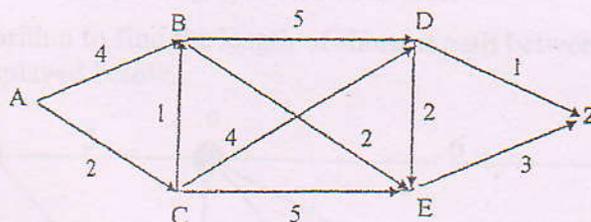


Exam.	Back		
Level	BE	Full Marks	80
Programme	BEI, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

*Subject: - Discrete Structure (CT 551)*

- ✓ 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. By using rules of inferences, show that the hypothesis "If you send me an email, then I will finish writing the program", "If you do not send me an e-mail message, then I will go to sleep early", and "If I go to sleep early, then I will wake up feeling refreshed" lead to the conclusion "If I do not finish writing the program, then I will wake up feeling refreshed". [8]
2. Use mathematical induction to prove that  $1 + 3 + 6 + 10 + \dots + [n(n+1)] / 2 = [n(n+1)(n+2)] / 6$  for all positive integers n. State Converse, Contrapositive and Inverse for the conditional statements: "I feel sleepy if I study till late night." [5+3]
3. Prove that  $\sqrt{2}$  is an irrational by giving a proof by contradiction. What are the significance of Tableau methods? [5+3]
4. Design a Finite State Automata that accepts precisely those strings over {a, b} that ends with "abb". Your design should include the proper definition of the finite-state automation, transition table and the transition diagram. Give regular expression for following language  $L = \{w \in \{a, b\}^* : w \text{ starts and ends with different symbols}\}$  [6+2]
5. Construct a Non-deterministic Finite Automata equivalent to the regular grammar G given below and convert in to the Deterministic Finite Automata. Here the regular grammar G is defined as:  
 $G = \{N, T, P, S\}$ , where N is non-terminal symbols, T is terminal symbols, P is production rules and S is the starting symbol. [4+4]
  - $N \rightarrow \{S, A\}$
  - $T \rightarrow \{a, b\}$
  - $P \rightarrow aAb, aaAb$
  - $A \rightarrow \epsilon$  (empty symbol)
6. Find all the solutions of the recurrence relation  $a_n = 2a_{n-1} + a_{n-2} + 2^n + 1$  with initial conditions  $a_1 = 7$  and  $a_2 = 19$ . [8]
7. Using Dijkstra's Shortest Path Algorithm to find the shortest path from A to Z in the following weighted graph. Also make highlight the shortest path from source to destination (A-Z). [8]



8. Prove that an undirected graph has even number of vertices of odd degree. Draw cycle with 5 vertices ( $C_5$ ) and 3-Dimensional Hypercube ( $Q_3$ ) and write their chromatic numbers. [2+6]
9. Differentiate between Hamiltonian and Euler Circuit with suitable examples. Define planar and regular graphs. [4+2+2]
10. Write short notes about following topics: [2×4]

Exam. Level	BE	Back- Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

*Subject: - Discrete Structure (CT 551)*

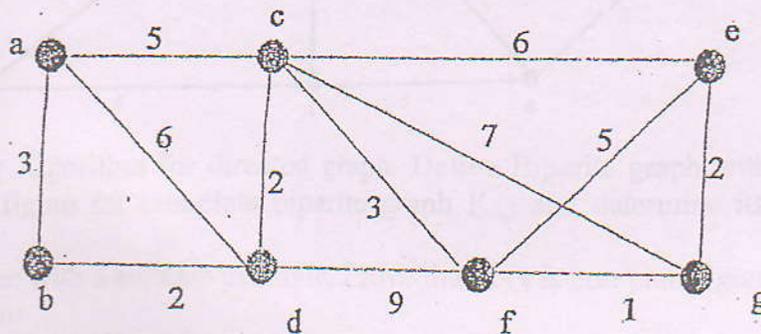
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Explain inclusive and exclusive disjunction with truth table and examples. [6]
2. Explain De Morgan's law for quantifiers with example. [4]
3. State the converse, contrapositive and inverse for the conditional statement "if any two sides of a triangle have equal length, then the triangle is isosceles" [3]
4. Check whether the following groups of statements are consistent to each other or not using tableaux method. If consistent, give the truth values to the variables for which the system is consistent. [6]
 

$\Phi = \{p \rightarrow (r \wedge t), (t \vee s) \rightarrow \neg q, \neg \neg (p \wedge q)\}$
5. Use mathematical induction to prove that  $n < 2^n$  for all positive integers n. [5]
6. Define regular expression with example. Design a DFA that accepts following language  $L = \{w \mid w \text{ is a binary string such that } w \text{ has both } 01 \text{ and } 10 \text{ as substring}\}$   
 Check your design for 10011 and 1101. [2+6]
7. Define Regular grammar. Construct a Non-Deterministic Finite State Automata for following grammar and convert it into its equivalent Deterministic Finite State Automata. [8]
 

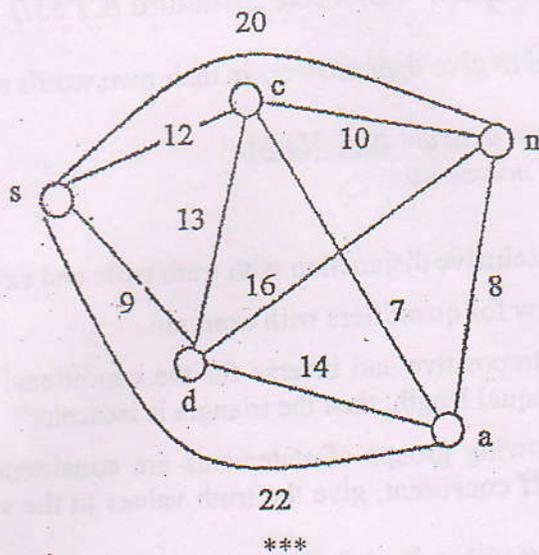
$G = (N, T, P, S)$  where  
 $N = \text{set of non-terminals} = \{S, A, B\}$   
 $T = \text{set of terminals} = \{a, b\}$   
 $P = \text{productions} = \{S \rightarrow aA \mid bB, A \rightarrow a \mid B \rightarrow a\}$   
 $S = \text{starting non-terminal}$
8. Find solution of following recurrence relation [8]
 

$a_n = 2a_{n-1} - a_{n-2} + 2^n$  for  $n \geq 2$  with  $a_0 = 1$  and  $a_1 = 2$
9. What is a bipartite graph? Is  $C_6$  bipartite? [2+2]
10. Explain matrix representations of graph with examples. [6]
11. Use Dijkstra's algorithm to find the length of shortest path between vertices a and g in the weighted graph displayed below. [8]



12. How does a tree differ from graph? Define balanced tree with example. [4]

13. Define spanning tree with example. Use Prim's algorithm to find minimum spanning tree of following graph. [2+8]



- ✓ Candidates
  - ✓ Attempt ALL
  - ✓ The figures
  - ✓ Assume suit
1. Use rules of bird or a ha
  2. Write the in will have o integer, the
  3. Define const set:  
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8. State Handl example. D number.
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11. Breadth

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

*Subject: - Discrete Structure ( CT 551 )*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
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- ✓ Assume suitable data if necessary.

1. Use rules of inference to show that the hypothesis "No humans can fly.", "Tweety is a bird or a human.", "Tweety can fly" implies the conclusion "Tweety is a bird". [8]

2. Write the inverse, covers and contrapositive of the statement "If Covid Spreads then we will have online classes". Use a mathematical induction to prove, if  $n$  is non-negative integer, then  $(n^5 - n)$  is divisible by 5. [3+5]

3. Define consistency and Completeness of the Logical System. Draw Tableau for formula set:  
 $\phi = \{(P \wedge Q) \vee R, P \rightarrow \neg Q, \neg P\}$  [2+6]

4. Given a Language  $L = \{ W \in \{a,b\}^* : W \text{ ends with 'ba'} \}$ . Write a regular expression and design a Finite state automata that accepts the language  $L$ . Your design should include proper definition of finite- state automation, transition table and transition diagram. [2+6]

5. Consider the regular grammar  $G = (N, T, P, \sigma)$  where, [4+4]

Set of Non-Terminals,  $N = \{\sigma, A, B\}$

Set of Terminals,  $T = \{a, b\}$

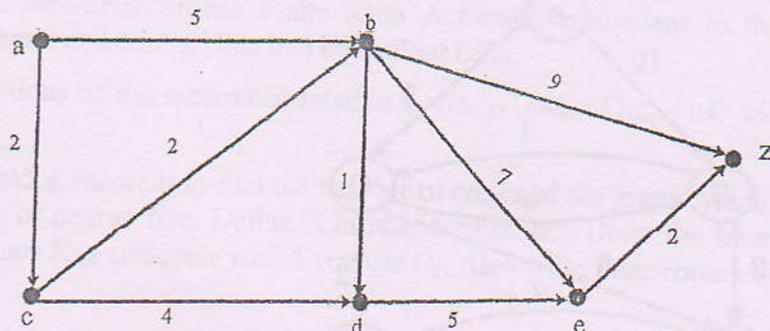
Set of productions,  $P = \{\sigma \rightarrow bB, \sigma \rightarrow bA, A \rightarrow a\sigma, B \rightarrow bB, B \rightarrow a, B \rightarrow \lambda\}$

and starting symbol  $\sigma$ .

Construction a Non- Deterministic Finite State Automata equivalent to the above given regular grammar and convert this into DFA.

6. Find all the solution of the recurrence relation:  $a_n = 6a_{n-1} - 8a_{n-2} + 3^n$ , where the initial conditions:  $a_0 = 4$  and  $a_1 = 10$ . [8]

7. Use Dijkstra's algorithm to find the length of shortest path between vertices 'a' and 'z' in the graphs below. Also highlight the shortest path. [8]



8. State Handshaking Algorithm for directed graph. Define Bipartite graph with a suitable example. Draw a figure for complete bipartite graph  $K_{3,5}$  and determine its chromatic number. [2+2+2+2]

9. Define spanning tree with a suitable example. Prove that  $K_{3,3}$  is non-planar graph. [3+5]

10. Write short notes on: [4+4]

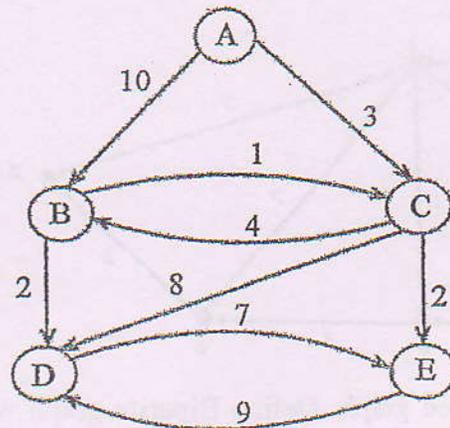
a) Breadth First and Depth First Traversal

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

*Subject: - Discrete Structure (CT 551)*

- ✓ 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. Show that the premises. "If the Council approves the funds, then New Atlantic will get the Olympic Games. If New Atlantic gets the Olympic Games, then New Atlantic will build a new stadium. New Atlantic does not build a new stadium. Therefore, the Council does not approve the funds, or the Olympic Games are canceled." [8]
2. Use mathematical induction to prove that  $2^n > n^2$  for  $n > 4$ . [8]
3. Define predicates. State the converse, contrapositive, and inverse of "I come to class whenever there is going to be a quiz." Prove that if  $n$  is a positive integer, then  $n$  is even if and only if  $7n + 4$  is even. [1+3+4]
4. Design a DFA that accepts a language  $L(M) = \{w \in \{0, 1\}^* : \text{all bit strings that contain the string } 101.\}$  Your design should include proper definition of DFA, transition table and transition diagram. [8]
5. Write the regular expression for set of strings of a's and b's ending with the string either ab or ba.}. Construct a finite-state machine that gives an output of 1 if and only if last three bits received are all 1s. [4+4]
6. Find all solutions of the recurrence relation  $a_n = 2a_{n-1} + 2n^2$  with initial condition  $a_1 = 4$ . [8]
7. Let  $G$  be a connected planar simple graph with  $e$  edges and  $v$  vertices. Let  $r$  be the number of regions in a planar representation of  $G$ . Then prove that  $r = e - v + 2$ . [4]
8. Are  $C_3$  and  $C_6$  bipartite? Justify your answer. Explain about Incidence Matrixes technique for graph representation with figure. [4+4]
9. Use Dijkstra's algorithm to find the length of a shortest path from the vertex "A" to other vertices in the graph below. [8]



10. What is Huffman coding? Why do you need it? Show that  $K_n$  has Hamilton circuit whenever  $n \geq 3$ . What is the chromatic number of  $C_n$  for  $n \geq 3$ ? [2+3+3]
11. Explain S-T cut theorem with example. [4]

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

*Subject: - Discrete Structure (CT 551)*

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- ✓ Attempt All questions.
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1. Use rules of inference to show that the hypothesis "Buddha will go to Lumbini or Pokhara", "He will not visit Mayadevi Temple if he goes to Pokhara", "He will not visit Mayadevi Temple only if he visits Sarangkot.", "If he visit Sarangkot, he will do paragliding.", "He will not do paragliding" imply the conclusion "He will go to Lumbini". [8]
2. Conjecture a formula for  $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots + \frac{1}{2^n}$  and prove the formula you conjectured using mathematical induction. [2+6]
3. a) State Converse, Contrapositive and Inverse for the conditional statement: [3+2]
 

