↑ FF → T
↓ TT → F

BMA-401

MCA MID-ODD SEMESTER EXAMINATION, 2017-2018

DISCRETE STRUCTURES

Time: $1\frac{1}{2}$ Hour M.M.: 30

Note: Attempt all questions.

1.(a) Examine $P \to Q, Q \to R, S \to \neg R$ and $P \wedge S$ for consistency.
 (b) Examine $\{\uparrow\}$ and $\{\downarrow\}$ for a functionally complete set of connectives.
 (c) Does P follow logically from $(\neg P \vee \neg Q) \to (R \wedge S)$, $R \longrightarrow T$ and $\neg T$?

2.(a) Develop a recurrence relation model for the number of valid n-digit codewards, each of which is a valid codeword if it contains an even number of 0 digits. Use genrating functions to solve the model .
 (b) Illustrate with examples one application of : (i) Hamilton circuit, (ii) Graph coloring.
 (c) Write adjacency matrices for K_n *and* $K_{m,n}$.

TSP

3.(a) Determine which amounts of postage can be formed using just 4-cent and 11-cent stamps only. Prove your answer using strong induction.
 (b) Examine a relation defined on $\mathbb{R} \times \mathbb{R}$ by $(a,b)R(c,d)$ iff $a + 2b = c + 2d$ for an equivalence relation. Determine $[(3,5)]_R$.
 (c) Examine the set of positive rational numbers for a countable set.

4.(a) Examine $(D_{70}, |)$ for a poset, a lattice and its types and a Boolean algebra.
 (b) Illustrate the use of Quine-McCluskey's method to find minimum SOP for:
 $f(a,b,c,d) = \sum m\,(2,3,7,9,11,13) + \sum \Phi(1,10,15)$.
 (c) Explain Boolean isomorphism. Examine $(D_{70}, |)$ and $(P(2,3,7), \subseteq)$ for isomorphic. Boolean algebras.

5.(a) Establish the validity of the following argument.
 "There is a man whom all men adore. Therefore, atleast one man adores himself."
 (b) Find the discrete numeric function corresponding to EGF: $E(Z) = e^{z^3}$
 (c) Develop a program in C/C^{++} to compute a transitive closure of a relation on the set $A = \{1,2,3\}$ given by $R = \{<1,2>, <2,3>, <3,1>\}$.

Isomorphism

∧, ∨, poset. Homomorphi

1 (b) (c) (d)

Date of showing evaluated answer books: 30.12.2017

No. of Printed Pages: 2 Subject Code: B M A 4 0 1

MCA ODD SEMESTER EXAMINATION, 2017-18

DISCRETE STRUCTURES

Time: 2:30 Hrs. **Max. Marks: 50**

Note: 1. Attempt *all* questions.
2. All questions carry marks as shown against them.

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1. (a) Use a proof by contraposition to prove the theorem: 2
"If $3n + 2$ is odd, then n is odd", where n is an integer.

(b) Establish the validity of the argument: 2
"If today is Tuesday, I have a test in Mathematics or Economics. If my Economics Professor is sick, I will not have a test in Economics. Today is Tuesday and my Economics Professor is sick. Therefore, I have a test in Mathematics."

(c) Examine $P \to Q, Q \to R, S \to \neg R$ and $P \wedge S$ for consistency. 2

(d) Establish the validity of the argument: 2
"Damini, a student in MCA class knows how to write programs in Java. Every one who knows how to write programs in Java can get a high-paying job. Therefore, someone in this class can get a high-paying job."

(e) Write a program in C/C++ to examine the logical equivalence of the statements: 2
$$(P \to Q) \wedge (P \to R) \quad and \quad P \to (Q \wedge R)$$

2. (a) Illustrate the application of mathematical induction in the analysis of computer algorithms/programs. 2

(b) Examine the set $N \times N \times N$ for a countable set. 2

(c) Examine the relation R on $\mathbb{R} \times \mathbb{R}$ defined by : 2
$$_{(a,b)}R_{(c,d)} \text{ if } a + 2b = c + 2d$$
for an equivalence relation. Find $[(3,4)]$.

