KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

NAMAKKAL- TRICHY MAIN ROAD, THOTTIAM, TRICHY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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24MA301 - DISCRETE MATHEMATICS AND LINEAR PROGRAMMING

QUESTION BANK

UNIT – I

PROPOSITIONAL CALCULUS

PART - A

1. What is meant by proposition and predicate?
2. Define Tautology and Contradiction.
3. Define Converse, Inverse and Contra positive.
4. Show that $(P \rightarrow Q) \wedge (R \rightarrow Q) \Leftrightarrow (P \vee R) \rightarrow Q$.

5. Show that $P \Rightarrow (\neg P \rightarrow Q)$.
6. State the truth value of "If tigers have wings then the earth travels round the sun".
7. Give the converse and contra positive of the implication "If it is raining then I get wet".
8. Show that $\sim (P \wedge Q) \rightarrow (\sim P \vee (\sim P \vee Q)) \Leftrightarrow (\sim P \vee Q)$ (use only laws).
9. Define DNF and CNF.
10. Prove $(\sim P(\sim Q \wedge R)) \vee (Q \wedge R) \vee (P \wedge R) \Leftrightarrow R$ (use only laws).
11. Define functionally complete set of connectives and give an example.
12. What are the rules of inferences?
13. Define conditional and biconditional statements.
14. Negate the following
a) Ottawa is a small town.
b) It is not easy that city in Canada is clean.

15. Verify whether $(P \wedge (P \leftrightarrow Q)) \rightarrow Q$ is a tautology.

PART - B

1. Prove that $[(p \vee q) \wedge (p \rightarrow r) \wedge (q \rightarrow r)] \rightarrow r$ is a tautology.
2. Check whether the hypothesis "It is not sunny this afternoon and it is colder than yesterday", "we will go swimming only if it is sunny" , "If we do not go swimming then we will take a canoe trip" and " If we take a canoe trip, then we will be home by sunset" lead to the conclusion " we will be home by sunset".
3. Check the validity of the following argument. "If the band could not play rock music or the refreshments were not delivered on time, then the

New Year's party would have been cancelled and Alice would have been angry. If the party were cancelled, then refunds would have to be made. No refunds were made".

4. Show that the following set of premises is inconsistent. "If the contract is valid, then John is liable for penalty. If John is liable for penalty, he will go bankrupt. If the bank will loan him money, he will not go bankrupt. As a matter of fact, the contract is valid and the bank will loan him money".
5. Show that the following premises are inconsistent:
   a) If Vijay misses many classes, then he fails in M.E
   b) If Vijay fails in M.E, then he is unemployed.
   c) If Vijay appears for lot of interviews, then he is not unemployed.
   d) Vijay misses many classes and appears for lot of interviews.

UNIT – II
PREDICATE CALCULUS

1. Prove that $(x)(P(x) \rightarrow Q(x)),(x)(Q(x) \rightarrow R(x)) \Rightarrow (x)(P(x) \rightarrow R(x))$.
2. Show that $(\mathrm{E}x)(P(x) \vee Q(x)) \Leftrightarrow (\mathrm{E}x)P(x) \vee (\mathrm{E}x)Q(x)$.
3. Show that the premises "One student in this class knows how to write programs in JAVA" and "Everyone who knows how to write programs in JAVA can get high paying job", imply the conclusion "Someone in this class can get high paying job".
4. Verify the validity of the following argument: "Every living thing is a plant or an animal. Joe's goldfish is alive and it is not a plant. All animals have hearts. Therefore, Joe's goldfish has a heart".
5. Validity of the following argument: "All men are mortal. Socrates is a man. Therefore, Socrates is mortal".
6. Show that $(\mathrm{E}x)M(x)$ follows logically from the premises $(6x)(H(x) \rightarrow M(x))$ and $(\mathrm{E}x)H(x)$.
7. Prove that the sum of two rational numbers is rational.
8. Demonstrate the indirect proof of the following theorem. "Let n be an integer. If $n^2 + 3$ is odd, then n is even".
9. Establish the direct proof of the theorem "For all integers m, is odd then m^2 is odd.
10. Demonstrate that if n is an integer and n3 + 5 is odd, then n is even.
11. Demonstrate $\sqrt{2}$ is an irrational number. Then $\sqrt{2}$ is rational by using proof by contradiction.
12. Verify the validity of the argument: "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. If I go to sleep early, then I will wake up feeling refreshed. Thus, if I do not finish writing the program, then I will wake up feeling refreshed".