"I won't get a degree if I do not pass in Discrete Structure."
- b) Define soundness and completeness of a proof system. Draw Tableau for formula sets:  $\Phi = \{P \rightarrow Q \vee R, P \wedge \neg Q, \neg(\neg P \wedge R)\}$  [3]
4. Design a DFA that accepts a language  $L(M) = \{w \in \{0,1\}^* : \text{Every } 0 \text{ in } w \text{ has } 1 \text{ immediately to its right}\}$ . Your design should include proper definition of DFA, transition table and transition diagram. [8]
5. Consider the regular grammar,  $G = (N, T, P, \sigma)$  where [4+4]
 

Set of Non-terminals,  $N = \{\sigma, A, B\}$

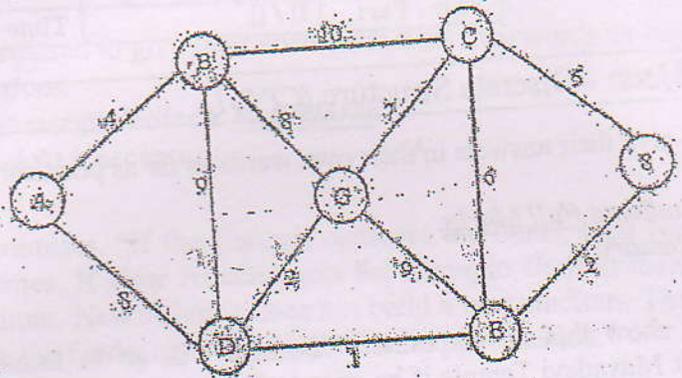
Set of Terminals,  $T = \{a, b\}$

Set of productions,  $P = \{\sigma \rightarrow aA, \sigma \rightarrow aB, \sigma \rightarrow bA, A \rightarrow bA, A \rightarrow \lambda, B \rightarrow b\}$

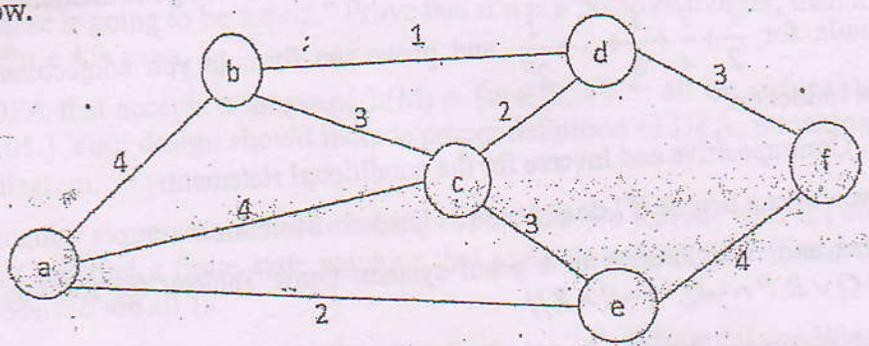
and starting symbol  $\sigma$ .

Construct a Non-deterministic Finite State Automata equivalent to the above given regular grammar and convert this into equivalent DFA.
6. Find all solutions of the recurrence relation  $a_n = 7a_{n-1} - 16a_{n-2} + 12a_{n-3} + n4^n$  with  $a_0 = -2, a_1 = 0,$  and  $a_2 = 5$ . [8]
7. Use handshaking theorem to find the number of edges of the graph which consists of 12 vertices each of degree five. Define "Chromatic Number". Draw the figure of complete bipartite graph  $K_{3,4}$  and cycle with 5 vertices  $C_5$ . Also write their chromatic numbers. [2+2+2+2]

8. Use Dijkstra's algorithm to find the length of a shortest path from the vertex "A" to other vertices in the graph below. [8]



9. Define Spanning Tree with example. Find the Minimum Spanning Tree from the graph given below. [2+5]



10. Write short notes on:

- a) Hamilton graph
- b) Max flow and Min cut theorem
- c) Planar Graph

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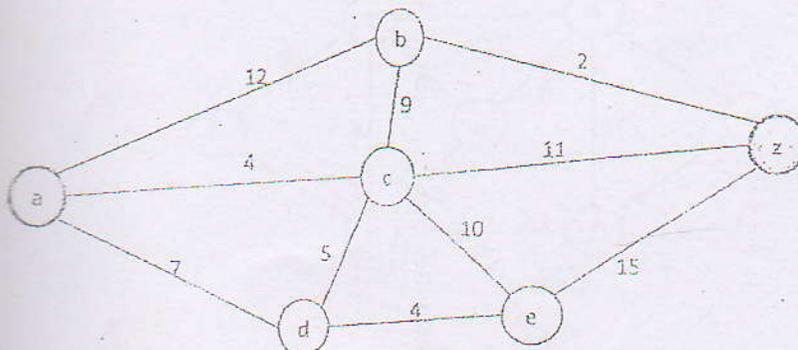
[3x3]

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

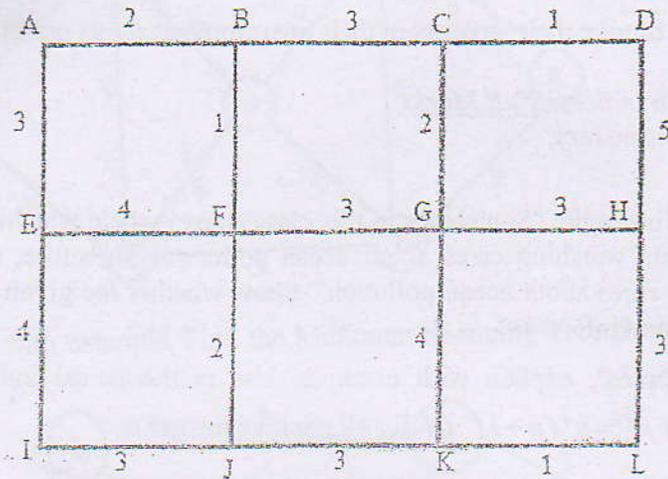
*Subject: - Discrete Structure (CT 551)*

- ✓ 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 Valid Argument in Logic. "Somebody in this class enjoys whale watching. Every person who enjoys whale watching cares about ocean pollution. Therefore, there is a person in this class who cares about ocean pollution." Show whether the given argument is valid or not using rules of inference. [2+6]
2. What are "Counterexamples", explain with example. Use mathematical induction to prove:  $1^3 + 2^3 + 3^3 + \dots + n^3 = n^2(n+1)^2 / 4$  for all positive integer n. [2+6]
3. Prove that if  $n=ab$ , where a and b are positive integers, then  $a \leq \sqrt{n}$  or  $b \leq \sqrt{n}$ . Determine whether the given expression is consistent or inconsistent using method of Tableaux:  $(P \wedge Q \rightarrow R) \wedge (\neg P \rightarrow S) \wedge Q \wedge \neg R \wedge \neg S$  [3+5]
4. Define Finite state machine with example. Design a Finite State Automata that accepts precisely those strings over {a,b} that does not end with the substring "abb". Your design should include the proper definition of the finite-state automation, transition table and the transition diagram. [2+6]
5. Consider the regular grammar defined by  $T=\{a,b\}$ ,  $N=\{S, A\}$  with productions  $S \rightarrow bS$ ,  $S \rightarrow aA$ ,  $A \rightarrow bA$ ,  $A \rightarrow b$  and starting symbol S. [4+4]
  - a) Construct a NDF A equivalent to the above given regular grammar.
  - b) Convert the NDF A into equivalent DFA.
6. Find all solutions of recurrence relation:  $a_n = 4a_{n-1} - 4a_{n-2} + 3^n$ . Also, find the solution with initial conditions:  $a_0=1$  and  $a_1=2$ . [8]
7. State and describe briefly the chromatic number of complete bipartite graph  $K_{3,4}$  and cycle  $C_5$ . Define Planar graph and show that  $K_5$  is not a planar graph. [4+4]
8. Use Dijkstra's algorithm to find the length of shortest path from vertex 'a' to vertex 'z' in the following weighted graph. Also highlight the shortest path in the graph. [8]



9. Define Spanning Tree and Minimum Spanning Tree. Find the minimum spanning tree from the given graph below. [1+1+5]



10. Write short notes on:

- Max flow and Min cut theorem
- Cut edges and Cut vertices
- Euler graph.

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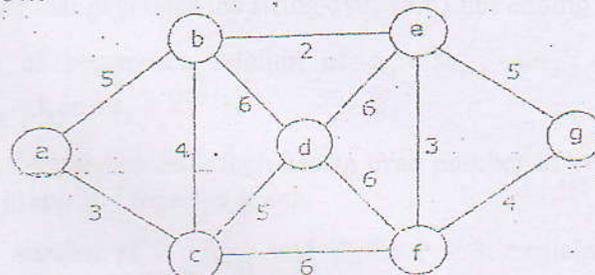


Exam.	Back		
Level	BE	Full Marks	80
Programme	BCT, BEX	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

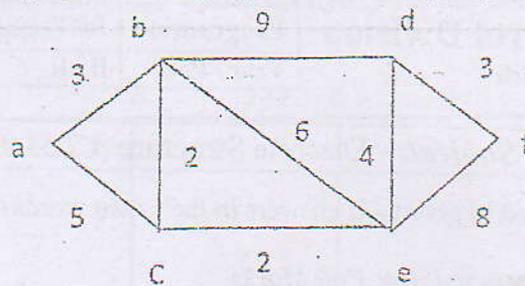
*Subject: - Discrete Structure (CT 551)*

- ✓ 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. a) "A student in this class has not read the book" and "Everyone in this class passed the first exam" implies that conclusion "someone who passed the first exam has not read the book." [5]
- b) Let  $Q(x,y)$  denote  $(x+y=0)$ . What is truth values of quantification  $\exists y \forall x Q(x,y)$  and  $\forall x \exists y Q(x,y)$ . [3]
2. Show that  $\{A \wedge C, (\neg A \vee B) \wedge (\neg B \vee \neg C)\}$  are unsatisfiability of the given set using method of tableaux. Prove that "If  $n$  is an integer and  $3n+2$  is odd, then  $n$  is odd." [5+3]
3. Use mathematical induction to prove that  $7^{n+2} + 8^{2n+1}$  is divisible by 57 for every non negative integer  $n$ . [8]
4. Design a FSA transition diagram that accepts the given set of string over  $\{a,b\}$ , [4+4]
  - i) which starts with  $ab$  and ends with  $baa$ .
  - ii) where every  $b$  is followed by  $a$ .
5. Design a Grammar to generate Palindrome for Binary Number. Consider the right linear Grammar  $N=\{N, T, P, S\}$ , where  $N$ =set of non-terminal =  $\{A, B, S\}$ ,  $T$ =Set of Terminal= $\{a, b, c\}$ , and  $P$  consists of the following rules:  $\{S \rightarrow abA/bbB/a, A \rightarrow aA/bB/b, B \rightarrow baB/aaaA\}$ . Construct the NFA equivalent to the given grammar. [4+4]
6. Find all the solutions of recurrence relation: [8]
 
$$a_n = 3a_{n-1} + 4a_{n-2} + 3^n$$
 with initial conditions  $a_0=1$  and  $a_1=2$ .
7. Are  $C_3$  and  $C_6$  bipartite, explain with figures. If  $G$  is a connected planar simple graph with  $E$  edges and  $V$  vertices, where  $V \geq 3$ , then prove that  $E \leq 3V-6$ . [4+4]
8. Define Binary tree, M-ary tree and Spanning tree. Find the minimal spanning tree from the graph given below. [3+5]



9. Use Dijkstra's Algorithm to find the length of shortest path from vertex a to vertex f in the following weighted graph. Also highlight the shortest path/paths in graph.



10. Write short notes on:

- Regular Graph with example.
- Max Flow and Min Cut Theorem

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[4-5]



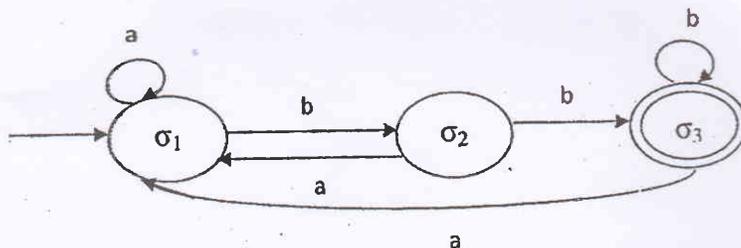
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCT/ BEX	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject: - Discrete Structure (CT551)**

- ✓ 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 the **terms** Tautology, Contradiction and Logical Equivalences. Show that  $\neg A \rightarrow \neg B$  and  $B \rightarrow A$  are Logically Equivalent. State the converse, contrapositive and inverse of the statement, "A positive integer is prime only if it has no divisors other than 1 and itself". [3+2+3]
2. Show that the **premises** "There is someone in this class who has been to Pokhara. Everyone **who goes** to Pokhara visit the Sarankot. Therefore, someone in this class has visited the **Sarankot**." [8]
3. Use **mathematical induction** to verify: [8]  

