This question paper contains 7 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **6508**

Unique Paper Code : **32341502** **HC**

Name of the Paper : **Theory of Computation**

Name of the Course : **B.Sc. (H) Computer Science**

Semester : **V**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

All questions from Part A are compulsory.

Attempt any *four* questions from Part B.

Assume $\Sigma = \{a\ b\}$ is the underlying alphabet unless mentioned otherwise. Parts of a question must be answered together.

Part A

1. (*a*) Consider the language S*, where S = {aa, b}. How many words does this language have of length 4 ? of length 5 ? of length 6 ? What can be said in general ? 2

(*b*) Let S = {ab, bb} and let T = {ab, bb, bbbb}. Show that S* = T*. 2

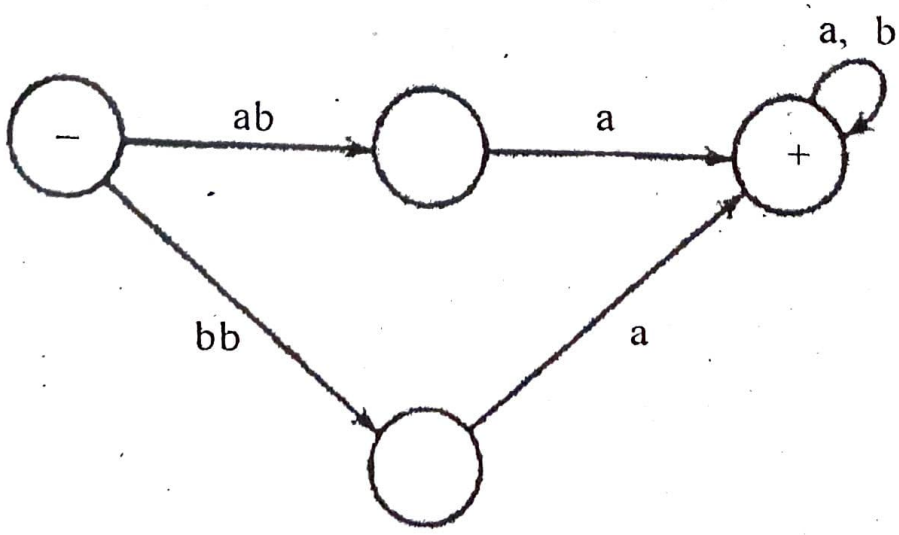
(*c*) Give a regular expression for the language of all the words that do not have '**aa**' as substring. 3

(*d*) Generate a CFG for b*a*. 3

(*e*) Design a Deterministic Finite Automata for the language of all the words that end in a double letter. 4

(*f*) Using Pumping Lemma, prove that language $\mathbf{a^n b^{2n}}$, **n>=0** is not regular. 4

(*g*) Convert the following Transition Graph into its equivalent Regular Expression : 4



(*h*) Show that the complement of a recursive language is also recursive. 4

(*i*) Construct a Push Down Automata for $a^n b^{n+1}$ where $n>=1$. 4

(*j*) If $L_1=(a+b)b(a+b)^*$ and $L_2=(a+b)^*b$, find a Regular Expression and Deterministic Finite Automata for $L_1 \cap L_2$. 5

Part B

2. (*a*) Begin with the grammar : 5

$S \rightarrow ABC|BaB$

$A \rightarrow aA|BaC|aaa$

$B \rightarrow bBb|a|D$

$C \rightarrow CA|AC$

$D \rightarrow \in$.

(*i*) Eliminate $\in$ productions.

(*ii*) Eliminate any unit productions in the resulting grammar.

(*iii*) Eliminate any useless symbols in the resulting grammar.

(*b*) Using Pumping Lemma, prove that language $\mathbf{a^n b^n a^n}$, n>=1 is non-context free. 5