13. Verify the value of the following argument: Lions are dangerous animal. There are Lions. There is dangerous animal.
14. Show that from $(\mathrm{E}x)(F(x) \square S(x)) \rightarrow (y)(M(y) \rightarrow W(y))$, $(\mathrm{E}x)(M(y) \square \square W(y))$ the conclusion $(6x)(F(x) \rightarrow \square S(x))$ follows.
15. Demonstrate $\sqrt{3}$ is irrational by giving a Proof using contradiction.
16. Give an indirect proof of "Let m be an integer. If n2+5 is odd, then n is even".

UNIT – III
COMBINATORICS

PART - A

1. State the principle of mathematical induction.
2. State the strong form of the principle of induction
3. Prove that $1+2+2^2+\ldots+2^n = 2^{n+1}-1$, $n \geq 0$ by mathematical induction
4. Use the mathematical induction, to that $n<2n$ for all positive integer n.
5. State the product rule.
6. How many 4-digit numbers less than 4000 using the digits 1, 2,3,5,7,8 without repetition?
7. Define combination. Give the value of C(n, r) in terms of factorials
8. How many bit strings of length 10 contain equal number of 0's and 1's?
9. State the generalized pigeonhole principle?
10. In a group of 100 people, several will have birth days in the same month. At least how many must have birth days in the same month?
11. Prove the inclusion principle for two sets.
12. Give a formula for the number of elements in the union of four sets.
13. Find a recurrence relation from $a_n = A\, 2^n + B\, (-3)^n$
14. Find the recurrence relation for the Fibonacci sequence of numbers.
15. Obtain the generating function for the sequence $\{a_n\}$. Where $a_n=n+1$.

PART – B

1. Prove by mathematical induction that for all $n \geq 1$, $n^3 + 2n$ is a multiple of 3.
2. Using the generating function, solve the difference equation
3. $y_{n+2} - y_{n+1} - 6\, y_n = 0$, $y_1 = 1$, $y_0 = 2$.
4. How many positive integers n can be formed using the digits 3,4,4,5,5,6,7 if n has to exceed 5000000?
5. Find the number of integers between 1 and 250 both inclusive that are divisible by any of the integers 2,3,5,7.

6. If n Pigeonholes are occupied by (kn+1) pigeons, where k is positive integer, prove that at least one Pigeonhole is occupied by (k+1) or more Pigeon. Hence find the minimum number of m integers to be selected from S={1,2,…9} so that the sum of two of the m integers are even.

UNIT – IV
LATTICES AND BOOLEA ALGEBRA

PART - A

1. If a poset has a least element, then prove it is unique.
2. Define a partially ordered set.
3. Give an example of a lattice. State any two properties of lattice.
4. Define Boolean algebra.
5. Consider (D4, ≤) and (D9, ≤) where for positive integer n, D_n denotes the set of all positive divisors of n and < is the divisibility. Obtain the Hasse diagram of the poset L= D_4 x D_9 under the product partial order.
6. Is there a Boolean algebra with 5 elements justify.
7. Give an example of two - element Boolean algebra.
8. Prove that every chin is a distributive lattice.
9. Draw the Hasse diagram of the set of all possible divisors of 36.
10. Show that absorption laws are valid in a Boolean algebra.
11. Give an example of a lattice which is modular but not distributive.
12. Draw the Hasse diagram of the set of partitions of 5.
13. Prove a.(a+b)=a+(a.b) is a Boolean Algebra.
14. Draw the Hasse diagram of D30={1,2,3,5,6,10,15,30}.
15. Find the value of the Boolean expression $x_1x_2(x_1x_4+ x_2'+ x_3x_1')$ if x_1=a, x_2=1, x_3=b and x4=1

PART - B

1. If L is a distributive lattice with 0 and 1, show that each element has at least one complement.
2. Let (L, ≤) be a lattice. For any a,b,c Є L ,if b≤ c, prove that a*b ≤ a*c and $a\oplus b \le a\oplus c$
3. In a distributive lattice, prove that
   $(a*b) \oplus (b*c) \oplus (c*a) = (a\oplus b)*(b\oplus c)*(c\oplus a)$
4. In a Lattice (L, ≤), Prove that $X \vee (Y \wedge Z) \le (X \vee Y) \wedge (X \vee Z)$
5. State and prove the distributive inequalities of a Lattice.