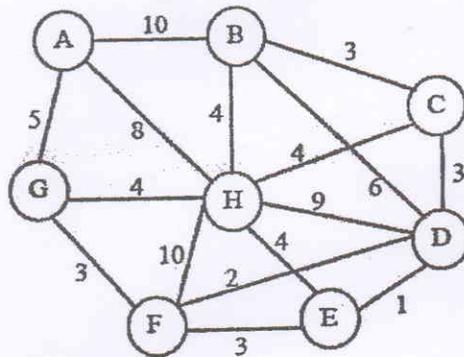
$$1^2 - 2^2 + 3^2 - 4^2 + \dots + (-1)^{(n+1)} n^2 = (-1)^{n+1} n(n+1)/2$$
4. a) State the **closure properties** of Regular Language. [3]  
 b) Let L be the **set** of strings accepted by the FSA shown below. Now construct a FSA that accepts the strings  $L^R = \{X_n, \dots, X_1 | X_1, \dots, X_n \in L\}$  [5]



5. i) Find the **language**  $L(G)$  over,  $\{a,b,c\}$  generated by the grammar,  $G$  with production:  $S \rightarrow aSb, aS \rightarrow Aa, Aab \rightarrow c$ . [4+4]  
 ii) Write a grammar that generates the string over  $\{a,b\}$  not ending with  $ab$ .
6. Find the solution of recurrence relation of  $a_n = 5a_{n-1} - 6a_{n-2} + 3n + 2^n$  with initial condition  $a_0 = 0, a_1 = 1$ , and  $a_2 = 2$ . [8]
7. Prove the theorem, "An undirected graph has an even number of vertices of odd degree." Describe complete graph and bipartite graph. [3+5]
8. What is chromatic number of  $K_5, K_{m,n}$  and  $C_p$  for  $P \geq 3$ , explain with suitable figure. How Euler graph is different from Hamilton graph, explain? [5+3]

9. Use Dijkstra's algorithm to find the length of a shortest path from the vertices A to other in the graph below.

[8]



10. Write short notes on:

[4+4]

- i) Max Flow and Min cut Theroem
- ii) Plannar Graph

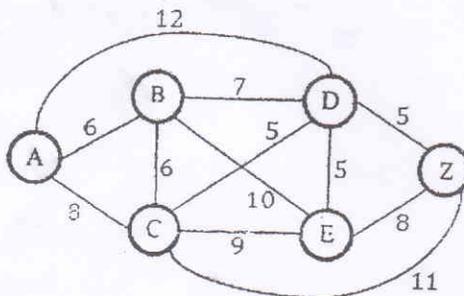
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Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

*Subject: - Discrete Structure (CT551)*

- ✓ 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. Use rules of inference to show that the hypothesis "If my cheque book is in office, then I have paid my telephone bill", "I was looking for phone bill at breakfast of I was looking for phone bill in my office", "If I was looking for phone bill at breakfast then my cheque book is on breakfast table", "If I was looking for phone bill in my office then my cheque book is in my office", "I have not paid my phone bill" imply the conclusion "My cheque book is on my breakfast table." [8]
2. Write the inverse, converse and contrapositive of the statement "I visit temple only if it's Saturday". Prove that if n is a positive integer, then n is even if and only if  $7n + 4$  is even. [3+5]
3. Define tableau method with its significances? Use mathematical induction to prove the formula for the sum of a finite number of terms of Geometric Progression: [4+4]
 
$$\sum_{j=0}^n ar^j = a + ar + ar^2 + \dots + ar^n = \frac{ar^{n+1} - a}{r-1},$$
 when  $r \neq 1$ , where n is non-negative integer.
4. Given a language,  $L = \{w \in \{a, b\}^* : w \text{ contain at-least three 'b' s}\}$   
 Write the regular expression for L and design a Finite State Automata that accepts the Language L. Your design should include the proper definition of the finite-state automation, transition table and the transition diagram. [2+6]
5. Consider the regular grammar  $G = \{N, T, P, \sigma\}$  where N = set of non-terminal symbols =  $\{\sigma, C\}$ , T = set of terminal symbols =  $\{a, b\}$ , P is the set of production rules =  $\{\sigma \rightarrow b\sigma, \sigma \rightarrow aC, C \rightarrow bC, C \rightarrow b\}$  and  $\sigma$  being the starting symbol. Construct a non-deterministic finite state automaton equivalent to the given regular grammar. Use this non-deterministic finite state automaton to generate equivalent deterministic finite state automaton. [3+5]
6. State linear homogeneous and non-homogeneous recurrence relation with examples. Find all solutions of the recurrence relation:  $a_n = 2a_{n-1} + 2n^2$  with initial condition  $a_1 = 4$ . [3+5]
7. Use Dijkstra's algorithm to find the length of shortest path from vertex A to vertex Z in the following weighted graph. Also highlight the shortest path/paths in the graph: [8]



8. State Handshaking Theorem for undirected graph. Define bipartite graph with suitable example. Draw the figure for Complete Bipartite Graph  $K_{3,4}$  and determine its chromatic number. [2+2+2+2]
9. How does Hamiltonian circuit differ from Euler circuit? Define Planar and Regular graphs with suitable examples. [4+2+2]
10. Write short notes on: [4+4]
- a) Tree and its applications
  - b) Max-flow Min-cut Theorem

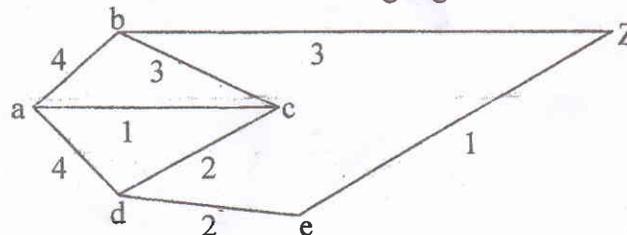
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Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Discrete Structure (CT551)