(d) Use the pigeon-hole principle to prove or disaprove the statement: 2
"If five points are selected in the interior of a square with side = 1unit, there are atleast two whose distance apart is less than $\frac{1}{\sqrt{2}}$."

(e) State the principle of inclusion-exclusion and illustrate its applications. 2

3. (a) An encoding function is defined by the generator matrix: 5
$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

(i) Examine whether the matrix is useful in correcting single errors in transmission.

(ii) Examine the encoding function for a group code and a Hamming

(6,3)

code. Find its rate.

(iii) Use the syndrome table to decode 101001 and find original message.

(iv) Decode the received word : 110001 and find original word.

(b) The operations ⊕ and ⊙ on $R = \{s, t, x, y\}$ of a ring $(R\ ⊕, ⊙)$ are given by the table below: 5

⊕	s	t	x	y
s	y	x	s	t
t	x	y	t	s
x	s	t	x	y
y	t	s	y	x

⊙	s	t	x	y
s	y	y	x	x
t	y	y	x	x
x	x	x	x	x
y	x	x	x	x

t,s
s,t

(i) Examine (R,⊕ , ⊙) for a commutative ring. (ii) Does it has a unity?
(iii) Find a pair of zero divisors. (iv)Is it an integral domain/field?

4. (a) Develop a partially ordered structure on the set of all positive integer divisors of 42 and examine it for a partially ordered set , well ordered set , lattice with its types and Boolean algebra. 5

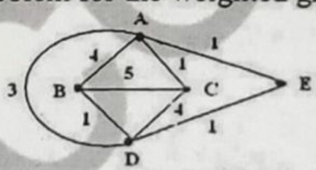
(b) Use Quine-McCluskey's method to find minimal-sum-of-products representation for 5

$$f(a,b,c,d) = \sum m(2,3,7,9,11,13,) + \sum \emptyset\,(1,10,15).$$

5. (a) A coding system encodes messages using strings of octal (base 8) digits. A codeword is considered valid if and only if it contains an even number of 7s. Develop a recurrence relation model for the number of valid code words of length n. 2

(b) Determine discrete numeric function corresponding to $EGF\ :\ e^{z^5}$. 2

(c) Solve the Chinese postman problem for the weighted graph : 2



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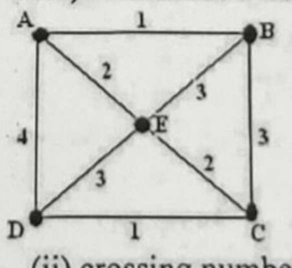
(d) Use Prim's algorithm (matrix version) to find MST for the weighted graph : 2



(e) Find (i) chromatic number of W_n (ii) crossing number of Petersen graph. 2 2

even-3
odd-4

BMA-401

MCA MID-ODD SEMESTER EXAMINATION, 2019-2020

DISCRETE STRUCTURES

M.M.: 30

Time: $1\frac{1}{2}$ Hour

Note: Attempt any *Five* questions. All questions carry marks as shown against them.

1.(a) Use two proof methods to examine the truth of the statement: "If $m + n \geq 73$, then $m \geq 37$ or $n \geq 37$, where m and n are positive integers." [3]

(b) Examine statement formulas: $p \to q,\ q \to r,\ s \to \neg r$ and $p \wedge s$ for consistency. [3]

2.(a) Examine whether $\neg q$ follows logically from: $(p \vee q) \to r,\ r \to s$ and $\neg s$. [3]

(b) Examine the validity of the argument : [3]
"Every faculty member either has a Ph.D. degree or has a Master degree. No officer who is a faculty member has a Ph.D. degree. Therefore, if every officer is a faculty member, then the officer has a Master degree."

