## FORMAL LANGUAGE AND AUTOMATA THEORY

## CS 402

## Multiple Choice Type Questions

1. Choose the correct alternatives for any ten of the following:
i) $L=\left\{a^{n} b^{n} c^{n}\right.$, where $\left.n € 1\right\}$ is
a) regular
b) context free but not regular
c) context sensitive but not context free
d) none of these
ii) $\quad S->a A B C \mid a$
$A \rightarrow a A \mid B$
$B \rightarrow a B A \mid C$
$C->\lambda \mid a C$
The null-able variables for the above grammar are
a) $S, A, B, C$
b) $A, B$
c) $S, A, C$
d) $A, B, C$
iii) $\quad$ a solution to the equation $R=Q+R P$ is
a) $R=Q P^{*}$
b) $Q=R P^{*}$
c) $P=R Q^{*}$
d) $R=P Q^{*}$
iv) Which of the following is regular?
a) Strings of 0 's whose length is a perfect square
b) Strings of all palindromes made up of 0's \& 1's
c) Strings of 0 's, whose length is a prime number
d) Strings of odd number of zeroes
v) A grammar that produces more than one parse tree for some sentences is said to be
a) contiguous
c) unambiguous
b) ambiguous
d) regular
vi) Input sequence of a 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
vii) Merger table is a substitute of
a) Merger graph
c) Minimized machine
b) Compatible graph
d) Finite state machine
viii) DFA converted from an NFA with $n$ states can have maximum
a) $n$ states
b) n ! states
c) $2^{n}$ states
d) ${ }^{n} \mathrm{C}_{2}$
ix) Let $\mathrm{R}_{1}$ and $\mathrm{R}_{2}$ be regular sets defined over alphabet $\Sigma$ then
a) $R_{1} \cap R_{2}$ is not regular
b) $R_{1} \cup R_{2}$ is regular
c) $\quad \Sigma \cap R_{2}$ is not regular
d) $R_{2}{ }^{*}$ is not regular
x) The regular sets are closed under
a) Union
c) Kleene closure
b) Concatenation
d) all of these
xi) 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

## Short Answer Type Questions

2. Show that $L=\left\{0^{n} 1^{n} \mid n \geq 1\right\}$ is not regular.
3. a) What do you mean by a sub-tree of a derivation tree?
b) Consider $G$ whose productions are $S->a A S / a, A->S b A / S S / b a$. Show that $s->$ aabbaa by constructing a derivation tree, by right most derivation, whose yield is aabbaa.
4. What is the basic difference between Mealy machine and Moore machine? Construct a Mealy machine which is equivalent to the Moore machine given below:

| $P S$ | $N S$ |  | $z$ |
| :---: | :---: | :---: | :---: |
|  | $x=0$ | $x=1$ |  |
| $q_{0}$ | $q_{1}$ | $q_{2}$ | 1 |
| $q_{1}$ | $q_{3}$ | $q_{2}$ | 0 |
| $q_{2}$ | $q_{2}$ | $q_{1}$ | 1 |
| $q_{3}$ | $q_{0}$ | $q_{3}$ | 1 |

5. a) State pumping Lemma for regular language.
b) Using this Lemma prove that $I=\left\{a^{n} b^{n} \mid n \geq 1\right\}$ is not regular.
6. a) State Myhill-Nerode's Theorem.
b) Let R be an equivalence relation in $\{0\}^{*}$ with the following equivalence classes:

$$
\begin{aligned}
& {[]_{R}=\{0\}^{0}} \\
& {[0]_{R}=\{0\} 1} \\
& {[00]_{R}=\{0\}^{2} \cup\{0\}^{3} \cup\{0\}^{4} \ldots \ldots \ldots . .}
\end{aligned}
$$

Show that $R$ is a right invariant.
7. Is the following machine information lossless? If yes, find the order of losslessness.

| PS | $N S, z$ |  |
| :---: | :---: | :---: |
|  | $x=0$ | $x=1$ |
| A | A, 0 | B, 0 |
| B | C, 0 | D, 0 |
| C | D, 1 | C, 1 |
| D | B, 1 | A, 1 |

## Long Answer Type Questions

8. a) What do you mean by k-equivalent? Why any two final states are 0-equivalent and any two non-final states are 0-equivalent?
b) Construct the minimum state equivalent DFA for the following DFA.

c) Construct a regular grammar G generating the regular set represented by

$$
P=a^{*} b(a+b)^{*}
$$

9. a) Define Pushdown Automata.
b) Construct an NPDA that accepts the language generated by the productions $\mathrm{S}-\mathrm{a} \mathrm{aSa} \mid \mathrm{bSb} \| \mathrm{c}$. Show that an Instantaneous Description of this string abcba for this problem.
10. a) Prove that
$\left(1+00^{*} 1\right)+\left(1+00^{*} 1\right)\left(0+10^{*} 1\right)^{*}\left(0+10^{*} 1\right)=0 * 1\left(0+10^{*} 1\right)^{*}$
b) $S$-> AB; A ->a, B -> C|b, C $->D$; D $->E, E->a$
remove the unit production.
$L=\left\{a^{n} b^{n} \mid n \geq 0\right\}$. Find a CFG to generate $L^{2}$.
c) Find a grammar generating $L=\left\{a^{n} b^{n} c^{j} \mid n \geq 1, j \geq 0\right\}$
11. a) State the difference between DFA and NFA.
b) Design an NFA which accepts set of all binary strings containing 1100 or 1010 as substrings.
c) Define parse tree. What is zero equivalent state?
d) Find the transition diagram of the NFA with the state table shown below:
$A=\{0,1\}, S=\left\{s_{0}, s_{1}, s_{2}\right\}, F=\left\{s_{0}\right\}$

| N |  |  |
| :---: | :---: | :---: |
| s |  |  |
| $\mathrm{s}_{0}$ | $\phi$ | $\left\{s_{1}, s_{2}\right\}$ |
| $\mathrm{s}_{1}$ | $\left\{\mathrm{~s}_{2}\right\}$ | $\left\{\mathrm{s}_{0}, s_{1}\right\}$ |
| $\mathrm{s}_{2}$ | $\left\{\mathrm{~s}_{0}\right\}$ | $\phi$ |

12. a) Find regular expressions over $\Sigma=\{a, b\}$ for the languages defined as follows:
i) $\quad L 1=\left\{a^{m} b^{m}: m>0\right\}$
ii) $\quad L 2=\left\{a^{2 n} b^{2 m+1} \mid n \geq 0, m n \geq 0\right\}$
iii) $\quad L 3=\left\{b^{m} a b^{n}: m>0, n>0\right\}$
b) Design a finite automata for the RE

$$
a^{*}+(a b+a)^{*}
$$

c) Find the regular expression corresponding to the following figure:


