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PES UNIVERSITY, BENGALURU

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UE15CS254

MAY 2017: END SEMESTER ASSESSMENT (ESA) B.TECH. IV SEMESTER

UE15CS254–THEORY OF COMPUTATION

TIME: **3 HRS.** **ANSWER ALL QUESTIONS** MAX MARKS:**100**

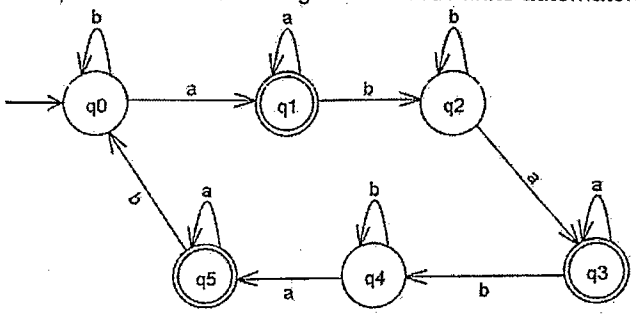
1. a) Define the following terms: 04
   i. Regular language
   ii. Extended transition function for a non–deterministic finite automaton

   b) Construct a deterministic finite automaton that accepts the following language over the alphabet {a, b} where $L = \{ba^2wab^2: w \in (a, b)^*\}$. 04

   c) Convert the following non–deterministic finite automaton to its equivalent deterministic finite automaton by clearly showing the subset construction method. 06

State	Input = 0	Input = 1	Input = 2	λ
→ q_0	{ }	$\{q_1\}$	$\{q_2\}$	$\{q_1, q_2\}$
q_1	$\{q_0\}$	$\{q_2\}$	$\{q_0, q_1\}$	{ }
*q_2	{ }	{ }	{ }	{ }

   d) Using table filling algorithm, minimize the following deterministic finite automaton: 06



2. a) Construct regular expressions for the following languages: 08
   i. Even binary numbers without leading zeros
   ii. $L = \{a^nb^m: (n + m) \text{ is odd}\}$
   iii. $L = \{a^nb^m: n \geq 3, m \text{ is odd}\}$
   iv. $L = \{vwv: v, w \in (a, b)^*. |v| = 2\}$

   b) Find a regular expression for the language $L = \{w \in \{a, b\}^*: n_a(w) \text{ is even } \& \ n_b(w) \text{ is odd}\}$. 08

   c) Show that the language of binary strings of even length having the same number of 0s in its two halves is not regular. 04

3. a) Show that the following language is ambiguous. 02
   $S \rightarrow aaS \mid aaaS \mid \lambda$

   b) Apply CYK algorithm to verify whether the string aaaabbb can be derived by the following grammar: 08
   $S \rightarrow AB$
   $A \rightarrow BB \mid a$
   $B \rightarrow AB \mid b$

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c) Convert the following grammar into CNF: 06
S → Aa | B | Ca
B → aB | b
C → Dd | D
D → E | d
E → ab

d) State the difference between GNF and S–grammar. Give an example where the grammar is in GNF but is not S–grammar. 04

4. a) Construct a PDA to accept the language $a^n b^m$, where m = n mod 3, n ≥ 0. How much stack memory is required to handle this language? 06

b) Discuss the steps involved in converting CFG to PDA & convert the following CFG to PDA. 10
S → aA | bB | cC, A → Sa, B → Sb, C → λ

c) What is the language accepted by the following PDA? 04
$\delta(q_0, b, Z) = (q_0, AZ)$
$\delta(q_0, b, A) = (q_0, AA)$
$\delta(q_0, n, Z) = (q_0, AZ)$
$\delta(q_0, n, A) = (q_0, AA)$
$\delta(q_0, a, A) = (q_0, \lambda)$
$\delta(q_0, \lambda, Z) = (q_1, Z)$
where q_0 is the initial state & q_1 is the final state.
Verify whether the string "**banana**" is accepted by the automaton or not.

5. a) Develop a Turing machine which finds the remainder of division of a given binary number by 2. Do not overwrite the given number. Put a separator between the given number and the remainder. 08

b) The following transitions define a Turing machine. 08
$\delta(q_0, 0) = (q_0, 0, R)$
$\delta(q_0, 1) = (q_1, 1, R)$
$\delta(q_1, 0) = (q_1, 0, R)$
$\delta(q_1, 1) = (q_0, 1, R)$
$\delta(q_0, Blank) = (q_2, \#, R)$
$\delta(q_1, Blank) = (q_3, \#, R)$
$\delta(q_2, Blank) = (q_4, 0, R)$
$\delta(q_3, Blank) = (q_4, 1, R)$
where q_0 is the initial state & q_4 is the final state.
What happens if the tape contains:
i) 10010
ii) 01011
What does the Turing machine do?

c) Define post correspondence problem (PCP) & solve PCP for the below given lists. 04

i.

	List A X_i	List B Y_i
1	11	111
2	100	001
3	111	11

ii.

	List A X_i	List B Y_i
1	110	110110
2	0011	00
3	0110	110

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