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KIRIRI WOMEN'S UNIVERSITY OF SCIENCE AND TECHNOLOGY
UNIVERSITY EXAMINATION, 2024/2025 ACADEMIC YEAR
SECOND YEAR, FIRST SEMESTER EXAMINATION
FOR THE BACHELOR OF BUSINESS & INFORMATION TECHNOLOGY
KBI 2108 – DISCRETE STRUCTURES

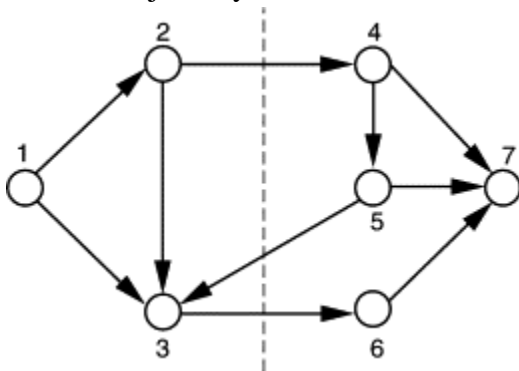
Date: 11TH April 2024
Time: 8:30AM – 10:30AM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS

QUESTION ONE (30 MARKS)

- a) List the set given below
- (i) $A = \{x | x \text{ is an even number than } 20\}$ (1 Mark)
 - (ii) $B = \{t | t \text{ is a perfect cube}\}$ (1 Mark)
 - (iii) $C = \{p | p \text{ is a less than } 100\}$ (1 Mark)
- b) Suppose $A = \{1, 2, 3, 5, 8, 13, 21, 34, 55\}$. Write A using set builder notation. (2 Marks)
- c) Let $X = \{1, b, c\}$. Find
- (i) $|X|$ (1 Mark)
 - (ii) $P(X)$ (3 Marks)
 - (iii) $|P(X)|$ (2 Marks)
- d) Use truth tables to verify that $p \wedge (q \vee r) \Leftrightarrow (p \wedge q) \vee (p \wedge r)$ (5 Marks)
- e) The following information was found in a survey of 120 university students. 40 studied discrete structures, 50 studied calculus for business information and 15 studied both discrete structures and calculus for business information. Determine the number of students who studied
- (i) Discrete structures only (3 Marks)
 - (ii) Calculus for business information only (1 Mark)
 - (iii) Exactly one subject (2 Marks)
 - (iv) Neither subject (2 Marks)
- f) Draw the adjacency matrix of the following graph (5 Marks)



- g) Illustrate using examples the meaning isomorphic graphs (1 Mark)

QUESTION TWO (20 MARKS)

- a) In a battle 100 men were shot. 42 were shot in the head, 43 in the arm, 32 in the legs, 5 were shot in the head and the arm, 8 in the arm and the legs, 6 in the legs and the head. Represent the above information in a well labelled Venn diagram and hence find how many were shot in all three places. (6 Marks)
- b) Give examples how reflexive relations are applied in Information and Technology (2 Marks)
- c) With an appropriate example, show that a set A with n elements has 2^{n^2} possible relations (5 Marks)
- d) Given $U = \{1,2,3,4,5, \dots, 10,12\}$, $A = \{1,2,3,4,5\}$, $B = \{2,4,6,8,10\}$ and $C = \{3,4,5,6,7\}$. Find
- (i) $(A \cup B)$ (1 Mark)
 - (ii) $A \cap B$ (1 Mark)
 - (iii) A' (1 Mark)
 - (iv) $(B \cup C)'$ (2 Marks)
 - (v) $(A \cap C)'$ (2 Marks)

QUESTION THREE (20 MARKS)

- a) With examples explain how transitivity in relations is applicable in real life. (3 Marks)
- b) If Waitherero buys an iPad then she either sold a Taifa Laptop or used her HELB money. Waitherero sold her Taifa Laptop if and only if she did not borrow money from HELB. Therefore Waitherero did not buy an iPad. Determine the validity of this argument (6 Marks)
- c) Show that $[(p \vee q) \wedge (p \rightarrow r) \wedge (q \rightarrow r)] \rightarrow r$ is a tautology (5 Marks)
- d) Show that $p \wedge (q \vee r)$ and $(p \wedge q) \vee (p \wedge r)$ are logically equivalent (6 Marks)

QUESTION FOUR (20 MARKS)

- a) A certain family consists of a mother, father, daughter and two sons. The family members have influence or power over each other in the following ways: the mother can influence the daughter and the oldest son; the father can influence the two sons; the daughter can influence the father; the oldest son can influence the youngest son and the youngest son can influence the mother. Model this family influence pattern with a directed graph. (3 Marks)
- b) Given the sets: $A = \{1,2\}$, $B = \{x, y, z\}$ and $C = \{3,4\}$, find $A \times B \times C$ (6 Marks)
- c) Given $A = \{1,2,3,4\}$ and $B = \{x, y, z\}$, let R be the relation from A to B such that $R = \{(1, y), (1, z), (3, y), (4, x), (4, z)\}$
- i) Determine the matrix of the relation. (4 Marks)
 - ii) Draw the arrow diagram of R . (3 Marks)
 - iii) Find the inverse relation of R . (2 Marks)
 - iv) Determine the domain and range of R . (2 Marks)

QUESTION FIVE (20 MARKS)

- a) Consider the (4,2) encoding function, given

$$e(00) = 0000$$

$$e(10) = 0110$$

$$e(01) = 1011$$

$$e(11) = 1100$$

How many errors will e detect?

(5 Marks)

- b) Find the code words generated by the encoding function with respect to the parity check matrix H ;

$$H = \begin{bmatrix} 0 & 1 & 1 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

(5 Marks)

- c) Consider the code $C = \{0000, 1011, 0101, 1110\}$.

i. Find the corresponding decoding table.

(3 Marks)

ii. Use the table to decode the received word 1101.

(2 Marks)

- d) Let $\begin{bmatrix} 0 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 1 & 0 & 1 & 1 & 1 \end{bmatrix}$ be a parity check matrix of the (7, 4) Hamming code. If $y = 1111011$ is received, determine the code word which was most likely sent.

(5 Marks)