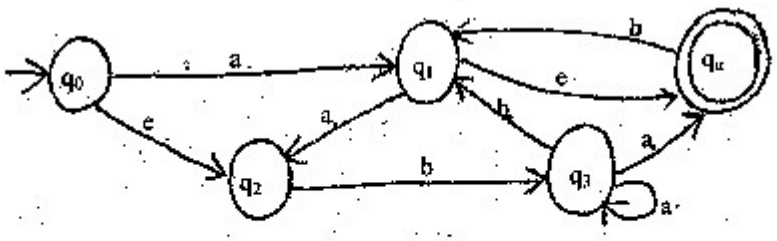
43 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Theory of Computation *(CT502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Define countably infinite and uncountable sets with example. Use principle of mathematical induction to prove (5^n-1) is divisible by 4 for all integers $n \geq 0$. [3+4]
2. Design a Deterministic Finite Automata (DFA) for the regular expression (a(ab)*b)*. Verify your design by taking one accepted and one rejected strings. [5+2]
3. State pumping lemma for regular language. Use this lemma to prove language, $L = \{a^{n^2} : n \geq 0\}$ is not regular. [2+5]
4. What are the differences between a DFA and a NFA? Convert the following NFA in to its equivalent DFA. [2+5]



5. Construct CFG for language, $L(G) = \{a^m b^n : m, n > 0, m \geq n\}$. Use this grammar to generate string "aaab". And also draw the parse tree. [4+1+1]
6. Convert following CFG to CNF [5]

   G = (V, Σ, R, S), where
   V = {S, A, B, a, b}
   Σ = {a, b}
   R = {S → aAb | Ba | A, A → SS| e, B → e}

7. Define the term ambiguity and inherent ambiguity in parse tree. For a CFG given by G = (V, Σ, R, S) with V = {S}, Σ = {a} and production rules R is defined as: [4]
   S → SS,
   S → a.
   Obtain the language L(G) generated by this grammar.

8. Design a PDA that accepts language, $L = \{a^n b^{3n} : n \geq 1\}$. Test your design for string "abbb". [5+1]

9. Write the differences between CFG and unrestricted grammar with example. Design a Turing machine that reads binary string and doubles the number represented by that string. A binary number is doubled if a '0' is added on the right end of the number. [3+5]

10. Define head shifting and symbol writing Turing Machines. Design a Turing Machine (TM) which computes following function $f(w) = ww^R$, where w^R is the reverse of string and $w \in \{0,1\}^*$. If your input string is #01# then TM should give the output string as #0110#. [3+6]

11. Define class-P and class-NP problems with example. How do they relate to NP-complete problems? [5]

12. What is an "Algorithm" according to Church-Turing Thesis? Why is it called thesis and not a theorem? Prove that if a language 'L' and its complement '$\overline{L}$' both are recursively enumerable, then L is recursive. [2+1+6]

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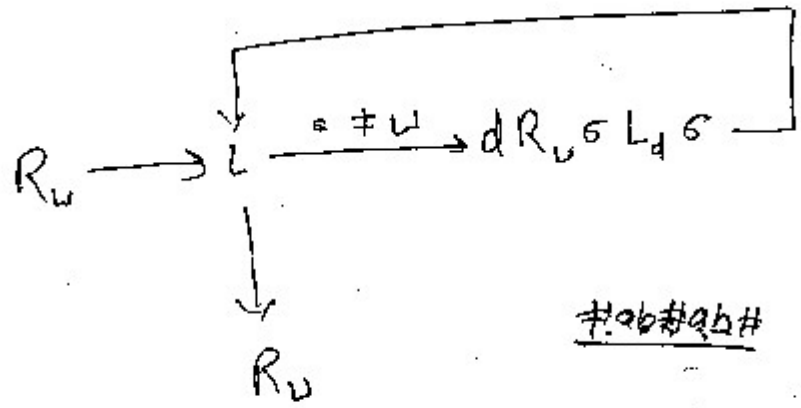

$S^K \cdot S - 1$

$5 \cdot K^K - 1$ $\quad S(B^{1K} - 1 \cdot +1) - 1$

$5 5^K - 5 + 4$ $\quad 5(5^K - 1) + 5 - 1$

$5(5^K - 1) + 4$ $\quad + 4$

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Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Theory of Computation *(CT502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Justify that "The complement of diagonal set is different from each row sets." with the help of diagonalization principle. Show that if 3n+2 is odd then n is odd by using proof by contradiction technique. [3+4]
2. Design a DFA that accepts the language L = {x ε {1,1}*: x has an even number of 0's and an even number of 1's}. Verify your design for at least two strings that are accepted by this DFA and 2 strings that are rejected. [5+2]
3. Show that for any Regular expression R, there is a NFA that accepts the same language represented by R. Construct a e-NFA for regular expression bb (a U b)*ab [3+3]
4. Use pumping lemma to prove that L = $\{a^n b^{2n} : n \geq 1\}$ is not regular. [4]
5. Consider the **regular grammar** G = (V, Σ, R, S) where [4]
   V = {S,A,B,a,b}, Σ = {a,b}
   R = {S → abA / B / baB / e
   A → bS / a
   B → aS
   }
   Construct a finite automaton M such that L (M) = L (G)
6. Write context free grammars (CFG) for the languages $L1 = \{a^m b^n c^n : m \geq 1, n \geq 1\}$ and $L2 = \{a^n b^n c^m : m \geq 1, n \geq 1\}$. Do you think that $L = (L1 \cap L2)$ is also context free? If not prove that the language thus obtained is not context free by using pumping lemma for context free language. [4+6]
7. Convert following CFG into CNF with explanation of each step. G = (V,Σ,R,S), where [6]
   V = {S, X, Y, Z, a, b, c},
   Σ = {a, b, c}
   R = {S→XYZ|XY|aZ, X→abX|ε, Y→bY|cZ|ab, Z→aXZ}
8. Design a PDA that accepts all the palindromes defined over {a, b}*. Your design should accept strings like ε, a, b, aba, bab, abba, babab etc. [5]
9. Define the term configuration of Turing Machine. Design a Turing machine which accepts the set of all palindromes over alphabets {0,1} [2+5]
10. Is Turing Machine a complete computer, support your answer in reference to different rules of Turing machines? Justify that unrestricted grammar can generate the language $L = \{a^n b^n c^n : n \geq 1\}$ [3+3]
11. Define Multiple tapes Turing machine. With reference to language they accept, compare Multiple tapes Turing machine with single tape Turing machine. [4]
12. "Turing machines is believed to be the ultimate calculating mechanism", elaborate with the help of Church-Turing thesis. How halting problems suffer the computational procedures? Explain with suitable example. [5+4]
13. With reference to Polynomial Time Reducibility, explain NP hard and NP- Complete Problems. [5]