- ✓ 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. Hypothesis: "If today is Sunday then I will have a test in MFC and IT. If my IT teacher is sick then I will not have a test in IT. Today is Sunday and my IT teacher is sick." Conclusion: "I will have a test in MFC." Use rule of inference to prove it. [8]
2. What do you mean by weak principle of mathematical induction? Prove that  $5^n - 1$  is divisible by 4 for all  $n \geq 1$  using Induction method. [3+5]
3. What are the central ideas of formal and informal proofs? Prove that  $\sqrt{2}$  is irrational. [4+4]
4. Define Non-Deterministic Finite State Automata. Design a finite-state automation that accepts only those set of strings over  $\{a,b\}$  which ends with  $aba$ . Precisely, only those strings which end with  $aba$  should accepted and other strings over  $\{a,b\}$  should be rejected. Your design should include the proper definition of the finite-state automation, transition table and the transition diagram. [2+6]
5. Consider the regular grammar  $G = (N, T, P, \sigma)$  where  $N$  =set of non-terminal symbols =  $\{\sigma, C\}$ ,  $T$  = set of terminal symbols =  $\{a, b\}$ ,  $P$  is the set of production rules =  $\{a \rightarrow b\sigma, \sigma \rightarrow aC, C \rightarrow bC, C \rightarrow b\}$  and  $\sigma$  being the starting symbol. Construct a non-deterministic finite state automaton equivalent to the given regular grammar. Use this non-deterministic finite state automaton to generate equivalent deterministic finite state automaton. [4+4]
6. What do you understand by recurrence relation? Explain in brief. Setup a recurrence relation for the sequence representing the number of moves needed to solves Hanoi Tower puzzle. [3+5]
7. Draw neat and clean graphs of:  $W_6$  (a wheel with 6 peripheral vertices),  $K_6$  (a complete graph with 6 vertices),  $Q_3$  (a 3 dimensional hypercube) and  $K_{2,5}$  (complete bipartite graph). Use graph coloring technique to color each of these graphs and state their respective chromatic numbers. [4+4]
8. Find the shortest path from vertex a to vertex Z Highlight the shortest paths in the graph. [6+2]



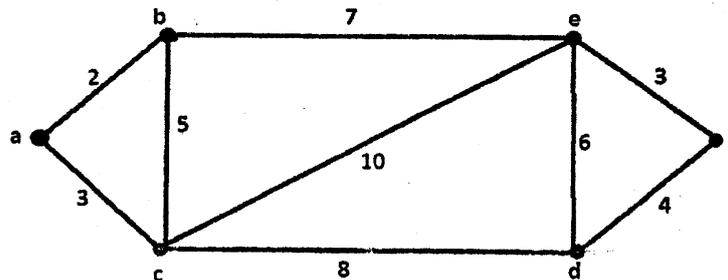
9. Explain the Euler circuit and Hamilton circuit with example. State the necessary and the sufficient conditions for them. [2+2+2+2]
10. Write short notes on: [4+4]
  - i) Spanning Trees
  - ii) Max-flow min-cut theorem

Exam.	Program		
Level	BE	Full Marks	60
Programme	BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject: - Discrete Structure (CT551)**

- ✓ 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. Using resolution principle, prove that the hypotheses "If today is Tuesday then I will have a test in Discrete Structure or Microprocessor". If my Microprocessor teacher is sick then I will not have a test in Microprocessor." and "Today is Tuesday and my Microprocessor teacher is sick." lead to the conclusion that "I will have a test in Discrete Structure". [8]
2. Prove that  $\sqrt{2}$  is irrational by giving a proof by contradiction. Draw the tableau for the formula  $(T \vee S) \rightarrow \neg Q$  where  $\neg$  denotes the negation of variable,  $\vee$  denotes the disjunction of variables and  $\rightarrow$  is the symbol for implication. [5+3]
3. State the contrapositive and inverse of the conditional statement, "If it snows tonight then I will stay at home". Using mathematical induction technique, prove that the following statement is true:  $3+3*5+3*5^2+\dots+3*5^n=3(5^{n+1}-1)/4$  whenever  $n$  is nonnegative integer. [2+6]
4. Differentiate between a Finite State Machine and a Finite State Automation. Design a Finite State Automata that accepts precisely those string over  $\{a,b\}$  that contains an even no. of a's. Your design should include the proper definition of the Finite State Automata, transition table and the transition diagram. [2+6]
5. Consider the regular grammar  $G = (N, T, P, \sigma)$  where  $N =$  set of non-terminal symbols  $= \{\sigma, C\}$ ,  $T =$  set of terminal symbols  $= \{a,b\}$ ,  $P$  is the set of production rules  $= \{\sigma \rightarrow b\sigma, \sigma \rightarrow aC, C \rightarrow bC, C \rightarrow b\}$  and  $\sigma$  being the starting symbol. Construct a non-deterministic finite state automaton equivalent to given regular grammar. Use this non-deterministic finite state automaton to generate equivalent deterministic finite state automaton. [4+4]
6. Find all the solutions of the recurrence relation: [8]  
 $a_n = 5a_{n-1} - 6a_{n-2} + 2^n$  with initial conditions  $a_0 = 1$  and  $a_1 = 4$
7. Explain the Euler path and Euler circuit with the help of a diagram. State the necessary and the sufficient conditions for Euler circuits and paths. [5+3]
8. Draw neat and clean graphs of:  $C_7$  (a cycle with 7 vertices),  $K_5$  (a complete graph with 5 vertices),  $Q_3$  (a 3 dimensional hypercube) and  $K_{3,4}$  (complete bipartite graph). Use graph coloring technique to color each of these graphs and state their respective chromatic numbers. [4+4]
9. Use Dijkstra's algorithm to find the length of shortest path in the following weighted graph. Also highlight the shortest path/paths in the graph. [8]



10. Write short notes on: [4+4]
  - i) Maximum Flow Mincut Theorem
  - ii) Handshaking Theorem

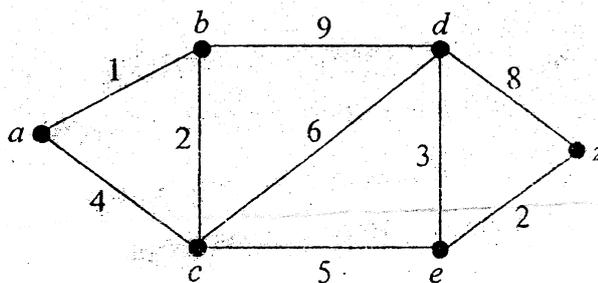
Exam.	Regular / Back		
	Level	BE	Full Marks
Programme	BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

*Subject: - Discrete Structure (CT551)*

- ✓ 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. Use resolution to show the hypothesis "It is not raining or Sita has her umbrella," "Sita does not have her umbrella or she does not get wet," and "It is raining or Sita does not get wet" imply that "Sita does not get wet." [8]
- ✓ 2. Use mathematical induction to show that [8]
 
$$1^3 + 2^3 + \dots + n^3 = [n(n+1)/2]^2$$
 whenever n is a positive integer.
- ✓ 3. State the converse, contrapositive and inverse for the conditional statement, "I go to the beach whenever it is a sunny summer day." [3]
- ✓ 4. Why is a tableau method important in propositional logic? Draw the tableau for the formula [2+3]
 
$$\Phi = (p \wedge \neg q) \rightarrow s$$
 Where  $\neg$  denotes the negation of a variable,  $\wedge$  denotes the conjunction of variables and  $\rightarrow$  denotes the implication.
- ✓ 5. Differentiate between Finite State Machines and Finite State Automata. Design a Finite State Automata that accepts precisely those strings over {a, b} that contain an odd number of b's. Your design should include the proper definition of the finite-state automation, transition table and the transition diagram. [2+6]
- ✓ 6. Consider the regular grammar  $G = (N, T, P, \sigma)$  where  $N =$  Set of Non-Terminals = { $\sigma, A, B$ },  $T =$  Set of Terminals = {a, b} with productions. [4+4]
 
$$\sigma \rightarrow aA, \sigma \rightarrow bB, A \rightarrow a, B \rightarrow a$$
 and starting symbol  $\sigma$ .  
 Construct a Non-Deterministic Finite State Automata equivalent to the above given regular grammar and convert this into equivalent Deterministic Finite State Automata.
- ✓ 7. Find all solutions of the recurrence relation [8]
 
$$a_n = 3a_{n-1} + 2^n$$
 with initial condition  $a_0 = 5$ .

