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Fifth Semester Examination – 2007
Automata Theory

Full Marks – 70 **Time – 3 hours**

Answer Question No. 1 which is compulsory and any five from the rest.

The figures in the right-hand margin indicate marks.

1. Answer the following questions: (2 x 10

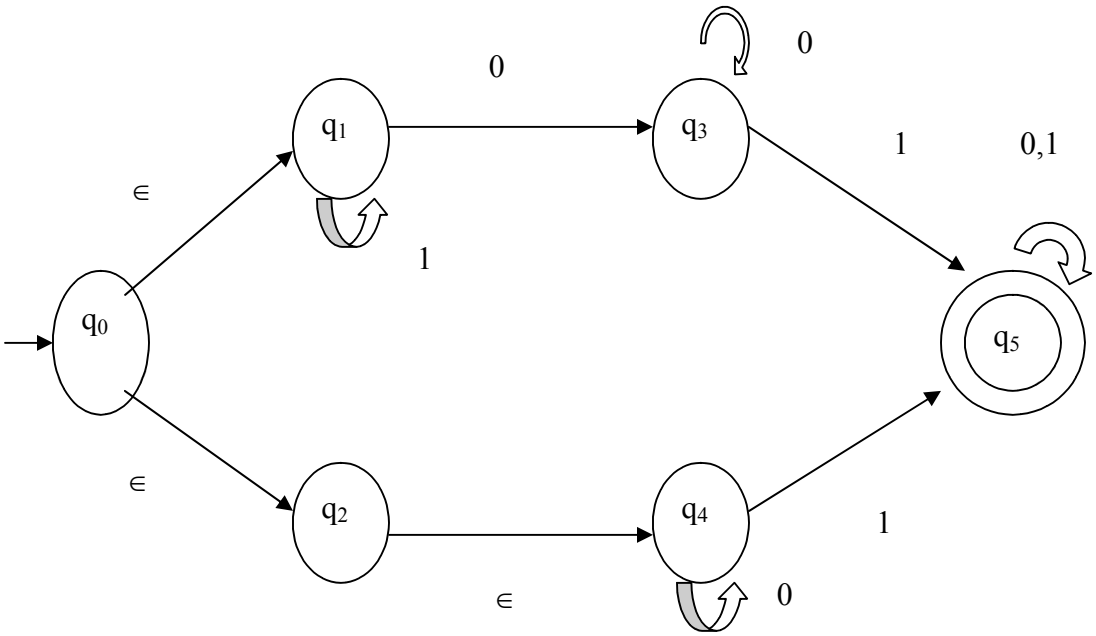
(a) Given an alphabet $\sum$, what do you mean by a language L over $\sum$?

(b) Devise a DFA which accepts all strings ending with 1. (Assume that $\sum = \{0,1\}$)

(c) Define a NFA.

(d) You have a DFA M_1 which accepts a language L_1 and another DFA M_2 which accepts the language L_2. Devise a $\in$ –NFA which accepts the language $L_1 \cup L_2$

(e) Find the $\in$–closure of the state $\{q_0\}$ from the following diagram:



(f) Define a pushdown automation.

(g) Find the language generated by the following context-free grammar:

S → a S a | b S b | a| b

(h) When is a context-free grammar said to be ambiguous?

(i) When is a language L said to be Turing recognizable? Turing decidable?

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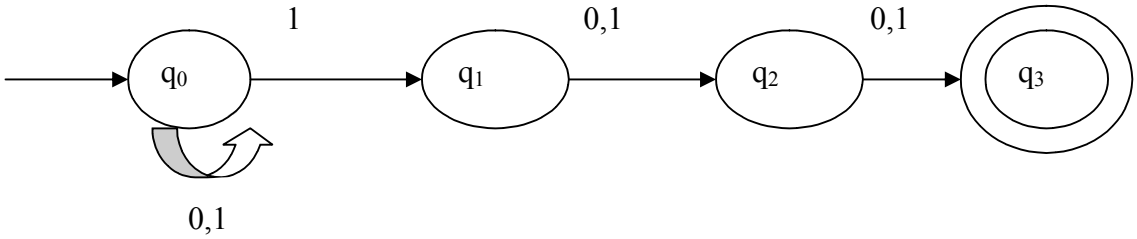
(j) Let f, g, h, k : **N** → **N**. Show that if f = O(h) and g = O(k), then fg = O(hk).

2.

