Question Paper

MANIPAL ACADEMY OF HIGHER EDUCATION

FOURTH SEMESTER B.TECH. DEGREE EXAMINATIONS - APRIL / MAY 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)
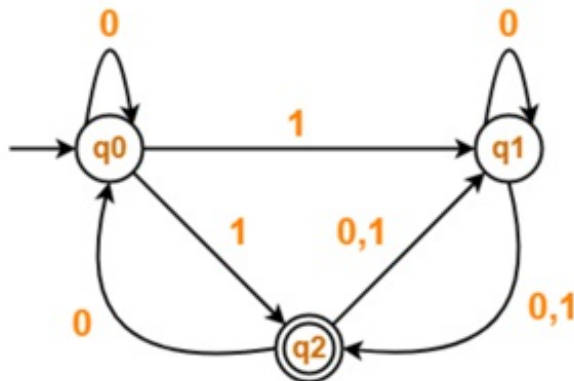
Marks: 50   **Duration: 180 mins.**

Answer all the questions.

1A) | Design a DFA with a transition diagram to accept the following language, | (3)
$L = \{ab^4 wb^2 : w \in (a, b)^*\}.$

1B) | Construct the equivalent DFA for the following NFA | (3)

1C) | Design a PDA with a transition diagram to accept the following language, | (4)

$$L = \{a^i b^j c^k \mid i, j, k \geq 0, i=j \text{ or } j=k\}.$$

Show whether the obtained PDA is deterministic or non-deterministic.

2A) | Describe with a diagram the Standard Turing Machine. Then show the situations of the tape before and after the move $\delta(q_0, a) = (q_1, d, R)$ | (2)

2B) | i) Describe the RE for the languages over $\Sigma = \{a,b\}$ | (4)
a. $\{ w \in \Sigma^* \mid w$ has exactly one pair of consecutive a$\}$
b. $\{ w \in \Sigma^* \mid w$ does not end with a pair of consecutive letter$\}$

ii) Draw a NFA for the RE $((aa)^*+bb^*)^*$

2C) | i) Construct an automaton that accepts the language generated by the grammar. | (4)
S → abA
A → baB
B → aA | bb

ii) Check whether the given grammar is ambiguous or not by using parse trees for the generation of the string aabbccdd

S → AB / C
A → aAb / ab
B → cBd / cd
C → aCd / aDd
D → bDc / bc

3A) Consider the grammar G whose productions are: (3)
S->aAS | A
A->SbA | SS | ba
Show that S=>*aabbaa and construct a derivation tree whose yield is aabbaa.

3B) Find a grammar in CNF that is equivalent to the following grammar (The only variable here is S): (3)
S-> ~S | [S⊃)] | p | q

3C) Design a PDA for accepting a language $\{a^nb^{2n} \mid n>=1\}$ with a transition diagram. Specify the (4)
corresponding 7 tuple specification.

4A) Find the S grammar to generate the language $L = \{a^mb^n|n>=1\}$ (3)

4B) Show that the language $L=\{ww:w \in \{a,b\}^*\}$ is not context free using pumping lemma. (3)

4C) Design a Turing Machine using transition function to accept a language $L= \{a^nb^m : n<m\}$ (4)
where the tape will have a, and b as the only input symbols.

5A) Design a transducer with 5 states using transition diagram to generate ww^R from w, where (4)
$w \in \{a,b\}^+$. Show the computation of the string ab in the transducer, which after processing will
contain abba.

5B) Discuss the automata, grammar, and the associated languages with appropriate examples at each (3)
level of the Chomsky Hierarchy.

5C) Elaborate on the Enumeration procedure with reference to universal Turing Machine. Discuss the (3)
relationship between enumeration procedures and Turing machines with respect to countability

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