3. There are two kinds of particles inside a nuclear reactor. In every second, an α particle will split into three α particles and one β particle, and a β particle will split into two α particles and one β particle. If there is a single α particle in the reactor initially,

(i) Develop a recurrence- relation model for the number of α and β particles in the reactor at time r. [3]

(ii) Use generating functions to solve the model. [3]

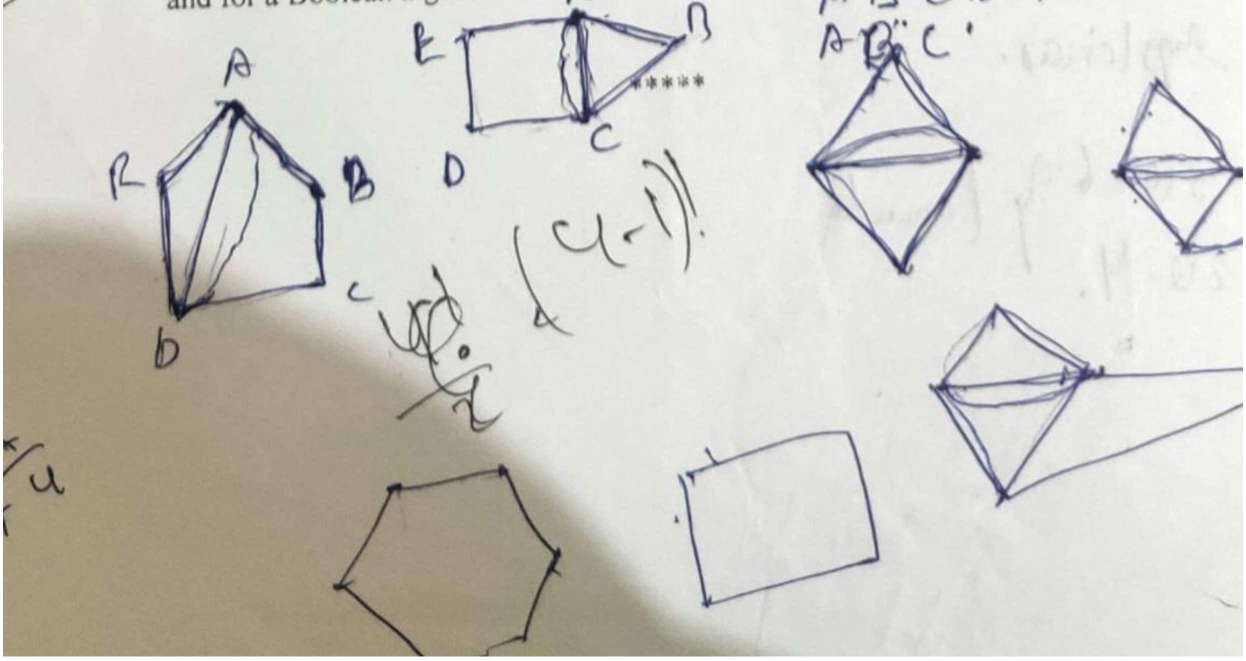
4.(a) Illustrate with an example how the Euler's formula for planar graphs can be used to examine the planarity of graphs. [3]

(b) Explain with an example how the Travelling Salesman Problem can be solved. [3]

5.(a) Discuss with an example how the principle of mathematical induction can be used to verify the correctness of a computer program. [3]

(b) If there are 5 points inside a square of side lengh 2, prove that at least two of the points are within a distance of $\sqrt{2}$ of each other. [3]

6. Examine $(D_{42}, |)$ for a poset, a lattice, a bounded, complemented and distributive lattice and for a Boolean algebra. [6]



IMA-102

MCA FIRST SEMESTER I MID-SEMESTER EXAMINATION, 2016-2017

DISCRETE STRUCTURES

Time: 1 Hour

M.M.: 15

Note: Attempt all questions.

1.(a) Use generating function to prove : $\binom{n}{r} = \binom{n-1}{r} + \binom{n-1}{r-1}$.

(b) Illustrate how the graph coloring can be used in animal habitats construction in a zoo.