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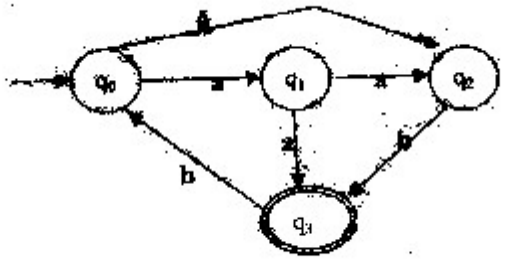
2068 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Theory of Computation *(CT 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What are the differences between reflexive relation and reflexive closure? Use mathematical induction to show that $2^n < n!$ for any positive integer $n \geq 4$. [2+5]
2. Design DFA that accepts the language L = { W∈ (0, 1)*: W is the multiple of five.} Check your design for 1010. [7]
3. Convert the following NDFA into equivalent DFA. [7]



4. Show that $L = \{a^{2n} ba^n : n \geq 1\}$ is not regular by using Pumping Lemma for regular language. Test all possible cases. [7]
5. What is CFG? Design CFG for the language $L(G) = \{WW^R: W \in \{0, 1\}^*\}$. [2+5]
6. Convert following CFG into CNF. G = (V, Σ, R, S), where [7]

   V = {S, A, B, C, a, b, c},
   Σ = {a, b, c},
   R = {S→ABA|abA|BC, A→aA|∈, B→baB|c, C→aC}.

7. Design a Nondeterministic PDA to accept the language L(G) = {W ∈{0, 1}*: W has equal number of 0's and 1's}. Check your design for 001110. [7]
8. Design a turning machine that scans to left to find at least two a's. Machine should print "yes" if at least two a's are present otherwise it must print "no" and then halts. Hence test your design for Δ#b#ab#ba# to A#yes#ab#ba#. Where Δ and # represent left end and blank symbols respectively with Σ = { Δ, #, a, b}. [9]
9. Explain about Unrestricted Grammar. Design a Turing Machine that accepts the language $L = \{a^n b^n : n \geq 0\}$. Show all configuration of TM for aabb. [2+6]
10. Define universal turning machine and explain its encoding technique in detail with suitable example. List undecidable problems about turning machine and grammar. [5+4]
11. Explain class-P and class-NP, with examples. [5]

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44 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Baishakh

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs

Subject: - Theory of Computation

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
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1. Let N be a set of natural numbers and R be any relation defined as R = {(a, b): a ≤ b}. Now test whether R is an equivalence relation or not. Prove that the function $f(x) = x^5 + 5x^3 + 16x + 5$ cannot have more than one real root by using proof by contradiction technique. [3+4]
2. How finite automata are useful in various fields? Design a DFA that accepts the language given by (M) = {w∈{0, 1}*: w does not contain four consecutive 0's}. Hence test your design for 01010001. [1+5]
3. Minimize the following DFA (Draw initial diagram first). Specify performed operations in each step. [5]

δ/Σ	0	1
→q_0	q_1	q_2
*q_1	q_1	q_3
*q_2	q_2	q_2
*q_3	q_5	q_2
*q_4	q_4	q_2
*q_5	q_4	q_2
q_6	q_5	q_6
q_7	q_5	q_6

4. Check whether L = {a^{n^2}: n ≥ 0} is regular or not by using Pumping Lemma for regular language. [5]
5. State closure properties of regular language and explain diagrams. [5]
6. What is ambigious grammar? Write Context Free Grammar for the language given by L = {w∈{(,)}*}: each string in w has balanced parentheses}. Use same to derive leftmost and rightmost derivations for (()) (). Hence also draw parse tree. [1+2+4+1]
7. What are the importance of CNF? Convert following CFG into CNF with explanation of each steps. [1+6]

   G = (V, Σ, R, S), where
   V = {S, A, B, a, b}
   Σ = {a, b}
   R = {S→bA/ Ba/ AaA,
   A→S/e,
   B→aB/ab}

8. Design a Non deterministic PDA for the language given by $L(M) = \{a^n b^n : n > 0\}$. Hence explain how it processes strings like aabb? [4+2]

9. What is Turing-decidable language? Design a Turing machine that recognizes the language given by $L = \{a^n b^n c^n : n \geq 0\}$. Hence test your design for #aabbcc. [1+5+2]

10. List three criteria that should be satisfied by a Turing machine. How unrestricted grammar differ from context free grammar? Design a Turing machine that recognizes the strings of matched parenthesis. [2+2+5]

11. State and explain halting problem with suitable example. Why Church's Turing thesis can not be a theorem? List unsolvable problems about grammar? [5+2+2]

12. State computational complexity theory. Explain class NP with suitable example. [1+4]

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