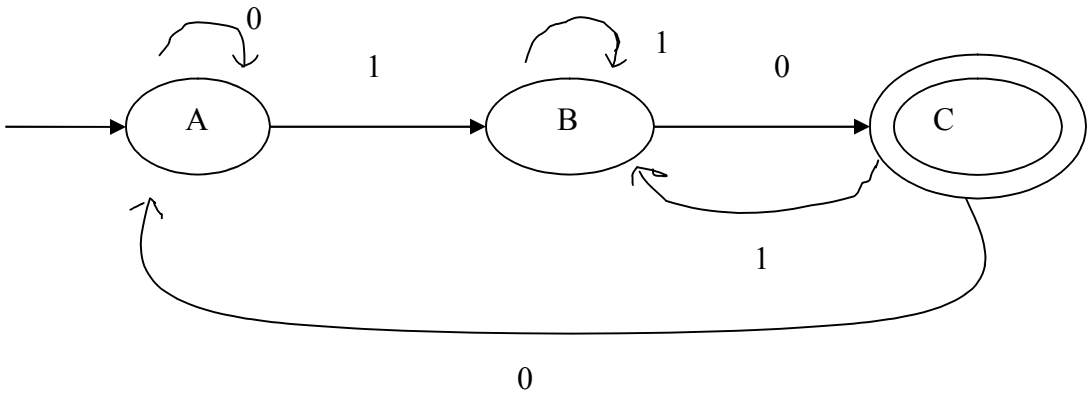
(a) Devise a DFA which accepts all binary strings which are divisible by 4. (5

(b) Convert the following NFA to its equivalent DFA. (5



3.

(a) From the diagram of a DFA given below, devise a regular grammar which generates the language of the DFA. (4



(b) Describe the regular expression corresponding to the language generated by the DFA in 3(a) above. (3

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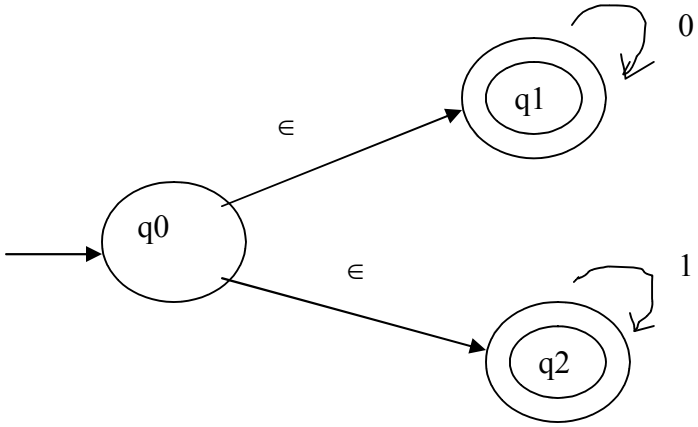
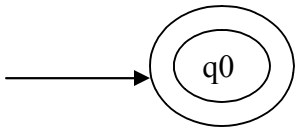
(c) Find the languages generated by the following DFA's:

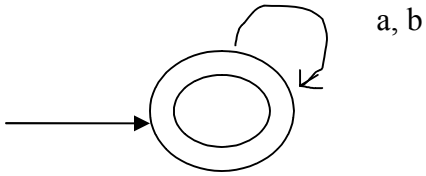
(i)



(ii)



(iii)



4.

(a) State and prove the pumping lemma for a regular language. (5

(b) Use the pumping lemma to show that the language (5

$L = \{0^n1^n : n \geq 1\}$ is not regular.

5.

(a) State and prove the pumping lemma for context-free languages. (5

(b) Show that the language $L = \{a^ncb^n : n \geq 1\}$ is accepted by a PDA. (5

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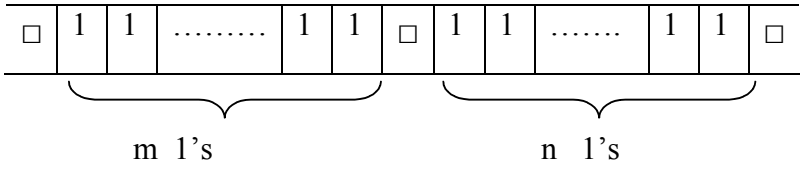
6.

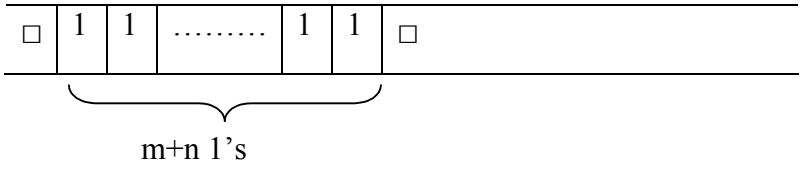
(a) Define a Turing machine. (5

(b) Devise a Turing machine which on a given pair of positive integers(m,n) as input, will produce m+n as output. [Assume that the positive integers are represented by a unary alphabet{1}]. (5

Therefore the input on the tape is:



The output should be



□ = blank symbol

7.

(a) Show that the set of all Turing recognizable languages is countable. (5

(b) Show that if a language L is decidable so is its complement. (5

8.

(a) When a function f : $\sum^* \rightarrow \sum^*$ said to be computable? (Where $\sum$ is a given alphabet). (2

(b) When is a language A said to be mapping reducible to another language B (both over the same alphabet)? (2

(c) Define the class NP. Describe three problems belonging to the class NP. (6

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