2.(a) Write the adjacency and incidence matrices for $K_{m,n}$.

(b) Illustrate three different algorithms to examine the planarity of a graph.

3. There are two kinds of particles inside a nuclear reactor. In every second , an α particle will split into three α particles and two β particle, and a β particle will split into two α particles and one β particle. There is a single β particle in the reactor initially.

(i) Develop a recurrence relation model for the number of α and β particles in the reactor at time r.

(ii) Use generating functions to solve the recurrence relation model.

4.(a) Examine the validity of the following argument. Give a counter example if it is invalid.
"All whales are heavy. All elephants are heavy. Therefore, all whales are elephants."

(b) Establish the validity of the following argument.
"There is a man whom all men adore. Therefore; atleast one man adores himself."

5.(a) Write a program in C/C++ to Establish the validity of the argument :

$$\begin{array}{l} P \rightarrow Q \\ R \rightarrow \neg Q \\ \hline \therefore\ P \rightarrow \neg R \end{array}$$

(b) Use a proof by contraposition and a proof by contradiction to examine the statement:
" If $m + n \geq 73$, then $m \geq 37$ or $n \geq 37$, where m and n are positive integers."

Date of showing evaluated answer books: Dec 28, 2015

No. of Printed Pages: 2

Subject Code: IMA-102

MCA Odd Semester Examination, 2015-16

DISCRETE STRUCTURES

Time: 3 Hours **Max. Marks:** 100

Note: . Attempt all question. All questions carry marks as shown against them.

1. (a) Establish the validity of the following argument or give a counter example to show that it is invalid : [5]

$$\begin{array}{c} P \rightarrow Q \\ Q \rightarrow \neg R \\ R \rightarrow (P \vee S) \\ \hline \therefore \neg P \vee (Q \wedge \neg R) \end{array}$$

[5]

(b) Establish the validity of the following argument:

$$\begin{array}{c} P \rightarrow (Q \rightarrow R) \\ \neg S \vee P \\ Q \\ \hline \therefore S \rightarrow R \end{array}$$

[5]

(c) Examine the validity of the following argument.
No mothers are males.
Some males are politicians.
Therefore, some politicians are not mothers.

(d) Use a proof by contraposition and a proof by contradiction to examine the statement : [5]
" If $m + n \geq 73$, then $m \geq 37$ or $n \geq 37$, where m and n are positive integers." [4]

2. (a) The sequence $< a_n >$ is defined by $a_0 = 2,\ a_1 = 1$ and $a_{n+2} = a_{n+1} + 2a_n$.
Prove by double induction that $a_n = 2^n + (-1)^n$ [4]

(b) Examine the set $Z^+ \times Z^+$ for a countable set : [4]

(c) For $X = \{0,1\}$, let $A = X \times X$. A relation R an A is defined by $(a,b)R(c,d)$ if (i) $a < c$; or (ii) $a = c$ and $b < d$
Examine R for a partial order relation. [4]

(1,6) (2,5)
(3,4) (4,3)
(5,2) (6,1)

(d) A relation R on $A = \{1,2,3,4,5,6\} \times \{1,2,3,4,5,6\}$ is defined by
$_{(a,b)}R_{(c,d)}$ if ab=cd
Examine R for an equivalence relation, Determine [(4,3)]. [4]

(e) State some elegant applications of the pigeon-hole principle.
Prove that any subset of size six from the set $\underline{S} = \{1,2,3, \ldots .9\}$ must contain two elements whose sum is 10. [10]

3. (a) An encoding function is defined by the parity-check matrix:

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

(i) Examine whether the matrix H is useful in correcting single errors in transmission.

MCA

FIRST SEMESTER II MID- SEMESTER EXAMINATION, 2014-15 IMA-102

DISCRETE STRUCTURES

Time: 1hour

M.M.: 15

NOTE: Attempt all questions.

(a) Define and verify on the set of positive divisors of 70 a poset, a lattice with its types, and a Boolean algebra.

