Module III

10. a) Let h be a homomorphism $h(a) = 01$, $h(b) = 0$.
    i) Find $h^{-1}(L_1)$, where $L_1 = (10+1)^*$
    ii) Find $h(L_2)$, where $L_2 = (a+b)^*$
    iii) Find $h^{-1}(L_3)$, where L_3 is the set of all strings of 0's and 1's with an equal number of 0's and 1's.

    b) Find the Greibach normal form grammar equivalent to the following CFG:
    $S \rightarrow AA \mid 0$
    $A \rightarrow SS \mid 1$

11. a) Show that the following languages are not context free:
    i) $\{a^i b^j c^i d^j \mid i, j >= 1\}$
    ii) $\{a^i b^j c^k \mid i < j < k\}$

    b) Give a CFG for the language N(M) where $M = (\{q_0, q_1\}, \{0, 1\}, \{Z_0, X\}, \delta, q_0, Z_0, \phi)$ and δ is given by $\delta(q_0, 1, Z_0) = \{(q_0, XZ_0)\}$, $\delta(q_0, \epsilon, Z_0) = \{(q_0, \epsilon)\}$, $\delta(q_0, 1, X) = \{(q_0, XX)\}$, $\delta(q_1, 1, X) = \{(q_1, \epsilon)\}$, $\delta(q_0, 0, X) = \{(q_1, X)\}$, $\delta(q_1, 0, Z_0) = \{(q_0, Z_0)\}$

Module IV

12. a) Write notes on the following:
    i) recursive and recursively enumerable languages
    ii) Chruch's hypothesis
    iii) decidable and undecidable problems
    iv) Turing machine with multiple tracks

    b) Design the Turing machine to recognize the following language:
    $\{0^n 1^n 0^n \mid n >= 1\}$

13. a) Design a Turing machine to implement multiplication function.

    b) Explain the variants of Turing machines.

(4 x 20 = 80 marks)