Exam Date & Time: 26-Jun-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

FOURTH SEMESTER B.TECH. DEGREE EXAMINATIONS - JUNE 2024
SUBJECT: CSE 2221/CSE_2221 - FORMAL LANGUAGES AND AUTOMATA THEORY
(COMPUTER SCIENCE AND ENGINEERING - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING / COMPUTER SCIENCE / COMPUTER SCIENCE AND ENGINEERING - CYBER SECURITY)

FORMAL LANGUAGES AND AUTOMATA THEORY [CSE 2221]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

1A) Transform the given Languages into equivalent Grammars
i) L = { $a^n b^{n+2}$ | n ≥ 0} with only one variable and ∑ ={a, b}
ii) L = { $a^{3n} b^n$ | n ≥ 1} with exactly 1 variable and ∑ ={a, b}
iii)L ={ $a^m b^n$ | m ≥ n, n ≥ 0} with exactly 2 variables ∑= { a, b} (3)

1B) i) Construct a DFA with exactly 3 states, which accepts set of all strings with over ∑ ={a, b} such that second symbol from RHS is 'a'.
ii) Construct a DFA which accepts set of all strings with
L ={ a^n | n ≥ 1, n ≠ 3} with ∑ ={a} (3)

1C) Construct a NPDA for accepting the language L = {$a^n b^m c^n$ | m,n>=1}
Explain the logic used in constructing the NPDA. Give the instantaneous representation of the NPDA (4)

2A) Describe the seven-tuple definition of a Turing Machine. What is a Non-deterministic Turing Machine? (2)

2B) i) Discuss the RE for the languages over Σ ={a,b}
{ w ∈ Σ* | w contains exactly one double letter }
ii) Draw a NFA for the RE (a+ba*)a* (4)

2C) i) Formally define a regular grammar that generates the language on Σ = {x, y} consisting of all strings with no more than three y's.
ii) Construct a NFA N from the grammar G= ({S, T, U}, {a, b}, S, P), where P is: S → a | b | aT | aU | bT | bU , T → a , U → b (4)

3A) i) Convert the given CFG to Greibach Normal Form. (4)
S → aA | aBB
A → aAA | λ
B → bB | bbC
C → B
ii) Let G be S → aS | Sa | a . Show that L is ambiguous. Can there be an unambiguous

grammar for G?

3B) Remove useless productions from the grammar. (3)

S→ aaA| Bb| C
A→ bB| AB| aA| λ
B→ bb| A| λ
C→ b| Bb

3C) Find S grammar for the regular expression (aaa*b+b) (3)

4A) Prove that the language L = {a^n: n is a prime number} is not context-free using Pumping Lemma. (3)

4B) Let a CFG with the following production rules. (3)

S → aA
A → aABC |bB| a
B → b
C → c

Using CFG to PDA conversion procedure, obtain the corresponding PDA with a transition diagram for the above CFG. Test whether "aaabc" is acceptable by this PDA.

4C) Design a Turing Machine with a transition diagram to accept a string *w* of 0's and 1's such that the number of 0's in *w* is equal to number of 1's in *w*. Show that the Turing machine accepts some valid input. (4)

5A) Let two positive integers A and B represented in unary. With a transition diagram design a Turing Machine which will replace the separator "0" with a "1" and the other current tape contents with "Blank" symbols, if A > B. Write instantaneous description (ID) for the string "1111011". (4)

5B) Explain the defining properties of context-sensitive grammars and discuss their role in the Chomsky hierarchy of formal languages. (3)

5C) Discuss the significance of the Post Correspondence Problem (PCP) in the context of algorithmic computation. With an example show that the Post correspondence problem is undecidable. (3)

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