



MASENO UNIVERSITY
UNIVERSITY EXAMINATIONS 2016/2017

**FIRST YEAR SECOND SEMESTER EXAMINATIONS FOR THE
DEGREE OF BACHELOR OF SCIENCE IN INFORMATION
TECHNOLOGY**

MAIN CAMPUS

CIT 112: DISCRETE STRUCTURES II

Date: 13th June, 2017

Time: 8.30 - 11.30 am

INSTRUCTIONS:

- Answer question ONE and any TWO questions from SECTION B
- Use a NEW PAGE FOR EVERY QUESTION attempted, and indicate number on the space provided on the page of the answer sheet.
- Fasten together all loose answer sheets used.
- Mobile phones and PDAs are NOT allowed in the examination room.

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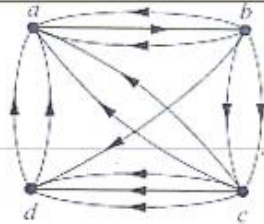


Question one (30 marks)

Answer all questions

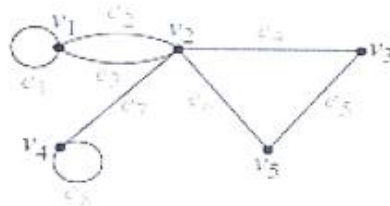
- a. Let \mathcal{R} be the relation on the set of real numbers such that $x\mathcal{R}y$ if and only if x and y are real numbers that differ by less than 1, that is $|x - y| < 1$. Show that \mathcal{R} is not an equivalence relation. [5 marks]

- b. Find the in-degree and out-degree of each vertex in the graph G with directed edges shown in the figure below [5 marks]



- c. Represent the pseudograph shown in Figure below using an incidence matrix.?

[5 marks]



- d. Let G be the grammar with vocabulary $V = \{S, A, a, b\}$, set of terminals $T = \{a, b\}$, starting symbol S , and productions $P = \{S \rightarrow aA, S \rightarrow b, A \rightarrow aa\}$. What is $L(G)$, the language of this grammar? [5 marks]

- e. Show that the graphs $G = (V, E)$ and $H = (W, F)$, displayed in Figure 3 below, are isomorphic? [5 marks]

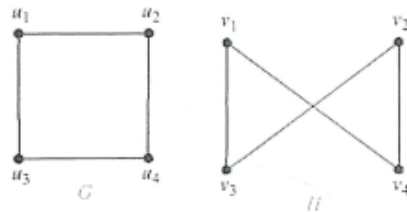


Figure 3

- f. Which of the directed graphs in Figure 4 have an Euler circuit? Draw the circuit. Of those that do not, which have an Euler path? [5 marks]

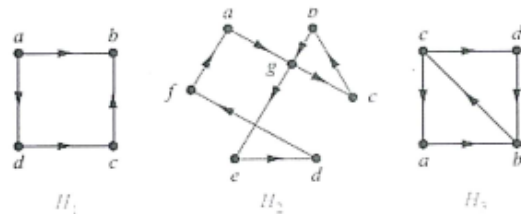


Figure 4

Section B

Answer any two questions

Question Two (20 marks)

- a. Determine whether the word $cbab$ belongs to the language generated by the grammar $G = (V, T, S, P)$, where $V = \{a, b, c, A, B, C, S\}$, $T = \{a, b, c\}$, S is the starting symbol, and the productions are
- $S \rightarrow AB$
 - $A \rightarrow Ca$
 - $B \rightarrow Ba$
 - $B \rightarrow Cb$
 - $B \rightarrow b$

C→cb

C→b.

[6 marks]

- b. Construct the state diagram for the finite-state machine with the state table shown in Table 2 [6 marks]

State	<i>f</i>		<i>g</i>	
	Input		Input	
	0	1	0	1
s ₀	s ₁	s ₀	1	0
s ₁	s ₃	s ₀	1	1
s ₂	s ₁	s ₂	0	1
s ₃	s ₂	s ₁	0	0

- c. Represent the expressions $(x + xy) + (x/y)$ and $x + ((xy + x)/y)$ using binary trees.

Write these expressions in

- Prefix notation.
- Postfix notation.
- Infix notation

[8 marks]

Question Three (20 marks)

- a. Show that the maximum number of vertices in a binary tree of height h is $2^{h+1} - 1$.

[6 marks]

- b. On a set $S = \{1,2,3,4,5\}$, find the equivalence relation on S , which generate the partition $\{\{1,2\}, \{3\}, \{4,5\}\}$. Draw the graph of the relation. [6marks]

- c. What is the solution of the recurrence relation $a_n = 6a_{n-1} - 9a_{n-2}$ with $a_0 = 1$ and $a_1 = 6$?

[8 marks]

Question Four (20 marks)

- a. Use Prim's algorithm to design a minimum-cost communications network connecting all the computers represented by the graph in Figure 1. **[6 Marks]**

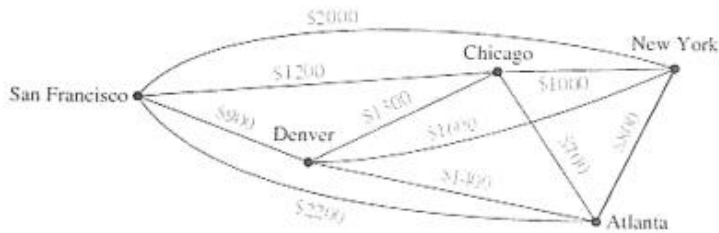


FIGURE 1 A Weighted Graph Showing Monthly Lease Costs for Lines in a Computer Network.

- b. i) Explain how to use preorder, inorder, and postorder traversals to find the prefix, infix, and postfix forms of an arithmetic expression.
 ii) Draw the ordered rooted tree that represents $((x - 3) + ((x/4) + (x - y) \uparrow 3))$.
 iii) Find the prefix and postfix forms of the expression in part (b).
- c. Each of the 50 students in the first year of Maseno university computer science department studies at-least one of the subsidiary subjects: mathematics, Electronics and accounting. Given that that 30 study mathematics, 18 study electronics 26 study accounting , 9 study mathematic and electronics, 16 study mathematics and accounting and 8 study electronics and accounting, 47 study at least one of three subject

(8 marks)

- i. how many students study none of the three subjects
- ii. how many students study all of the three subjects.
- iii. How many students study mathematics and electronics but not accounting

- iv. How many students study mathematics but neither electronics nor accounting
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Question Five (20 marks)

- a. Let G be a connected graph. Show that if T is a spanning tree of G constructed using depth-first search, then an edge of G not in T must be a back edge, that is, it must connect a vertex to one of its ancestors or one of its descendants in T . **(9 marks)**
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- b. Define Boolean algebra. Prove that the power set of any set will form a Boolean algebra. **(6 marks)**
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- c. A committee of three individuals decides issues for an organization. Each individual votes either yes or no for each proposal that arises. A proposal is passed if it receives at least two yes votes. Design a circuit that determines whether a proposal passes. **(5 marks)**
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