3. (*a*) Prove that the regular languages are closed under complement. 3

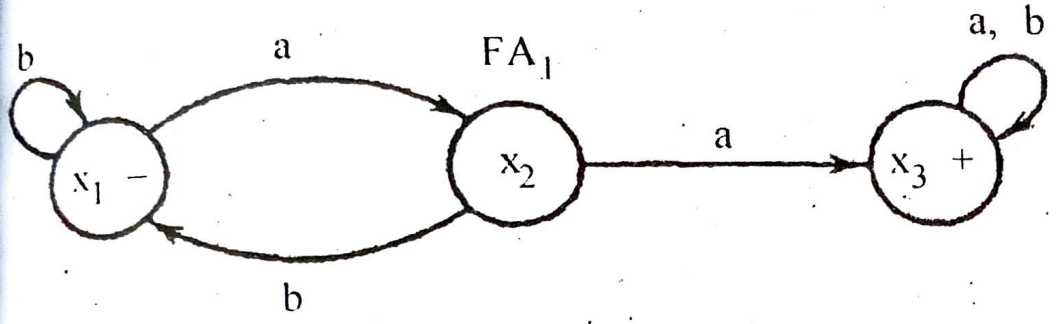
(*b*) Give a CFG for the langauge of all the words having **'bbb'** as substring. 3

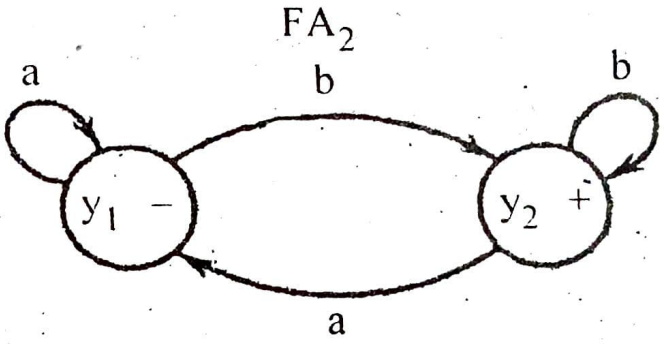
(*c*) Show that the following grammar is ambiguous : 4

$\mathbf{S \rightarrow XbaaX|aX}$

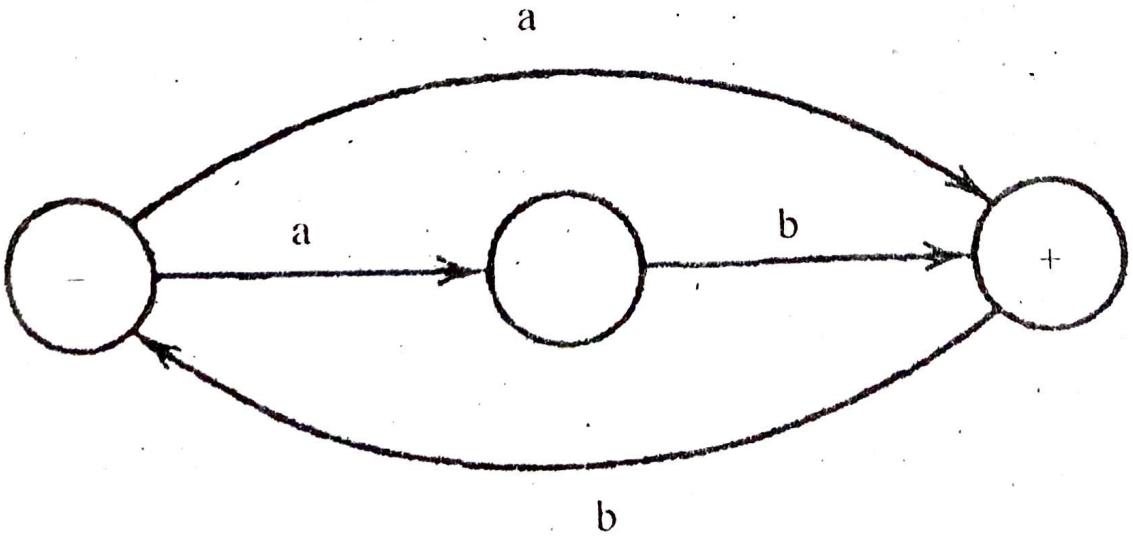
$\mathbf{X \rightarrow Xa|Xb|\wedge.}$

4. (*a*) Find FA_1FA_2(concatenation) for the following automata : 5





(*b*) Find the equivalent Deterministic Finite Automata for the following Non-deterministic Finite Automata : 5



5. (*a*) Describe the language for the following regular expressions : 4

(*i*) **(a+b)* ab(a+b)***

(*ii*) **((a+b)b)*.**

(*b*) Build a DFA that accepts all words with fewer than four letters. 3

(*c*) Give a regular expression for the language of all the words that do not have a double letter. 3

