ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2007

FORMAL LANGUAGE AND AUTOMATA THEORY

SEMESTER – 4

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct choices for the following : $10 \times 1 = 10$

i) A solution to the equation $R = Q + RP$ is

a) $R = QP^*$ b) $Q = RP^*$

c) $P = RQ^*$ d) $R = PQ^*$.

ii) Which of the following sets is regular ?

a) $\{ a^t : t = n^2 , \ n >= 1 \}$ b) $\{ a^p : p \text{ is a prime} \}$

c) $\{ ww : w \text{ is in } \{ a, b \}^* \}$ d) $\{ a^{2n} : n >= 1 \}$.

iii) The value of $L (\phi^*)$ is

a) Σ b) $\{ \varepsilon \}$

c) $\{ \}$ d) none of these.

iv) The regular expression representing the set of all strings over $\{ x, y \}$ ending with xx beginning with y is

a) $xx (x + y)^* y$ b) $yy (x + y)^* x$

c) $y (x + y)^* xx$ d) $y (xy)^* xx$.

v) Pumping Lemma for CFL is used to show that

a) a given language is Regular

b) a given language is Context Free

c) a given language is Context Sensitive

d) a given languae is not Context Free.

vi) A grammar in CNF may contain productions like

a) $A \rightarrow B$ b) $A \rightarrow BC$

c) $A \rightarrow aB$ d) $A \rightarrow aBCD$.

vii) Palindromes cannot be recognized by any FSM because

a) an FSM cannot remember arbitrary, large amount of information

b) an FSM cannot deterministically fix the mid-point

c) even of the mid-point is known, an FSM cannot find whether the second half of the string matches the first half

d) all of these.

viii) The basic limitation of Finite State Machine is that

a) it cannot remember arbitrary large amount of information

b) it cannot recognize grammars that are regular

c) it sometimes recognize grammars that are not regular

d) all of these.

ix) Input sequence of an information lossless machine can be determined from the knowledge of

a) only output sequence

b) output sequence and initial state

c) output sequence, initial state and final state

d) initial state.

x) Regular expression $(a \mid b)(a \mid b)$ denotes the set

a) $\{ a, b, ab, aa \}$ b) $\{ a, b, ba, bb \}$

c) $\{ a, b \}$ d) $\{ aa, ab, ba, bb \}$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Show that $L = \{ 0^n 1^n \mid n \geq 1 \}$ is not regular.

3. Prove the following identity :

$r (s + t) = rs + rt.$

4. a) State Myhill-Nerode's Theorem. 2

b) Let R be an equivalence relation in $\{0\}^*$ with the following equivalence classes :

$$[\,]_R = \{0\}^0$$

$$[0]_R = \{0\}^1$$

$$[00]_R = \{0\}^2 \cup \{0\}^3 \cup \{0\}^4 \ldots\ldots\ldots\ldots$$

Show that R is a right invariant. 3

5. Construct a regular grammar G generating the regular set represented by

$$P = a^* b\ (a + b)^*$$

6. Convert the following context free grammar into an equivalent grammar in CNF.

$S \rightarrow aAbB$

$A \rightarrow abAB \mid aAA \mid a$

$B \rightarrow bBaA \mid bBB \mid b.$

GROUP – C

(Long Answer Type Questions)

Answer any *three* questions. $3 \times 15 = 45$

7. a) Find the equivalence partition for the machine shown in **Table-1**. Show a standard form of the corresponding reduced machine and find a minimum-length sequence that distinguishes state A from state E. 7

Table – 1

PS	NS, Z	
	X = 0	X = 1
A	B, 1	H, 1
B	F, 1	D, 1
C	D, 0	E, 1
D	C, 0	F, 1
E	D, 1	C, 1
F	C, 1	C, 1
G	C, 1	D, 1
H	C, 0	A, 1

b) For the incompletely specified machines shown in **Table-2** find a minimum-state reduced machine containing the original one. 8

Table – 2

PS	NS, Z	
	I_1	I_2
A	E, 0	B, 0
B	F, 0	A, 0
C	E, —	C, 0
D	F, 1	D, 0
E	C, 1	C, 0
F	D, —	B, 0

8. a) Define Pushdown Automata. 5

b) Construct an NPDA that accepts the language generated by the productions $S \rightarrow aSa \mid bSb \mid c$. Show an Instantaneous Description of this string *abcba* for this problem. 10

9. a) Design a 2-input 2-output Mealy machine, which takes as input a binary stream and generates an output of 1 only when a sequence of the pattern 01011 is found in the input stream. Design should be clearly justified. 7

b) From the Mealy machine above find the equivalent Moore machine. 4

c) Check whether the Mealy machine you obtained is a minimal one or not. Give proper justification to your answer. 4

10. a) For the following machine shown in **Table-3** determine whether or not it is lossless. If it is lossy, find the shortest output sequence produced by two different input sequences with the same initial and final states. If it is lossless, determine its order. 7

Table – 3

PS	NS, Z	
	X = 0	**X = 1**
A	A, 0	B, 0
B	C, 0	D, 0
C	D, 1	C, 1
D	B, 1	A, 1

b) Design a minimal inverse of the machine shown in **Table-4** : 8

Table – 4

PS	NS, Z	
	X = 0	X = 1
A	C, 0	D, 1
B	D, 0	C, 1
C	A, 0	B, 0
D	C, 1	D, 1

11. a) Construct a minimum state automaton equivalent to a given automaton *M* whose transition table is given below : 8

State	Input	
	a	b
→ q_0	q_0	q_3
q_1	q_2	q_5
q_2	q_3	q_4
q_3	q_0	q_5
q_4	q_0	q_6
q_5	q_1	q_4
(q_6)	q_1	q_3

b) Find the regular expression corresponding to the following figure : 7