(b) Use Karnaugh map or Quine-McClusky method to obtain a minimal sum-of-products representation for

$$f(x, y, z, w, t) = \sum m\,(0, 2, 4, 6, 8, 10, 12, 13, 14, 15, 16, 17, 29, 31).$$

(a) Examine $(Z^+ \times Z^+, \leq)$ for a well-ordered set, where $\leq$ is a lexicographic order.

(b) Develop a program in C/C++ to determine the transitive closure of a relation.

(a) Illustrate with example how mathematical induction can play a major role in computer programs verification.

(b) Find the smallest relation containing the relation $\{(1,2), (1,4), (3,3), (4,1)\}$ that is

(i) symmetric and transitive.

(ii) reflexive, symmetric and transitive.

(a) Establish the validity of the following argument:

"There is a man whom all men despise."

"Therefore, at least one man despises himself."

(b) Examine (i) $K_{2,2,3}$ for a planar graph.

(ii) $K_{m,\,n}$ for Eulerian and Hamiltonian graphs.

(a) Let $X = \{0, 1, 2\}$ and $A = X \times X$. Define the relation R on A by

$(a, b) R (c, d)$ if (i) $a < c$; or (ii) $a = c$ and $b \leq d$.

Examine R for a partial order on A.

(b) Illustrate the use of the time-complexity functions in the analysis (comparison) of algorithms.

Date of showing evaluated answer books: Dec 30, 2014

No. of Printed Pages: 2

Subject Code: IMA-102

MCA Odd Semester Examination, 2014-15

DISCRETE STRUCTURES

Time: 3 Hours

Max. Marks: 100

Note: 1. Attempt all parts.

2. All questions carry marks as shown against them.

1.(a) Examine the validity of the following argument: [5]

$$(A \wedge Q) \to M$$
$$(F \to Q) \wedge (\neg P \to A)$$
$$\overline{\therefore \neg M \to (\neg F \vee P)}$$

(b) Establish the validity of the following argument: [5]

"A mother is a loving person."

"Therefore, the heart of a mother is the heart of a loving person."

(c) Establish the validity of the following argument or give a counter example to show that it is invalid: [5]

$$R \to (C \vee L)$$
$$\neg C \to \neg N$$
$$\neg T \to \neg L$$
$$\overline{\therefore R \to (N \vee T)}$$

(d) Develop a program in C/C++ to find the principal conjunctive normal form of the statement formula: $(\neg P \to R) \wedge (Q \leftrightarrows P)$ [5]

2.(a) Examine the set $N \times N \times N$ for a countable set. [5]

(b) Use a proof by contraposition to prove the pigeonhole principle. Use it to prove or disprove the statement: "If 10 points are selected inside an equilateral triangle of unit side, then atleast two of them are no more than 1/3 of a unit apart". [5]

(c) Determine which amounts of postage can be formed using just 4-cents and 11-cents stamps only. Prove your answer using strong Induction. [5]

(d) Examine the relation $\sim$ on $\mathbb{N} \times \mathbb{N}$ given by. $(a,b) \sim (c,d)$ if $a + d = b + c$ for an equivalence relation. If yes, identify the equivalence classes. [5]

3.(a) An encoding function is defined by the generator matrix: [10]

$G = [I_{4\times4}\ A_{4\times3}]$

$$G = \left[\begin{array}{cccc|ccc} 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{array}\right]$$

$4 \to 7$

(i) Examine the encoding function for a group code.

(ii) If yes, examine the group code for a Hamming code and find the rate of this code. $= \frac{2^r - r - 1}{2^r - 1}$

(iii) Encode the message: 1111.

(iv) Decode the received word: 1110111.

(v) Construct a decoding table consisting of the syndromes and coset leaders for this code.

(vi) Use the result in part (v) to decode the received word 0010001.

