
| q2 | q1 | 1 | q2 | 0 |

8. Explain Finite Automata. Classify different types of FA. Convert the following NDFA to DFA. (CO1, Analyze, HOT)




**UNIT II**

**Section A (10 marks)**

9. Explain algebraic laws of regular expression, (CO2, Understand, LOT)

10. Construct the DFA for the regular expression (a +b) $^{*}$aa (b+a)$^{*}$. (CO2, Apply, LOT)

11. Explain Arden's theorem and prove it. (CO2, Understand, LOT)

12. Write a note on pumping lemma for Regular languages. (CO2, Understand, LOT)

13. Design a DFA for strings having a) even number of 0s and odd number of 1s. b) even number of 0s and even numbers of 1s (CO2, Apply, LOT)

14. Convert the following regular expression into a DFA: (0+1) * 01. (CO2, Evalaute, HOT)

15. Design a FA from given regular expression 10 + (0 + 11)0* 1. (CO2, Evaluate, HOT)

**Section B (20 marks)**

16. Design following DFA: [CO2] [Unit-II] [Evaluate, HOT]

    (a)That will accepts set of all string over {0, 1} of length 2.

    (b)That will accepts set of all string over {0,1} with three consecutives '0'.

    (c)That will accepts set of all string over {0,1} which ends with 1.

    (d)That will accepts set of all string over {0,1} which contains 0.

    (e)That will accepts set of all string over {0,1} which ends with 11.

**UNIT III**

17. Explain Chomsky hierarchy of grammars with their recognizers as well as the form of production rules. (CO3, Understand, LOT)

18. Convert the CFG with the following productions into CNF. (CO3, Apply, LOT)

    S→ AACD, A→ aAb | Λ, C → aC | a, D→ aDa | bDb | Λ

19. Explain ambiguity in Context Free Grammar with proper example. (CO3, Understand, LOT)

20. Describe ambiguous grammar. Show that the following grammar is

    Ambiguous S →aSbS| bSaS| Ɛ for the string abab. Draw the parse tree. (CO3, Analyze, HOT)

21. Convert the CFG with the following production into GNF. (CO3, Evaluate, HOT)

    S→AB, A→ BSB, A→ BB, B→ aAb, B →a, A→ b

22. Convert the CFG with the following productions into CNF. CO3, Evaluate, HOT)

S→ AACD, A→ aAb | Λ, C → aC | a, D→ aDa | bDb | Λ

23. Convert the given CFG into GNF S->AB, A->BS|1, B->SA|0. (CO3, Apply, LOT)

24. Explain left recursion with an example. Eliminate left recursion from the given grammar (CO3, Apply, LOT)

S→ Sa | Sb | c | d

25. Write down the closure properties of Context Free Languages. [CO3] [Unit-III] [Understand, LOT]

**Section B (20 marks)**

26. Classify Chomsky normal form and explain with suitable examples. (CO3, Analyze, HOT)

27. Explain a) Reduced grammar b) Epsilon production c) Unit productions.

Convert the following grammar into an equivalent grammar without ε-productions and unit productions, (CO3, Apply, LOT)

S→ A| €

A→B| a

B→ b | | €

**UNIT IV**

**28.** Design a Pushdown Automaton for the language $L = \{a^n b^n \mid n \geq 1\}$. Draw the state transition diagram and explain the stack operations. (CO4, Evaluate, HOT)

29. Explain Pushdown automata with its components. Differentiate between DPDA and NPDA. (CO4, Understand, LOT)

30. Explain the block diagram of Pushdown Automata with its components, specification, language and transition table. (CO4, Understand, LOT)

**Section B (20 marks)**

31. Construct a PDA equivalent to the following context free grammar S→ 0BB, B →0S| 1S|0. Test whether 010000 is accepted by PDA. (C04. Evaluate, HOT)

**UNIT V**

32. Write short notes on a) NP completeness b) Cook's Theorem (CO5, Understand. LOT)

33. Explain the halting problem of Turing machine. (CO5, Understand, LOT)

34. Design a Turing Machine to check whether a given string is a palindrome over {0,1}. Draw the state transition diagram. (CO5, Evaluate, HOT)

35. Classify different types of Turing machine. (CO5, Analyze, HOT)

36. Explain briefly about P, NP, NP-Hard and NP-Complete problems with examples. (CO5, Understand, LOT)

**Section B (20 marks)**

37.Write short notes on (C05, Understand, LOT)

a) Rice Theorem

b) Halting problem

38. Construct a Turing machine that recognize the language $\{1^n 2^n 3^n \mid n>=1\}$. Give a graphical representation for the obtained TM. (CO5, Evaluate, HOT)

## Summary Sheet

**CO Wise**

| CO | Q. No | Marks |
|---|---|---|
| CO1 | Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8 | 100 |
| CO2 | Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16 | 90 |
| CO3 | Q17, Q18, Q19, Q20, Q21, Q22, Q23, Q24, Q25, Q26, Q27 | 130 |
| CO4 | Q28, Q29, Q30, Q31 | 50 |
| CO5 | Q32, Q33, Q34, Q35, Q36, Q37, Q38 | 90 |
| **Total** | | **460** |

**Unit Wise**

| Unit | Q. No | Marks |
|---|---|---|
| Unit 1 | Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8 | 100 |
| Unit 2 | Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16 | 90 |
| Unit 3 | Q17, Q18, Q19, Q20, Q21, Q22, Q23, Q24, Q25, Q26, Q27 | 130 |

| | | |
|---|---|---|
| Unit 4 | Q28, Q29, Q30, Q31 | 50 |
| Unit 5 | , Q32, Q33, Q34, Q35, Q36, Q37, Q38 | 90 |
| **Total** | | **460** |

**Blooms Taxonomy Level (BTL) Wise**

| **BTL** | **Q. No** | **Marks** |
|---|---|---|
| LOT | Q1, Q2, Q4, Q5, Q6, Q7, Q9, Q10, Q11, Q12, Q13, Q17, Q18, Q19, Q23, Q24,Q25, Q27, Q29, Q30, Q32, Q33, Q36, Q37 | 270 |
| HOT | Q3, Q5, Q8, Q14, Q15, Q16, Q20, Q21, Q22, Q26, Q28, Q31, Q34, Q35, Q38 | 190 |
| **Total** | | **460** |

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**Disclaimer: -**This is a Practice set. The Question in End term examination will differ from the Practice set. This Practice set is meant for practice only.