6. (*a*) Explain halting problem. 2

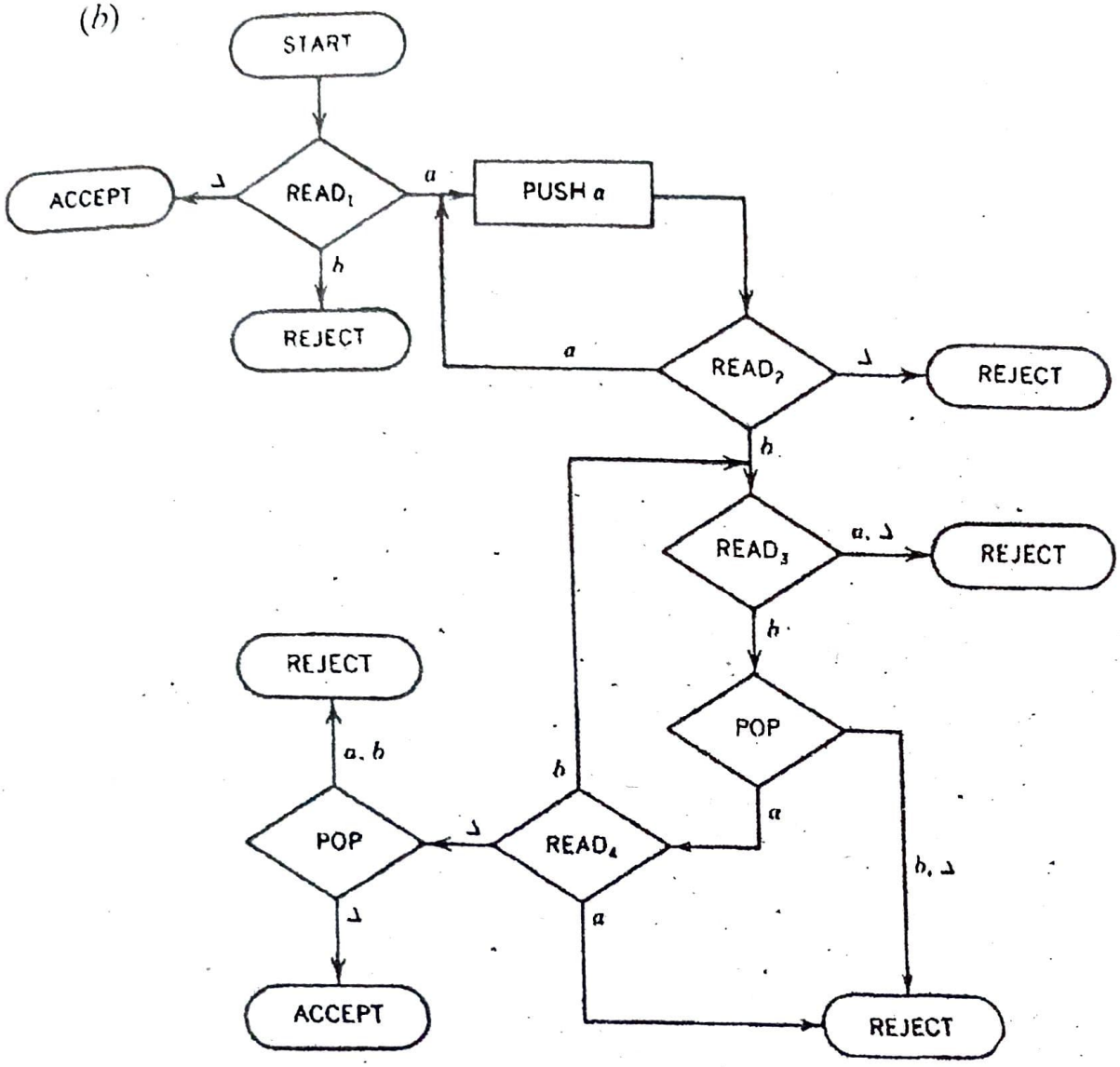
(*b*) Show that if language L is recursive, then L is recursively enumerable also. 3

(*c*) Design a Turing Machine for $\mathbf{a^n b^n}$ for n>=1. 5

7. (*a*) Design a PDA for the following language : 5

$L=\{a^nS$, where S starts with b and length(S)=n$\}$.

(*b*)



(*i*) Define the language defined by above PDA. 2

(*ii*) Trace the word '**abb**' on the above PDA. 3