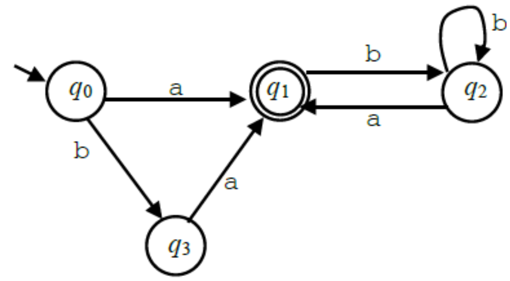
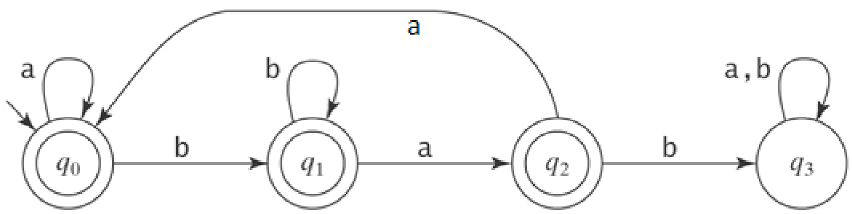
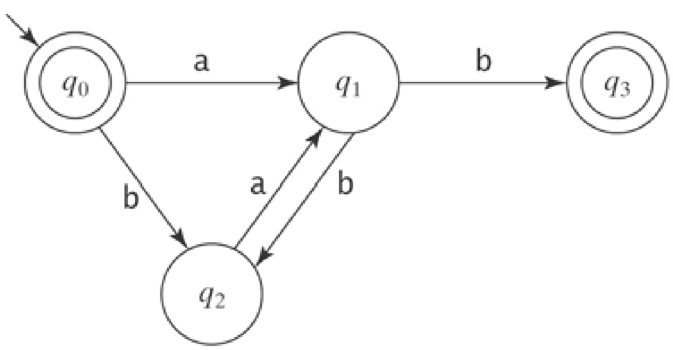
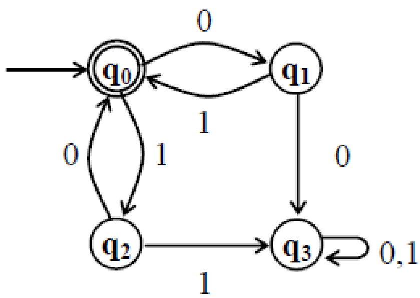
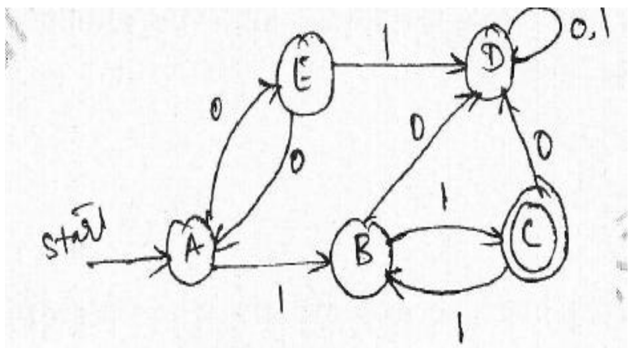
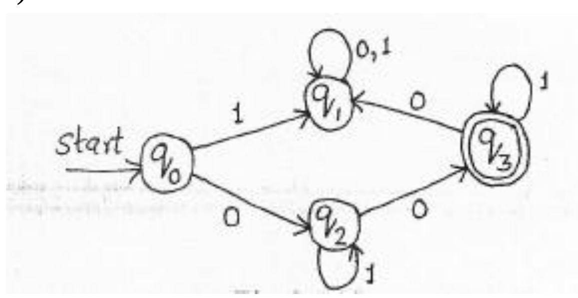
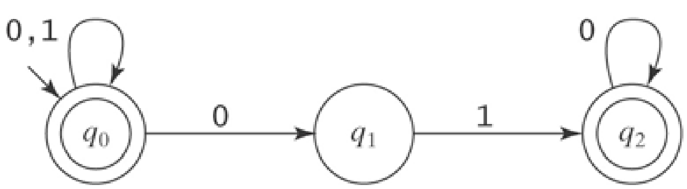
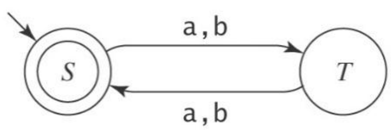
Automata Theory and Computability - 15CS54

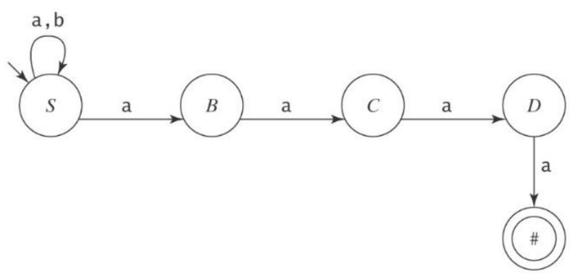
Module-2: Review Questions (up to IA1)