(b)(I) The operations $\oplus$ and $\odot$ on $R = \{a, b, c, d\}$ given by the table below: [5]

[illegible]	[illegible]	[illegible]	[illegible]	d
[illegible]	[illegible]	[illegible]	d	c
[illegible]	[illegible]	d	b	a
[illegible]	[illegible]	[illegible]	[illegible]	b

$\odot$	a	b	c	d
a	a	a	a	a
b	a	a	b	a
c	a	b	c	d
d	a	a	d	a

(i) Examine $(R, \oplus, \odot)$ for a commutative ring. (ii) Does R has a unity?

(iii) Find a pair of zero divisors. (iv) Is R an integral domain/field?

(b) Let G be the symmetric group (S_3, o). [5]

(i) Examine $H = \{(1)(2)(3), (132), (123)\}$ for an abelian subgroup of G.

(ii) Find all cosets of H in G and examine H for normal subgroup of G.

(iii) Verify Lagrange's theorem ad find index of H in G.

2,3,17

(c) Illustrate how partially ordered structures are useful in modeling. [10]

Develop and verify a structure on the set of positive divisors of 646 which is a poset, totally ordered set, well-ordered set, a lattice and its types, and Boolean algebra.

(d)(i) Use Quine-McClusky method to find a minimal-product-of-sums representation for [5]

$$f(w, x, y, z) = \Pi\, M(1,5,7,9,10,13,14,15)$$

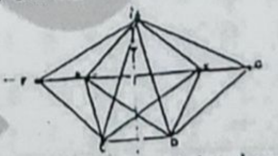
(ii) Design a circuit for a light fixture controlled by three switches, where flipping one of the switches turns the light on when it is off and turns it off when it is on. [5]

(5) There are two kinds of particles inside a nuclear reactor. In every second, an α particle will split into two α-particles and one β particle, and a β particle will split into one α particle and one β particle. If there is a single α particle in a reactor initially, develop a recurrence- relation model for the number of α and β particles in the reactor at time n and solve the model. [4]

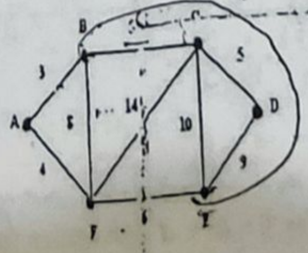
(b) A company hires 25 new employees. Use generating functions to find the number of ways to assign these people to the four subdivisions so that each subdivision receives atleast 3, but no more than 10 new people. [4]

(c) Illustrate with examples how Polya's enumeration theorem can be used to solve combinatorial problems/graph enumeration problems. [4]

(d) Use Kuratowski's theorem to examine the planarity of the graph: [4]



(e) Solve the Chinese postman problem for the weighted graph: [4]



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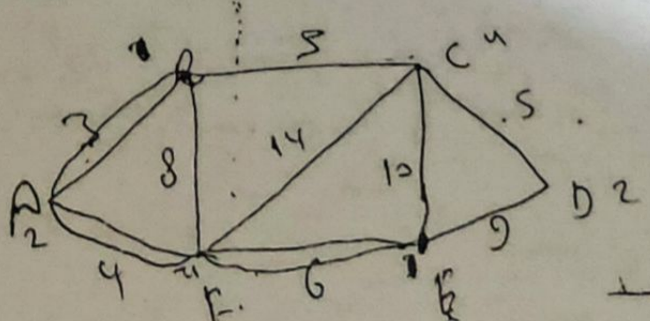

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ate of showing evaluated answer books: 30.12.2019

o. of Printed Pages: 2 Subject Code: B M A 4 0 1

MCA ODD SEMESTER EXAMINATION, 2019-20

DISCRETE STRUCTURES

Time: 2:30 Hrs. **Max. Marks: 50**

ote: 1. Attempt *all* questions.
2. All questions carry marks as shown against them.

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1. (a) Use a proof by contraposition to examine the statement for its truth : 2
“ If $x + y \geq 100$, then $x \geq 50$ or $y \geq 50$, where x and y are real numbers”.

