Indian Institute of Engineering Science and Technology, Shibpur
Department of Computer Science and Technology
Dual Degree (B.Tech & M. Tech.) 4th Semester End-Term Examination, April 2016
Theory of Computation (CS 404)

Full Marks: 70

Time: 3 hours

- Attempt all the questions.

- Answers should be **brief, to the point** and in your own words as far as practicable.

- Make your own assumptions as and when necessary and state them at proper places.

1. Justify the truth or falsity of **any four** of the following statements.

   (a) Intersection of two context free languages may also be context free.

   (b) Every context-free grammar is also an unrestricted grammar.

   (c) A context free language can never be a proper subset of a regular language.

   (d) Nondeterministic Finite automaton is a special case of Push-Down Automaton.

   (e) There are uncountably infinite number of Turing Machines.

   $[4 \times 4]$

2. Construct Context-Free grammar for **any four** of the following languages.

   (a) $\{a^i b^j c^k \mid j = i + k\}$

   (b) $\{a^i b^j c^k \mid j \neq i + k\}$

   (c) $\{a^i b^j c^k \mid i = j \text{ or } i = k\}$

   (d) $\{a^i b^j c^k d^l \mid i + j = k + l\}$

   (e) $\{a^m b^n : n \leq m \leq 2n\}$

   $[4 \times 4]$

3. (a) Formally define the concepts of Context Free Grammar G, the *Derives in One Step* relation under G and the *Language generated by G*.

   (b) Show that each context free language (that is, the language generated by a context-free grammar) is accepted by some pushdown automaton.

   (c) Let $G = (V, \Sigma, R, S)$ be a grammar with $V = \{S, a, b, c\}$, $\Sigma = \{a, b, c\}$, $R = \{S \to aSa, S \to bSb, S \to c\}$. Construct a pushdown automata accepting the language $L(G)$ following the policy you have proposed for part (b) above.

   $[4+8+4]$

4. Formally substantiate **any two** of the following statements.

   (a) There exists a regular expression R for every Deterministic Finite Automaton M such that $L(R) = L(M)$.

   (b) All the initial functions in the context of Primitive Recursive Functions are Turing Computable.

   (c) Every Computations by a Turing Machine M can be *simulated* by a suitably constructed grammar G.

   $[8+8]$

5. Write short notes on **any two** of the following.

   (a) Universal Turing Machine

   (b) Grammar computing Function

   (c) Nondeterministic Turing Machine

   $[2 \times 3]$