UNIT V
LINEAR PROGRAMMING

I. GRAPHICAL METHOD

1. Solve the following LPP by graphical Method.

Minimize $z = 20x_1 + 10x_2$

Subject to,

$$x_1 + 2x_2 \square 40$$
$$3x_1 + x_2 \square 30$$
$$4x_1 + 3x_2 \square 60$$
$$x_1, x_2 \square 0$$

2. Find the maximum value of $z = 5x_1 + 7x_2$

Subject to, the constraints,

$$x_1 + x_2 \square 4$$
$$3x_1 + 8x_2 \square 24$$
$$10x_1 + 7x_2 \square 35$$
$$x_1, x_2 \square 0$$

3. A company produces 2 types of hats A and B .Every hat A requires twice as much labour time as the second hat B. If the company produces only hat B then it can produce a total of 500 hats per day . The market limits daily sales of hat A and B to 150 and 250 respectively. The profits on hat A and B are Rs. 8 and Rs.5 respectively. Solve graphically to the optimal solution.

4. Use graphical method solve the following LPP

Find the maximum value of $z = 3x_1 + 4x_2$

Subject to,

$$5x_1 + 4x_2 \square 200$$
$$3x_1 + 5x_2 \square 150$$
$$5x_1 + 4x_2 \square 100$$
$$8x_1 + 4x_2 \square 80$$
$$x_1, x_2 \square 0$$

5. Use graphical method solve the LPP

Find the maximum value of $z = 6x_1 + 4x_2$

Subject to,

$$-2x_1 + x_2 < 2$$
$$x_1 - x_2 \square 2$$
$$3x_1 + 2x_2 \square 9$$
$$x_1, x_2 \square 0$$

6. Use graphical method to solve the LPP

Find the maximum value of $z = 3x_1 + 2x_2$

Subject to,

$$5x_1 + x_2 \square 10$$
$$x_1 + x_2 \square 6$$
$$x_1 + 4x_2 \square 12$$
$$x_1, x_2 \square 0$$

7. Use graphical method solve the LPP

Find the maximum value of $z = 100x_1 + 40x_2$

Subject to,

$$5x_1 + 2x_2 \square 1000$$
$$3x_1 + 2x_2 \square 900$$
$$x_1 + 2x_2 \square 500$$
$$x_1, x_2 \square 0$$

8. Solve the following LPP.
Maximum value of

$$z = 3x_1 + 2x_2$$
$$x_1 - x_2 \square\ 1$$
$$x_1 + x_2 \square\ 3$$
$$x_1, x_2 \square\ 0$$

9. Solve the following LPP.
Maximum value of

$$z = x_1 + x_2$$
$$x_1 + x_2 \square\ 1$$
$$-3x_1 + x_2 \square\ 3$$
$$x_1, x_2 \square\ 0$$

10. Use graphical method solve the LPP. Find the maximum value of $z = 3x_1 + 2x_2$
Subject to,

$$-2x_1 + x_2 \square\ 1$$
$$x_1 \square\ 2$$
$$x_1 + x_2 \square\ 3$$
$$x_1, x_2 \square\ 0$$

11. Use graphical method solve the LPP. Find the maximum value of $z = 4x_1 + 3x_2$
Subject to,

$$3x_1 + 4x_2 \square\ 24$$
$$8x_1 + 6x_2 \square\ 48$$
$$x_1 \square\ 5, x_2 \square\ 6\, x_1,$$
$$x_2 \square\ 0$$

12. Use graphical method solve the LPP .Find the maximum value of $z = 12x_1 + 25x_2$
Subject to,

$$12x_1 + 3x_2 \square\ 36$$
$$15x_1 - 5x_2 \square\ 30$$
$$x_1, x_2 \square\ 0$$

13. Use graphical method solve the LPP .Find the minimum value of $z = 6x_1 + 8x_2$
Subject to,

$$2x_1 + 3x_2 \square\ 16$$
$$4x_1 + 2x_2 \square\ 16$$
$$x_1, x_2 \square\ 0$$

14. Use graphical method solve the LPP .Find the maximum value of $z = 20x_1 + 10x_2$
Subject to,

$$10x_1 + 5x_2 \square\ 50$$
$$6x_1 + 10x_2 \square\ 60$$
$$4x_1 + 12x_2 \square\ 48$$
$$x_1, x_2 \square\ 0$$

II. SIMPLEX METHOD

1. A firm has available 240, 370 and 18 Kilos of wood, plastic and steel respectively. The firm produces two products A & B .Each unit of product requires 1,3 and 2. Kilos of wood, plastic and steel respectively. The corresponding requirement for each unit of B are 3, 4 and 1 respectively . If A Sells for Rs. 4 and B should be produced to obtain the maximum gross income. Formulate the problem mathematically. Solve the problem by simplex method.