8. Use Dijkstra's algorithm to find the length of the shortest path between the vertices a and z in the weighted graph displayed below. [8]



9. Draw the figure for the complete graph with 6 vertices (This is usually denoted by  $K_6$ ). Define the term graph coloring and the chromatic number of a graph coloring. What is the chromatic number of the complete graph  $K_6$ ? [2+2+2+2]

10. Explain the Hamiltonian path and Hamiltonian circuit with the help of a diagram. State the necessary and sufficient conditions for Euler circuits and paths. How is Euler circuit different from the Hamiltonian circuit? [3+2+2]

11. Write short notes on: [3+3+3]

- Spanning tree
- Cutsets and Cutvertices
- Application of trees

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63

37 TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING

**Examination Control Division**  
2070 Bhadra

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

**Subject: - Discrete Structure (CT551)**

- ✓ 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. If  $P = F, Q = T, S = T, R = F$ , then find truth value of: [4+4]
  - 8 a)  $(S \rightarrow (P \wedge \bar{R})) \wedge ((P \rightarrow (R \vee Q)) \wedge S)$
  - b)  $((P \wedge \bar{Q}) \leftrightarrow (Q \wedge R)) \rightarrow (S \vee \bar{Q})$
2. Using rules of inferences, show that the hypothesis "It is not rainy today and its hotter than yesterday", "We will go for movie only if it is rainy", "If we do not go for movie, then we will go for shopping", and "If we go for shopping, then we will be home by sunset" lead to the conclusion "We will be home by sunset". You are required to show each steps and give reasons for those steps before you come to desired conclusion from the hypothesis. [8]
3. Prove by Mathematical Induction: [8]
  - 8  $1.2.3 + 2.3.4 + 3.4.5 + \dots + n(n+1)(n+2) = n(n+1)(n+2)(n+3)/4$
- +4. Design a Finite State Machines (FSM) that performs binary serial addition. Define DFA and NFA. Construct DFA that recognize the language "The set of bit strings that do not contain three consecutive 0's. Show only necessary figures and state diagrams. [3+2+3]
- 4 +5. Define and differentiate between context-sensitive, context free and regular grammars with suitable examples. Explain in short the role of regular expressions. [6+2]
6. 6. What do you understand by recurrence relation? Explain in brief. Derive and solve the recurrence relation for Tower of Hanoi puzzle. [2+6]
- 4 +7. Is  $K_{3,3}$  graph a planar graph? Explain it with suitable reasons. [4+4]
6. 8. Define Regular and Bipartite graphs with suitable examples. [3+3]
2. 9. Define level and height of tree? What is full m-ary tree and balanced tree? [2+2]
6. 10. State the handshaking theorem for the undirected graph and use it to prove the theorem that an undirected graph has an even number of vertices of odd degree. [2+4]
11. Write down the short notes on the following: [4+4]
  - 6 a) Maximum Flow Mincut Theorem
  - b) Graph Coloring

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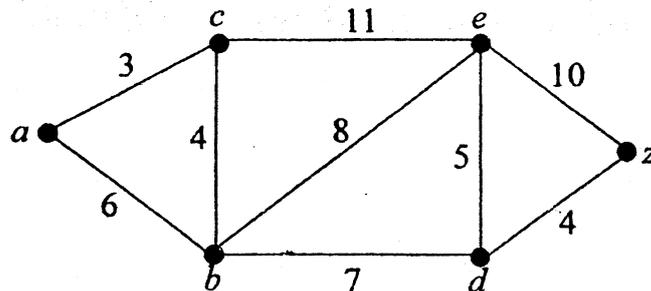
Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

*Subject: - Discrete Structure (CT551)*

- ✓ 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. Construct an argument using rules of inference to show that the hypotheses "Randy works hard," "If Randy works hard, then he is a dull boy," and "If Randy is a dull boy, then he will not get the job" imply the conclusion "Randy will not get the job." [8]
2. Use mathematical induction to show that  $1^2 + 2^2 + \dots + n^2 = n(n+1)(2n+1)/6$  whenever  $n$  is a positive integer. [8]
3. State the converse, contrapositive and inverse for the conditional statement, "A positive integer is a prime only if it has no divisors other than 1 and itself." [3]
4. Define satisfiable and unsatisfiable formulas. Draw the tableau for the formula  $\Phi = \neg((p \wedge q) \vee r)$  where  $\neg$  denotes the negation of a variable,  $\vee$  denotes the disjunction of variables and  $\wedge$  denotes the conjunction of variables. [2+3]
5. Define Finite State Machines. Design a Finite State Automata that accepts precisely those strings over  $\{a, b\}$  that contain two consecutive a's. Your design should include the proper definition of the finite-state automaton, transition table and the transition diagram. [2+6]
6. Consider the regular grammar  $G = (N, T, P, \sigma)$  where  $N =$  Set of Non-Terminals  $= \{\sigma, A, B\}$ ,  $T =$  Set of Terminals  $= \{a, b\}$  with productions  $\sigma \rightarrow a, \sigma \rightarrow bB, A \rightarrow bA, A \rightarrow aB, A \rightarrow b, A \rightarrow a, B \rightarrow b$  and starting symbol  $\sigma$ . Construct a Non-Deterministic Finite State Automata equivalent to the above given regular grammar and convert this into equivalent Deterministic Finite State Automata. [4+4]
7. Find all solutions of the recurrence relation  $a_n = 2a_{n-1} + 2^n$  with initial condition  $a_0 = 2$ . [8]

8. Use Dijkstra's algorithm to find the length of the shortest path between the vertices  $a$  and  $z$  in the weighted graph displayed below. [8]



