ST. JOSEPH'S COLLEGE OF ARTS & SCIENCE

(AUTONOMOUS)

CUDDALORE-1

SUB:OPERATION RESEARCH
CLASS: III B.SC
SUB CODE:EMT617S
SUB INCHARGE:S.JOHNSON SAVARIMUTHU

2 – MARKS QUESTIONS

1. Write the general model of the L.P.P.
2. Write matrix form of general model of L.P.P
3. Define a basic feasible solution
4. Define optimal solution.
5. Define surplus variables.
6. Define objective function.
7. Define slack variables.
8. Write difference between slack and surplus variable in L.P.P.
9. Find the initial basic feasible solution for the LPP

   $Maximize \quad Z = 2x_1 + 3x_2 \ subject\ to\ x_1 + x_2 \le 1,\ 3x_1 + x_2 \le 4\ and\ x_1, \quad x_2 \quad \ge 0$
10. What are the different cases of feasible solution in graphical method?
11. Give two limitations of graphical method of solving a L.P.P.
12. Write the general model of canonical form of the L.P.P.
13. What are characteristics of canonical form of the L.P.P?
14. Write the general model of standard form of the L.P.P.
15. What are characteristics of standard form of the L.P.P?

5 – MARKS QUESTIONS

1. The Davis Company wishes to schedule the production of two items namely chairs and tables. The management of the company has to decide as to how many chairs and tables to be produced per day to maximize the profit. The following information is available to themanagement. The profit per item is Rs. 35 and Rs.55 respectively. In order to produce the two items that requires resources-wood, manpower and machine hour. The supply of wood is restricted to1500kgs per day. The manpower available per day is 75 carpenters. Also the maximum of 120 machine hours available per day. The production formula is as given in the following Table.

	Requirement per unit		
	Wood / kg	Manpower (persons)	Machine / hr
Chair	6	2	4
Table	12	3	6

Formulate an LP model to determine the daily production rate of various models in order to maximize the profit.

2. Solve the following LPP by Graphical method

$$\begin{aligned} &\textit{Maximize} && Z = 25x_1 + 40x_2 \\ &\textit{subject to} && 4x_1 + 4x_2 \le 48 \\ & && 2x_1 + 5x_2 \le 50 \\ & && 5x_1 + 3x_2 \le 60 \\ &\textit{and} && x_1,\ x_2 \ge 0 \end{aligned}$$

3. Find all the basic solutions to the following problem

$$\begin{aligned} &\textit{Maximize} && Z = x_1 + 3x_2 + 3x_3 \\ &\textit{subject to} && x_1 + 2x_2 + 3x_3 = 4 \\ & && 2x_1 + 3x_2 + 5x_3 = 7 \end{aligned}$$

Also find which of the basic solutions are
a) Basic feasible
b) Non-degenerate basic feasible
c) Optimal basic feasible.

4. Solve the LPP:

$$\begin{aligned} &\textit{Maximize} && Z = 45x_1 + 80x_2 \\ &\textit{subject to} && 5x_1 + 20x_2 \le 400 \\ & && 10x_1 + 15x_2 \le 450 \\ &\textit{and} && x_1,\ x_2 \ge 0 \end{aligned}$$

5. Solve the following L.P.P by the graphical method

$Max Z = 3x_1 + 2x_2, \textit{subject to}\ -2x_1 + x_2 \le 1;\ x_1 \le 2,\ x_1 + x_2 \le 3, \textit{and}\ x_1, x_2 \ge 0$

10 – MARKS QUESTIONS

1. Solve the LPP:

$$\textit{Minimize} \quad Z = x_2 - 3x_3 + 2x_5$$

$$\textit{subject to} \quad x_1 + 3x_2 - x_3 + 2x_5 = 7$$

$$x_1 + 4x_2 \geq 4$$

$$-2x_2 + 4x_3 + x_4 = 12$$

$$-4x_2 + 3x_3 + 8x_5 + x_6 = 10$$

$$\textit{and} \quad x_j \geq 0$$

2. Solve the LPP:
   $\textit{Minimize} \quad 2x_1 + x_2 \ \textit{subject to} \quad 3x_1 + x_2 \geq 3,\ 4x_1 + 3x_2 \geq 6,\quad 2x_2 \geq 2, \textit{and}\ x_1, x_2 \geq 0$
3. Solve using Two-Phase simplex method:
   $\textit{Min}Z = x_1 + x_2; \textit{subject to} \quad 2x_1 + 4x_2 \geq 4;\ x_1 + 7x_2 \geq 7; \textit{and} \quad x_1, x_2 \geq 0$
4. Solve using Big-M method:
   $\textit{Maximize}\, Z = 6x_1 + 4x_2, \textit{subject to} \quad 2x_1 + 3x_2 \geq 30,\ 3x_1 + 2x_2 \leq 24,\ x_1 + x_2 \geq 3, \textit{and} \quad x_1, x_2 \geq 0$

5. A company manufactures 2 types of prints circuits. The requirement of transistors and Capacitors for each type of printed circuits along with other data are given below.

