BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSC **SEMESTER : V**
BRANCH: MATHEMATICS **SESSION : MO/2023**

SUBJECT: CS310 FORMAL LANGUAGES AND AUTOMATA THEORY

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Show that the language $L = \{awa: w \in \{a, b\}^*\}$ is regular. Further, show that L^2 is also regular. Also write an explicit expression for L^2 in terms of set notations.	[5]	CO1	4
Q.1(b)	Define an NFA. How it is different from its deterministic counterpart? Find an NFA with four states for the language $L = \{a^n: n >= 0\} \cup \{b^n a: n >= 1\}$.	[5]	CO1	1, 3
Q.2(a)	For $\Sigma = \{0, 1\}$, give a regular expression r such that $L(r) = \{w \in \Sigma^*: w$ has at least one pair of consecutive zeros$\}$. Also find a regular expression for the language $L = \{w \in \{0, 1\}^*: w$ has no pair of consecutive zeros$\}$.	[5]	CO2	3
Q.2(b)	If L_1 and L_2 are regular languages, then show that $L_1 \cup L_2$ and $L_1 \cap L_2$ are also regular.	[5]	CO2	4
Q.3(a)	Discuss the differences between linear and non-linear grammars. Specify the language for the grammar S→aSb | SS | λ.	[5]	CO3	2, 3
Q.3(b)	Eliminate the useless symbols and productions from G = (V, T, S, P), where V = {S, A, B, C} and T = {a, b}, with P consisting of S → aS | A | C, A → a, B → aa, C → aCb.	[5]	CO3	3
Q.4(a)	Give a schematic representation of a pushdown automata. Construct an npda for the language $L = \{w \in \{a, b\}^*: n_a(w) = n_b(w)\}$.	[5]	CO4	1, 3
Q.4(b)	Show that the family of context-free languages is closed under UNION and CONCATENATION operations.	[5]	CO4	4
Q.5(a)	Draw a diagram giving an intuitive visualization of a Turing machine. Construct a Turing machine which, for a given instance, does not halt. In analogy with programming terminology, we say that the Turing machine is in an infinite loop.	[5]	CO5	1, 3
Q.5(b)	Design a Turing machine that accepts $L = \{a^n b^n c^n: n>=1\}$.	[5]	CO5	3

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