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PES University, Bangalore
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UE17CS204

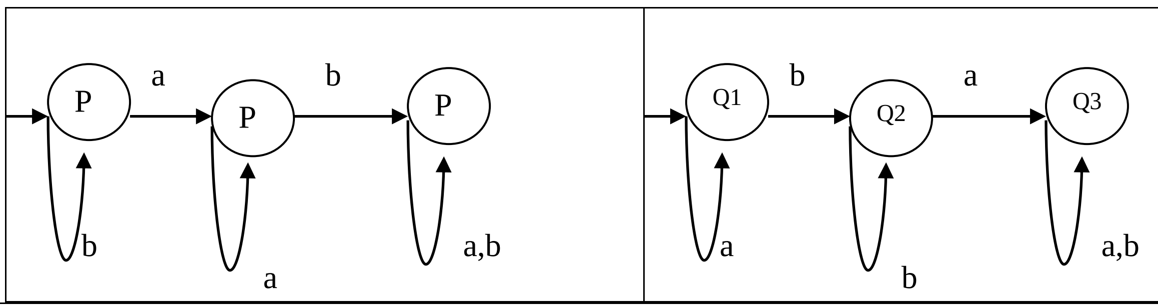
END SEMESTER ASSESSMENT (ESA) B. TECH IV SEMESTER- MAY 2020

UE18CS254 – Theory Of Computation

Time: 3 Hrs	Answer All Questions	Max Marks: 100

Note: All answers must be precise and to the point.

1.	a)	Consider a problem of designing a machine (or a "computer") that controls a toll gate. When a car arrives at the toll gate, the gate is closed. The gate opens as soon as the driver has paid coins worth `25. We assume that we have only three coin denominations: `5, `10, and `25. We also assume that no excess change is returned. After having arrived at the toll gate, the driver inserts a sequence of coins into the machine. At any moment, the machine has to decide whether or not to open the gate, i.e., whether or not the driver has inserted the coins worth `25 (or more). Observe that this machine has a property that it only needs to remember which state it is in at any given time. Draw a DFA for depicting the behavior of the machine for ∑ = {5, 10, 25}. Assume that initial state is q0. In this state the car arrives at the toll gate and the machine has not collected any money yet.	10
	b)	Construct the product of the following two DFAs that accepts the intersection of the languages of the two DFAs.	10



2	a)	Consider the language L over the alphabet ∑ = {3, 5} of all words for which the arithmetic sum of the constituent symbols is divisible by 5. For example, ε ∈ L since 0 is divisible by 5), 555 ∈ L (5 + 5 + 5 = 15 which is divisible by 5), and 335333 ∈ L (3 + 3 + 5 + 3 + 3 + 3 = 20 which is divisible by 5), but not 333 Is L a regular language or not? If it is, construct a DFA A such that L(A) = L. If L is not a regular language, prove this by using the pumping lemma for regular languages.	13
	b)	Let ∑ =(a,b). Let double be the function from ∑* to ∑* that doubles each character in a string. For example, double(baaba) = bbaaaabbaa. For the definition of double, say true or false for the following statements.	7

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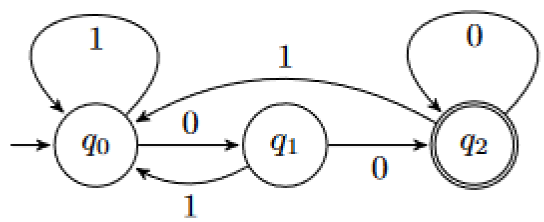
		i. If L is a regular language over $\sum$, then double(L) is regular. ii. If L is a finite language over $\sum$, then double(L) is finite. iii. If L $\subseteq$ $\sum^*$ is not regular, then double(L) is not regular. iv. If L1 and L2 are regular languages over $\sum$, then L1$\cup$ L2 is regular. v. If L1 and L2 are finite languages over $\sum$, then L1 $\cup$ L2 is finite. vi. If L1 $\subseteq \sum^*$ and L2 $\subseteq \sum^*$are not regular, then L1 $\cup$ L2 is not regular. vii. double($\mathcal{E}$) = $\mathcal{E}$	
3.	a)	Construct a context-free grammar for the following DFA: 	7
	b)	Show that the grammar ({S},{a,b},R,S) with rules R=S$\rightarrow$aS|aSbS|ϵ is ambiguous.	6
	c)	What is wrong with the following "proof" that $a^n b^{2n} a^n$ is context free? Step1: Both $\{a^n b^n: n>=0\}$ and $\{b^n a^n:n>=0\}$ are context free Step2: $a^n b^{2n} a^n=\{a^n b^n\}\{b^n a^n\}$ Step3: since the context free languages are closed under concatenation, $a^n b^{2n} a^n$ is context free	7
4.	a)	Give a grammar in Chomsky Normal Form that generates the same language as the grammar G= (V,Σ,R,S) with V={S,X,Y}, Σ ={a,b,c}, and R being the following set of rules: $S \rightarrow XY$ $X \rightarrow abb \mid aXb \mid \epsilon$ $Y \rightarrow c \mid cY$	13
	b)	Use the pumping lemma to prove the following language is not CFL $\{ww^R w \mid w \in \{a,b\}^*\}$	7
5.	a)	Design a Standard Turing Machine with Σ={a,b} that accepts the language L $L=\{a^{2i}b^i \mid i>=0\}$	11
	b)	State ***true or false*** for the following statements: i. A Turing machine has a single start state, but may have many accept states. ii. It is possible to make a Turing machine with only one state. iii. A Turing machine halts when its head reaches the end of its input iv. All decidable languages are regular languages. v. A nondeterministic TM can recognize more languages than a deterministic TM.	5
	c)	Classify each of the following problems as either	4

		(D) decidable, (R) recognizable but not decidable, (U) not recognizable A. {<M> | M is a Turing machine that accepts at least 42 different strings}. B. {<M> | M is a Turing Machine that has at least 42 states}. C. {<M> | M is a Turing Machine that runs for at least 42 steps when started with a blank input tape}. D. {<M> | L (M) is recognized by a Turing Machine that has an even number of states}.	