(b) Establish the validity of the argument: 2
“A researcher is a genius person.
Therefore, the brain of a researcher is the brain of a genius person.”.

(c) Examine whether $\neg r \rightarrow s$ follows logically from $p \rightarrow r$, $\neg p \rightarrow q$ and $q \rightarrow s$. 2

(d) Examine whether the conclusion $\forall x\ [\neg r(x) \rightarrow p(x)]$ follows logically from : 2
$\forall x[p(x) \vee q(x)]$ *and* $\forall x\ [(\neg p(x) \wedge q(x)) \rightarrow r(x)]$.

(e) Write a program in C/C++ to examine the consistency of the statements: 2
$$p \rightarrow (q \rightarrow r),\ \ q \rightarrow (r \rightarrow s),\ \ p \wedge q \wedge \neg s$$

2. (a) Let $a_0 = a_1 = a_2 = 1$ and $a_n = a_{n-2} + a_{n-2}$ for $n \geq 3$. Prove by strong mathematical induction that $a_n \leq (4/3)^n$ for each integer $n \geq 0$. 2

(b) Examine the set $\{(a, b, c)|a, b, c, \in Z^+\}$ for a countable set. 2

(c) Examine the relation R on $\mathbb{R} \times \mathbb{R}$ defined by : 2
$$_{(a,b)}R_{(c,d)} \text{ if } a + 2b = c + 2d$$
for an equivalence relation. Find [(3,5)].

(d) Use the pigeon-hole principle to examine the statement for its truth: 2
“If 10 points are selected in the interior of an equilateral triangle of unit side, there must be at least two whose distance apart is less than $\frac{1}{3}$”.

(e) Illustrate one application of $n - ary$ relations. 2

3. (a) An encoding function is defined by the generator matrix: 5
$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

(i) Examine whether the matrix is useful in correcting single errors in transmission.

(ii) Examine the encoding function for a group code and a Hamming code.

(iii) Decode 000110, 011111 and find original messages.

(iv) Comment on the error-detection and error-correction capabilities of the code.

(b) Examine $(Z_5, \oplus_5, \otimes_5)$ for (i) a ring, (ii) an integral domain, and (iii) a field, where $\oplus_5$ *and* $\otimes_5$ are the operations of addition and multiplication modulo5. 5

4. (a) Develop a partially ordered structure on the set of all positive integer divisors of 110 and examine it for a partially ordered set, well ordered set, lattice with its types and Boolean algebra. 5

(b) Find (i) minimal-sum-of-products representation for 5

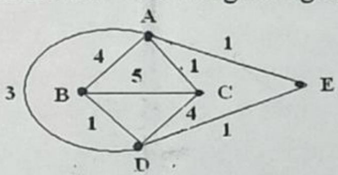
$f(a,b,c,d) = \sum m(0,1,2,3,4,6,7,8,9,11,15)$ by Quine-McCluskey's method.

(ii) the minimal product-of-sums representation for

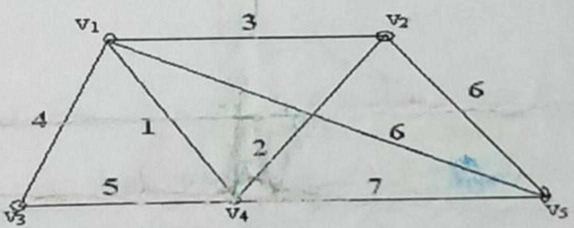
$f(a,b,c,d) = \prod M(1,3,5,7,8,10,11,12,14)$ by Karnaugh map.

5. (a) A coding system encodes messages using strings of octal (base 8) digits. A codeword is considered valid if and only if it contains an even number of 5s. Develop a recurrence relation model for the number of valid code words of length r and solve the model using generating functions. 4

(b) Solve the Chinese postman problem for the weighted graph : 2



(c) Use Prim's algorithm (matrix version) to find MST for the weighted graph : 2



(d) (i) Find chromatic polynomial of $K_{2,s}$.

(ii) Give an example of a self-dual graph.