	Circuit		Stock available
	A	B	
Transistor	15	10	180
Resistor	10	20	200
Capacitor	15	20	210
Profit	Rs.5	Rs.8	

   How many circuits of each type should the company produce from the stock to earn maximum profit, using graphical method?

6. Solve the following LPP using simplex method

$$\textit{Maximize} \quad Z = 300x_1 + 200x_2$$

$$\textit{subject to} \quad 5x_1 + 2x_2 \leq 180$$

$$3x_1 + 3x_2 \leq 135$$

$$\textit{and} \quad x_1,\ x_2 \geq 0$$

7. Use simplex method to solve the LPP

$$\textit{Maximize} \quad Z = 4x_1 + 10x_2$$

$$\textit{subject to} \quad 2x_1 + x_2 \leq 50$$

$$2x_1 + 5x_2 \leq 100$$

$$2x_1 + 3x_2 \leq 90$$

$$\textit{and} \quad x_1,\ x_2 \geq 0$$

8. Use Two-phase simplex method to solve

$$\textit{Maximize} \quad Z = 5x_1 + 8x_2$$

$$\textit{subject to} \quad 3x_1 + 2x_2 \geq 3$$

$$x_1 + 4x_2 \geq 4$$

$$x_1 + x_2 \leq 5$$

$$\textit{and} \quad x_1, \; x_2 \geq 0$$

9. Explain the stages of development, applications and limitations of operations research.

10. A firm manufactures 2 types of products A & B and sells them at a profit of Rs. 2 on type A and Rs. 3 of type B. Each product is processed on two machines M1 and M2. Type A requires 1 minute of processing time on M1 and 2 minute on M2. Type B requires 1 minute on m1 and 1 minute on m2. Machine m1 is available for not more than 6 hours 40 minutes, while machine 2 is available for 10 hours during any working day. Formulate the problem as LPP so as to maximize the profit.

11. A firm produces 3 products. These products are processed on 3 different machines. The time required to manufacture 1 unit of each of 3 products and the daily capacity are give in the table.

Machine	**Time per unit**			**Machine capacity (in min)**
	A	**B**	**C**	
M1	**2**	**3**	**2**	**440**
M2	**4**	**--**	**3**	**470**
M3	**2**	**5**	**--**	**430**

It is required to determine the number of units to be manufacture for each product daily. The profit per unit for product 1,2& 3 is Rs. 4,5 & 6 respectively. It is assumed that all the amount produced are consumed in the market. Formulate the mathematical model in the problem.

12. A firm produce an alloy having the following specification,
(i) specific gravity ≤ 0.98 (ii) chromium $\geq 8\%$
(iii) melting point $\geq 450^0$C
Raw materials A, B & C having the properties shown in the table.

Property	**Raw material**

	A	B	C
specific gravity	**0.92**	**0.97**	**1.04**
chromium	**7%**	**13%**	**16%**
melting point	**440°C**	**490°C**	**480°C**

Cost of the various raw material per unit tone Rs. 90 for A, Rs. 280 for B, Rs. 40 for C. Find the prospection in which A,B& C be used to obtain an alloy of desired properties while the cost of Raw material is minimum.

13. A dietician wishes to mix two types of food in such a way that the vitamin contains of the mixture contains atleast 8 units of vitamin A and 10 units of vitamin B. Food one contains 2 units per Kg of vitamin A and 1 unit per Kg of vitamin B. While the food two contains 1 unit per Kg of vitamin A and 2 unit per Kg of vitamin B. It cost Rs. 5 per Kg to purchase food one and Rs. 8 per Kg to purchase food two. Prepare a Mathematical model of the problem stated above.
14. A person wants to decide the constituents of a diet which will fulfill his daily requirements of protein, fat & carbohydrate at the minimum cost. The choice is to be make form 4 different types of foods. The yields per unit of these foods are given in following table. Formulate the LPP

Food type	**Yields(per unit)**			**Cost per unit**
	Protein	**Fat**	**Carbohydrate**	
Food 1	**3**	**2**	**6**	**45**
Food 2	**4**	**2**	**4**	**40**
Food 3	**8**	**7**	**7**	**85**
Food 4	**6**	**5**	**4**	**65**
Minimum requirement	**800**	**200**	**700**	

15. A company makes 2 types of leather product A & B. product A is of high quality and product B is of low quality the respective profits are Rs 4 & Rs 3 per product. Each product A requires twice as much time as product B and if all products were of type B the company could make 1000 per day. The supply of leather is sufficient for only 800 products per day(both A & B combined). Product A requires a special spare part & only

400 per day are available. There are only 700 special spare parts at daily available for product B. Formulate this as LPP

16. A dealer wishes to purchase a number of fans and sewing machines. He has only Rs.5,760 to invest and has space almost for 20 items. A fan cost Rs. 360 and a sewing machine cost Rs. 240. His expectation is that he can sell a fan at a profit of Rs. 22 and sewing machine at a profit of Rs. 18 assuming that he can sell all the items that he can buy, how should he invest this money in order to maximize his profit. Formulate this as LPP and use graphical method to solve it.