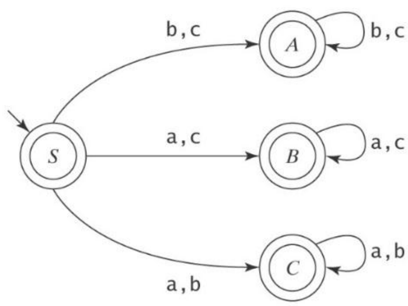
Sl. No.	Questions	Marks
Regular Expression		
1.	Define regular expression.	5
2.	Write the RE for following languages. a. {*w* ∈ {a, b}* : every a in *w* is immediately preceded and followed by b}. b. {*w* ∈ {a, b}* : *w* does not end in ba}. c. {*w* ∈ {0, 1}* : *w* corresponds to the binary encoding, without leading 0’s, of natural numbers that are evenly divisible by 4}. d. {*w* ∈ {0, 1}* : *w* corresponds to the binary encoding, without leading 0’s, of natural numbers that are powers of 4}. e. {*w* ∈ {0-9}* : *w* corresponds to the decimal encoding, without leading 0’s, of an odd natural number}. f. {*w* ∈ {0, 1}* : *w* has 001 as a substring}. g. {*w* ∈ {a, b}* : *w* has both aa and bb as substrings}. h. {*w* ∈ {0, 1}* : none of the prefixes of *w* ends in 0}. i. {*w* ∈ {a, b}* : $\#_a(w) \equiv_3 0$}. j. {*w* ∈ {a, b}* : $\#_a(w) \leq 3$}. k. {*w* ∈ {a, b}* : *w* contains no more than two occurrences of the substring aa}. l. {$a^{2n}b^{2m}$ | m>=0, n>=0 } m. {a^nb^m | n>=4, m<=3 } n. {w :|w| mod 3=0 where w ε (a,b)*} o. strings of 0's and 1's having no two consecutive 0's. p. strings of a's and b's starting with 'a' and ending with 'b'	3 each
3.	Let *L* be the language accepted by the following finite state machine:	4

	Indicate, for each of the following regular expressions, whether it correctly describes *L*: a. (a ∪ ba)bb*a. b. (ε ∪ b)a(bb*a)*. c. ba∪ ab*a. d. (a ∪ ba)(bb*a)*. 	
4.	State Kleene's theorem.	2
5.	Convert following RE's into FSM's a. (ab*)* b. (a U b)* c. a*U b* d. (aUb)ab	3 each
6.	Convert following FSM's to RE's (a)  (b) 	6 each

	c)   d) e) 	
7.	Given the following DFSM *M*, write a regular expression that describes ¬*L*(*M*): 	
6.	Briefly explain the applications of regular expression.	6
7.	Simplify each of the following regular expressions: a) (a ∪ b)* (a ∪ ε) b*. b) (Ø* ∪ b) b*. c) (a ∪ b)*a* ∪ b. d) ((a ∪ b)*)*. e) ((a ∪ b)+)*. f) a ((a ∪ b)(b ∪ a))* ∪ a ((a ∪ b) a)* ∪ a ((b ∪ a) b)*.	3 each

<table>
<tr><td colspan="3">Regular Grammars</td></tr>
<tr><td>8.</td><td>Define regular grammar</td><td>2</td></tr>
<tr><td></td><td>Give regular grammar for each of the following languages:
a) {w ∈ {a, b}* : w contains an odd number of a’s and an odd number of b’s}.
b) {w ∈ {a, b}* : w does not end in aa}.
c) {w ∈ {a, b}* : w contains the substring abb}.
d) {w ∈ {a, b}* : if w contains the substring aa then |w| is odd}.
e) {w ∈ {a, b}* : w does not contain the substring aabb}.
f) {w ∈ {a, b}* : every a in w is immediately followed by at least one b}.</td><td>3 or 4 each</td></tr>
<tr><td>9.</td><td>Give regular grammar for following FSM’s
(a)


(b)


(c)

</td><td>6 each</td></tr>
<tr><td>10.</td><td>Construct FSM for the following regular grammar
(a) $S \rightarrow aT$
$T \rightarrow bT$
$T \rightarrow a$ $T \rightarrow aW$
$W \rightarrow \varepsilon$
$W \rightarrow aT$

(b) S → bS
S → aT
S → ε
T → bS</td><td>4 each</td></tr>
</table>

Regular and Non-Regular Languages (Pumping Theorem)		
11.	State and prove pumping theorem for regular languages	6
12.	List the applications of pumping lemma	4
13.	Prove that “The regular languages are closed under complement, intersection, difference, reverse, and letter substitution”	6
14.	Prove that following languages are **not regular** using pumping theorem • **$L = \{a^n b^n \mid n \geq 0\}$** • Balanced parenthesis language • Even palindrome language (palindrome over {a,b} with even length) • The language with more a’s than b's • The prime number of a's, $L = a^n$ where n is prime	8 each