9. Draw the figure for the complete graph with 5 vertices (This is usually denoted by  $K_5$ ). Define the term graph coloring and the chromatic number of a graph in graph coloring. What is the chromatic number of the complete graph  $K_5$ . [2+2+2+2]
10. Construct an influence graph for the board members of a company if the President can influence the Director of Research and Development, the Director of Marketing, and the Director of Operations; the Director of Research and Development can influence the Director of Operations; the Director of Marketing can influence the Director of Operations; and no one can influence, or be influenced by, the Chief Financial Officer. [4]
11. How is Euler circuit different from the Hamiltonian circuit? Explain [3]
12. Write short notes on [3+3+3]
- a) Spanning tree and its applications
  - b) Network Flows
  - c) Regular graphs

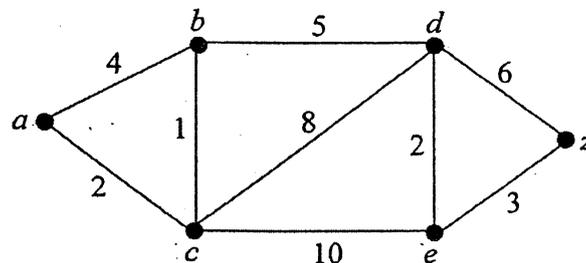
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Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject: - Discrete Structure**

- ✓ 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) Using rules of inferences, show that the hypotheses "If you send me an e-mail message, then I will finish writing the program," "If you do not send me an e-mail message, then I will go to sleep early," and "If I go to sleep early, then I will wake up feeling refreshed" lead to the conclusion "If I do not finish writing the program, then I will wake up feeling refreshed." You are required to show each steps and give reasons for those steps before you come to the desired conclusion from the hypotheses. (8)
- 2) Use mathematical induction to prove that (8)  
 $3 + 3 \cdot 5 + 3 \cdot 5^2 + \dots + 3 \cdot 5^n = 3(5^{n+1} - 1) / 4$   
 whenever n is a nonnegative number.
- 3) Prove that  $\sqrt{2}$  is irrational by giving a proof by contradiction. Draw the tableau for the formula  $(TVS) \rightarrow \neg Q$  where  $\neg$  denotes the negation of a variable,  $\vee$  denotes the disjunction of variables and  $\rightarrow$  is the symbol for implication. (5+3)
- 4) Design a finite-state automaton that accepts only those set of strings over  $\{a, b\}$  which starts with  $baa$ . Precisely, only those strings which begin with  $baa$  should be accepted and other strings over  $\{a, b\}$  should be rejected. Your design should include the proper definition of the finite-state automaton, transition table and the transition diagram. (3+2+3)
- 5) Discuss regular expressions and regular languages in detail with suitable examples. Explain the different properties of regular languages. (4+4)
- 6) Find all solutions of the recurrence relation (8)  
 $a_n = 2a_{n-1} + 3^n$   
 with initial condition  $a_1 = 5$ .
- 7) Use Dijkstra's algorithm to find the length of the shortest path between the vertices  $a$  and  $z$  in the weighted graph displayed below. (8)



- 8) Draw the figure for the complete bipartite graph  $K_{3,4}$  and the cycle graph with 5 vertices (This is usually denoted by  $C_5$ ). What is the chromatic number of the drawn complete bipartite graph  $K_{3,4}$  and the cycle graph  $C_5$ . (2+2+2+2)
- 9) State the handshaking theorem for the undirected graph and use it to prove the theorem that an undirected graph has an even number of vertices of odd degree. (2+4)
- 10) Write short notes on: - (4+3+3)
  - a) Eulerian graph
  - b) Hamiltonian graph
  - c) Spanning tree

Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

*Subject: - Discrete Structure (CT551)*

- ✓ 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 Construct an argument using rules of inference to show that the hypotheses "If it does not rain or if it is not foggy, then the sailing race will be held and the lifesaving demonstration will go on," "If the sailing race is held, then the trophy will be awarded," and "The trophy was not awarded" imply the conclusion "It rained." You are required to show each step and give reasons for those steps before you come to the desired conclusion from the hypotheses. [8]
- 2 Use mathematical induction to prove the inequality  $n < 2^n$  for all positive integers  $n$ . [8]
- 3 Why tableau method is important in the propositional logic? Draw the tableau for the formula set  $\Phi = \{(p \wedge \neg q) \rightarrow s, \neg q \vee \neg r, p \wedge t\}$  where  $\neg$  denotes the negation of a variable,  $\vee$  denotes the disjunction of variables,  $\wedge$  denotes the conjunction of variables and  $\rightarrow$  denotes the implication. [2 + 6 = 8]
- 4 Differentiate between Deterministic Finite State Automata and Non-Deterministic Finite State Automata. Design a Finite State Automata that accepts precisely those strings over  $\{a, b\}$  that contain an even number of a's. Your design should include the proper definition of the finite-state automaton, transition table and the transition diagram. [2+6 = 8]
- 5 Consider the regular grammar defined by  $T = \{a, b\}$ ,  $N = \{\sigma, C\}$  with productions  $\sigma \rightarrow b\sigma$ ,  $\sigma \rightarrow aC$ ,  $C \rightarrow bC$ ,  $C \rightarrow b$  and starting symbol  $\sigma$ . Construct a Non-Deterministic Finite State Automata equivalent to the above given regular grammar and convert this into equivalent Deterministic Finite State Automata. [4 + 4 = 8]

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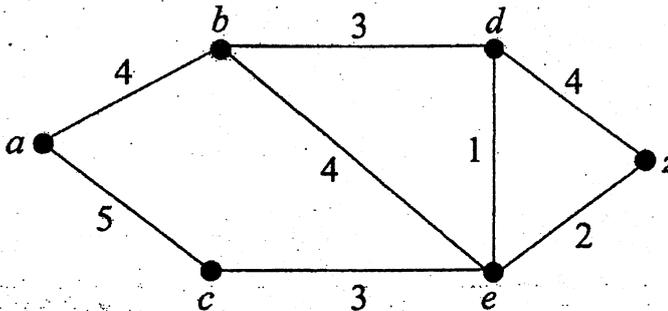
Find all solutions of the recurrence relation

$a_n = 7a_{n-1} - 16a_{n-2} + 12a_{n-3} + n4^n$   
with initial condition  $a_0 = -2$ ,  $a_1 = 0$  and  $a_2 = 5$ .

[8]

- 7 Use Dijkstra's algorithm to find the length of the shortest path between the vertices  $a$  and  $z$  in the weighted graph displayed below.

[8]



- 8 Draw the figure for the complete bipartite graph  $K_{4,5}$  and the cycle graph with 6 vertices (This is usually denoted by  $C_6$ ). What is the chromatic number of the drawn complete bipartite graph  $K_{4,5}$  and the cycle graph  $C_6$ .

[2+2+2+2]

- 9 Define a tree and discuss its various properties as well as applications of trees.

[1+2+4=7]

- 10 Write short notes on: -

- Eulerian graph
- Max flow, min cut theorem
- Planar and regular graphs

[3+3+3=9]

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