M.A./M.Sc. Examination, 2017
Semester-IV
Mathematics
Course: MMO-41 (A3/P3)
(Theory of Computation-II)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

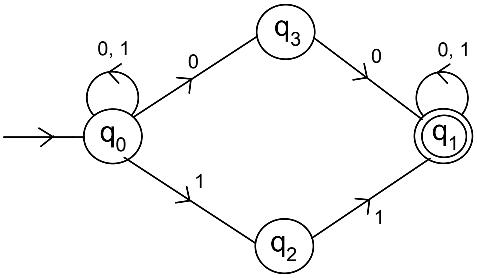
Answer ***any four*** questions

1. a) Define a grammar G for a language L.
Consider a grammar $G=\langle \{S, A\}, \{0, 1, 2\}, P, S\rangle$,
where $P=\{S\to 0SA2, S\to 012, 2A\to A2, 1A\to 11\}$.
Find $L(G)$, the language generated by G. 1+3

   b) Construct a grammar generating $L=\left\{a^i b^n c^n \mid n\geq 1; i\geq 0\right\}$. 3

   c) Define a regular set. Show that the language $L=\left\{a^i b^i \mid i\geq 1\right\}$ is not regular. 1+2

2. a) Define a regular expression. Show that every regular expression corresponds to a transition system. Design a transition system for the regular expression $(0+1)^* 100$. Construct a regular expression corresponding to the transition system 1+2+1+2



   b) Construct a minimum state deterministic finite automation equivalent to the regular expression $(0+1)^*(00+11)$. 4

3. Describe a pushdown automaton using instantaneous description. State the move operation of a pushdown automaton. Define acceptance of a tape by final state. Construct a pushdown automation A accepting $L=\left\{wcw^T / w\in\{a, b\}^*\right\}$ by final state. 3+1+1+5

4. Define parsing of words. Describe Top-down parsing. For the grammar $G=\langle\{S, A, B\},\{a, b\}, P, S\rangle$ where P consists of

$$\begin{aligned} &\left\{\begin{array}{l} S\to aAB, \\ S\to bBA, \end{array}\right. \\ &A\to bS, \\ &A\to a, \\ &\left.\begin{array}{l} B\to aS, \\ B\to b \end{array}\right\}, \end{aligned}$$

construct a deterministic pushdown automation accepting $L(G)$. Find a left-most derivation of *abbab* (write down the parse table). 1+2+5+2

P.T.O.

5. a) Describe a Turing machine using instantaneous descriptions. Briefly discuss the move operation for a Turing machine. The transition function of a Turing machine is given in the following table:

present state	**Tape symbols**				
	0	1	x	y	b
$\rightarrow q_1$	xRq_2	—	—	—	bRq_5
q_2	$0Rq_2$	yLq_3	—	yRq_2	—
q_3	$0Lq_4$	—	xRq_5	yLq_3	—
q_4	$0Lq_4$	—	xRq_1	—	—
q_5	—	—	—	yRq_5	bRq_6
$\textcircled{q_6}$	—	—	—	—	—

Compute $w_1 = 0011;\ w_2 = 011.$ 3+1+2

b) Design a Turing machine that recognize the language $L = \left\{ a^n b^n c^n \middle| n \geq 1 \right\}.$ 4

6. Define primitive and partial recursive functions over $\mathbb{N}$. Show that $f(x, y) = x^y$ is primitive recursive. Construct a Turing machine to compute the projection function U_i^m. Hence compute $U_2^3(1, 2, 1)$. 1+1+2+5+1