2. Find the non – negative values of X_1 , X_2 and X_3

Which maximize $Z = 3x_1 + 2x_2 + 5x_3$

Subject to

$$x_1 + 4x_2 \square 420$$

$$3x_1 + 2x_2 \square 460$$

$$x_1 + 2x_2 + x_3 \square 430$$

3. Apply the simple method to solve the problem

Maximize

$$Z = 100x_1 + 200x_2 + 50x_3$$

Subject to

$$5x_1 + 5x_2 + 10x_3 \square 1000$$

$$10x_1 + 8x_2 + 5x_3 \square 2000$$

$$10x_1 + 5x_2 \square 500$$

$$x_1, x_2, x_3 \square 0$$

4. Use simplex method to solve the given LPP

Max $Z = 5x_1 + 3x_2$

Subject to the constraints

$$x_1 + x_2 \square 2$$

$$5x_1 + 2x_2 \square 10$$

$$3x_1 + 8x_2 \square 12, \; x_1, x_2 \square 0$$

5. Use simplex method to

Minimize $Z = x_1 - 3x_2 + 2x_3$

Subject to

$$3x_1 - x_2 + 2x_3 \square 7$$

$$-2x_1 + 4x_2 \square 12$$

$$-4x_1 + 3x_2 + 8x_3 \square 10 \; and \; x_1, x_2, x_3 \square 0$$

6. Use simplex method to

Maximize $Z = 5x_1 + 6x_2 + x_3$

Subject to

$$9x_1 + 3x_2 - 2x_3 \square 5$$

$$4x_1 + 2x_2 - x_3 \square 2$$

$$x_1 - 4x_2 + x_3 \square 3 \; and \; x_1, x_2, x_3 \square 0$$

7. Use simplex method to

Maximize $Z = 30x_1 + 40x_2 + 20x_3$

Subject to

$$10x_1 + 120x_2 + 70x_3 \square 100000$$

$$7x_1 + 10x_2 + 8x_3 \square 8000$$

$$x_1 + x_2 + x_3 \square 1000$$

$$x_1, x_2, x_3 \square 0$$

8. Use simplex method to

Maximize $Z = 10x_1 + 15x_2 + 20x_3$

Subject to

$$2x_1 + 4x_2 + 6x_3 \;\square\; 24$$
$$3x_1 + 9x_2 + 6x_3 \;\square\; 30$$
$$x_1, x_2, x_3 \;\square\; 0$$

III. BIG M METHOD

1. Solve the following L.P.P using big-M method

Minimize $Z = 10x_1 + 15x_2 + 20x_3$

Subject to

$$2x_1 + 4x_2 + 6x_3 \;\square\; 24$$
$$3x_1 + 9x_2 + 6x_3 \;\square\; 30$$
$$x_1, x_2, x_3 \;\square\; 0$$

2. Solve the following L.P.P using big-M method

Minimize $Z = 3x_1 + 2x_2 + 3x_3$

Subject to ,

$$2x_1 + x_2 + x_3 \;\square\; 2$$
$$3x_1 + 4x_2 + 2x_3 \;\square\; 8$$
$$x_1, x_2, x_3 \;\square\; 0$$

IV. TWO PHASE METHOD

1. Solve the following L.P.P using two –phase method

Minimize $Z = x_1 + x_2$

Subject to

$$2x_1 + x_2 \;\square\; 4$$
$$x_1 + 7x_2 \;\square\; 7$$
$$x_1, x_2 \;\square\; 0$$

2. Solve the following L.P.P using two –phase method

Minimize $Z = 5x_1 + 8x_2$

Subject to

$$3x_1 + 2x_2 \;\square\; 3$$
$$x_1 + 4x_2 \;\square\; 4$$
$$x_1 + x_2 \;\square\; 5$$
$$x_1, x_2 \;\square\; 0$$