DHARMSINH DESAI UNIVERSITY, NADIAD
FACULTY OF TECHNOLOGY
B.TECH. SEMESTER V [Information Technology]
SUBJECT: (IT 511) Theory of Automata and Formal Language

Examination	: Third Sessional	Seat No.	:
Date	: 9/10/2017	Day	:Monday
Time	: : to :00	Max. Marks	: 36

INSTRUCTIONS:
1. Figures to the right indicate maximum marks for that question.
2. The symbols used carry their usual meanings.
3. Assume suitable data, if required & mention them clearly.
4. Draw neat sketches wherever necessary.

Q.1 Do as directed. [12]

(a) Turing machine is more powerful than: [01]
1) Finite automata 2) Push down automata 3) Both (1) and (2) 4) None of these

(b) Which of the following statement is wrong? [01]
1) A Turing machine(TM) cannot solve halting problem
2) Set of recursively enumerable language is closed under union
3) A finite state machine with 3 stacks is more powerful than finite state machine with 2 stacks
4) Context sensitive grammar can be recognized by a linearly bounded memory machine

(c) Context free language can be recognized by – [01]
1) Finite State Automaton 2) Linear bounded automaton
3) Pushdown automaton 4) Both 2 and 3

(d) Assume statements S1 and S2 defined as : [01]
S_1 : L_2-L_1 is recursive enumerable where L_2 and L_1 are recursive and recursive enumerable respectively.
S2 : The set of all Turing machines is countable.
Which of the following is true ?
1) S1 is correct and S2 is not correct. 2) Both S1 and S2 are correct.
3) Both S1 and S2 are not correct. 4) S1 is not correct and S2 is correct.

(e) Consider three decision problems P_1, P_2 and P_3. It is known that P_1 is decidable and P_2 is undecidable. Which one of the following is TRUE? [02]
1) P_3 is decidable if P_1 is reducible to P_3 2) P_3 is undecidable if P_3 is reducible to P_2
3) P_3 is undecidable if P_2 is reducible to P_3 4) P_3 is decidable if P_3 is reducible to P_2's complement

(f) Which of the following statements is/are FALSE? [02]
1) For every non-deterministic Turing machine, there exists an equivalent deterministic Turing machine.
2) Turing recognizable languages are closed under union and complementation.
3) Turing decidable languages are closed under intersection and complementation.
4) Turing recognizable languages are closed under union and intersection.
5) The halting problem for Turing machines is undecidable
6) determining whether a context-free grammar is ambiguous is un-decidable
7) Given two arbitrary context-free grammar, G_1 andG_2, it is undecidable if $L(G_1) = L(G_2)$
8) Given two regular grammars G_1 and G_2, it is undecidable whether $L(G_1) = L(G_2)$

(g) $L_1 = \{a^{n+m} b^n c^m | n, m \geq 0\}$ [02]
$L_2 = \{a^{n+m} b^{n+m} c^m | n, m \geq 0\}$
$L_3 = \{a^{n+m} b^{n+m} c^{m+n} | n, m \geq 0\}$
Which of these languages are not CF.
1) L_1 only 2) L_3 only 3) L_1 and L_2 4) L_2 and L_3

(h) Let L_1 be a regular language and L_2 a deterministic CFL. $L_3$is recursively enumerable but not recursive. Which one of the following statement is FALSE? [02]
1) $L_1 \cap L_2$ is a DCFL 2) $L_3 \cap L_1$ is recursive

3) $L_1 \cup L_2$ is context-free 4) $L_1 \cap L_2 \cap L_3$ is recursively enumerable

Q.2 Attempt any two from following

(a) Explain in detail all components of Chomsky hierarchy. [06]

(b) Write short note on : Universal Turing machine and other variations of TM. [06]

(c) If L is a CFL, then $\exists p$ (pumping length) such that $\forall z \in L$, if $|z| \geq p$ then $\exists u, v, w, x, y$ such [01 + 05]

that $z = uvwxy$ and

1. $|vwx| \leq p$ 2. $|vx| > 0$ 3. $\forall i \geq 0$, $uv^iwx^iy \in L$.

What is the above theorem popularly known as ?
Use it to prove the following language is non context free.
$L=\{a^ib^jc^id^j \mid i,j>=0\}$. Assume $z = a^pb^pc^pd^p$ belongs to L ,to prove your claim.

Q-3 (a) Consider TM depicted in Figure1 and answer following questions with reference to it :-
In figure1, "B" indicates Blank symbol on tape.

1) Give the informal working logic of Turing machine. [02]
2) Is given TM Decider? Justify. [02]
3) What is the corresponding language used by TM? [02]
4) Give trace of the machine on appropriate input. [02]

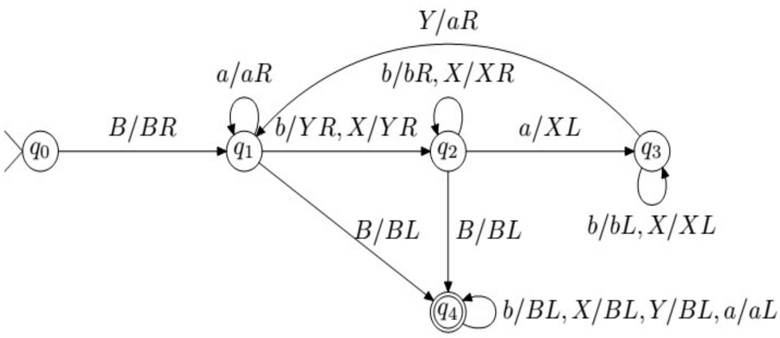

Figure 1

(b) Explain with example any one Undecidable problem. [04]

OR

Q.3

(a) How to find time complexity of Turing machine? Explain with example. [04]

(b)
Consider TM designed as follows-
$Q = \{q_0, q_1, q_2, q_3, q_f\}$ where q_0 is the start state and q_f the only final state.
$\Sigma = \{1\}$ $\Gamma = \{1, \dot{1}, \square\}$ where $\square$ is the blank tape symbol, and δ is defined as follows:

$\delta(q_0, 1) = (q_0, 1, R)$ $\delta(q_1, 1) = (q_2, 1, R)$

$\delta(q_0, \square) = (q_1, \square, L)$ $\delta(q_2, 1) = (q_2, 1, R)$

$\delta(q_1, 1) = (q_1, 1, L)$, $\delta(q_2, \square) = (q_3, 1, R)$

$\delta(q_3, \square) = (q_1, 1, L)$ $\delta(q_1, \square) = (q_f, \square, R)$

1) Give the pictorial representation of above TM. [02]
2) Explain the informal logic of above Turing machine. [03]
3) Show trace on some appropriate input string. [03]