M.A./M.Sc. Examination, 2019
Semester-IV
Mathematics
Optional Course: MMO-41
(New Syllabus-P10/A12) and (Old Syllabus-P03)
(Theory of Computation-II)

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

Questions are of value as indicated in the margin.

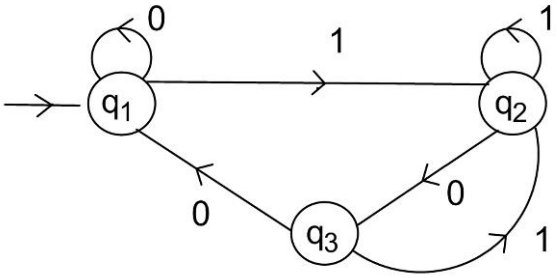
Answer ***any four*** questions

1. a) Define a phrase-structure grammar G. Define $L(G)$, language generated by G. If $G=\langle\{S\},\{a,b\},\{S\to aS\mid bS\mid a\mid b\},S\rangle$, find $L(G)$. Construct a grammar G generating language $L(G)=\{a^n b^n e^i \mid n\geq 1, i\geq 0\}$. 1+1+1+2

   b) Define type-1 and type-2 rules in connection with context sensitive language (CSL) and Context Free Language (CFL) respectively. Show that $L(CSL)\supseteq L(CFL)$. 1+1+3

2. a) Define regular expression and valuation of regular expression. Show that every regular expression corresponds to a transition system. 1+1+2

   b) Construct a regular expression whose state diagram is given by 3



   b) Construct a deterministic finite automaton corresponding to the regular expression $(a^*\mid b^*)ab$. 3

3. a) Define a Context-Free Grammar (CFG). Find an equivalent reduced grammar corresponding to $G=\langle\{S,A,B,C\},\{a,b\},P,S\rangle$

   where $P=\{S\to AB\mid CA, B\to BC\mid AB, A\to a, C\to aB\mid b\}$. 1+3

   b) Define a push-down automaton. Construct a deterministic push-down automaton accepting the language generated by a CFG, $G=\langle\{S,A,B,C\},\{a,b,c\},P,S\rangle$

   where $P=\{S\to AB, A\to Ca, B\to Ba\mid Cb\mid b, C\to cb\mid b\}$. 1+5

4. What is parsing? Construct a top-down parser for the grammar of arithmetic expressions involving + and * generated by the production rules

   $E\to E+T\mid T$

   $T\to T*F\mid F$

   $F\to(E)\mid id$.

   Find a left-most derivation of $(id+id)*id$. 1+8+1

P.T.O.

5. a) Define a Turing machine. A Turing machine is described by the transition table

	$\not b$	O	1
q_1	$1Lq_2$	ORq_1	—
q_2	$\not bRq_3$	OLq_2	$1Lq_2$
q_3	—	$\not bRq_4$	$\not bRq_5$
q_4	ORq_5	ORq_4	$1Rq_4$
q_5	OLq_2	—	—

write down the computation sequence of the input string $OO\not b$. 2+3

b) Design a Turing machine to recognize the language $\left\{1^n 2^n 3^n \mid n \geq 1\right\}$. 5

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

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