17. Solve the following LPP by graphical method.

$Min\ Z = 3x_1 - 5x_2 ; subject\ to\ \ -4x_1 + 2x_2 \le 1;\ \ 5x_1 - 4x_2 \le 3\ \ and\ \ x_1,\ x_2 \ge 0$

18. Express the following LPP in Canonical form and also in standard form,

$$\begin{aligned} &Minimize && Z = 5x_1 + 7x_2 \\ &subject\ to && 3x_1 + 4x_2 \ge 3 \\ & && x_1 + x_2 \ge 8 \\ & && 6x_1 + 7x_2 \ge 5 \\ &and && x_1,\ x_2 \ge 0 \end{aligned}$$

19. Obtain all the basic solution to the following system of linear equation

$$\begin{aligned} &Maximize && Z = 2x_1 + 3x_2 + 4x_3 + 7x_4 \\ &subject\ to && 2x_1 + 3x_2 - x_3 + 4x_4 = 8 \\ & && x_1 - 2x_2 + 6x_3 - 7x_4 = -3 \\ &and && x_1,\ x_2,\ x_3,\ x_4 \ge 0 \end{aligned}$$

20. Use Big M- method to solve

$$\begin{aligned} &\text{Minimize Z} = && 4x_1 + 3x_2 \\ &\text{Subject to the constraints} && 2x_1 + x_2 \ge 10 \\ & && -3x_1 + 2x_2 \le 6 \\ & && x_1 + x_2 \ge 6 \\ &\text{and} && x_1, x_2 \ge 0\ . \end{aligned}$$

21. Write the dual of the LPP.

$$\begin{aligned} &\text{Maximize Z} = && 3x_1 - 2x_2 + 4x_3 \\ &\text{Subject to the constraints} && 3x_1 + 5x_2 + 4x_3 \ge 7 \\ & && 6x_1 + x_2 + 3x_3 \ge 4 \\ & && 7x_1 - 2x_2 - x_3 \le 10 \\ & && x_1 - 2x_2 + 5x_3 \ge 3 \\ & && 4x_1 + 7x_2 - 2x_3 \ge 2 \end{aligned}$$

and $x_1, x_3, x_2 \geq 0$

22. Find the non-negative values of x_1, x_2 *and* x_3 which

Maximize Z = $3x_1 + 2x_2 + 5x_3$

Subject to the constraints $x_1 + 4x_2 \leq 420$

$3x_1 + 2x_3 \leq 460$

$x_1 + 2x_2 + x_3 \leq 430$

and $x_1, x_2, x_3 \geq 0$.

UNIT – II :

2 – MARKS UNIVERSITY QUESTIONS

1. Define optimum solution
2. What is the use of MODI Method?
3. Define feasible solution to the transportation problem.
4. Find the initial basic feasible solution for the transportation problem using least cost method.

	A	B	C	D	
X	14	9	18	6	11
Y	10	11	7	16	13
Z	25	20	11	34	19
	6	10	12	15	43

5. Give mathematical formulation of transportation problem.
6. What do you mean by balanced and unbalanced transportation problem?
7. Mention the methods of solving unbalanced transportation problem.
8. Write down the methods of finding an initial feasible solution.

5 – MARKS UNIVERSITY QUESTIONS

1. Obtain an initial basic feasible solution to the following T.P. using the matrix minima method:

	D_1	D_2	D_3	D_4	Supply
O_1	1	2	3	4	6
O_2	4	3	2	0	8
O_3	0	2	2	1	10
Demand	4	6	8	6	

2. Find the initial basic feasible solution for the transportation problem

		Destination 1	2	3	4	Supply
Origin	1	11	13	17	14	250
	2	16	18	14	10	300
	3	21	24	13	10	400
Requirement		200	225	275	250	

3. Solve the following travelling salesman problem

		TO A	B	C	D
FROM	A	–	13	16	40
	B	41	–	50	40
	C	82	32	–	40
	D	40	40	36	–

4. Solve the transportation problem by vogel's approximation

6	8	10	11
15	9	7	14
8	10	7	

10 – MARKS UNIVERSITY QUESTIONS

1. Determine an initial basic feasible solution to the following transportation problem Using north-west corner rule

		AVAILABLE				SUPPLY
FROM	3	4	6	8	9	20
	2	10	1	5	8	30
	7	11	20	40	3	15
	2	1	9	14	16	13
DEMAND	40	6	8	18	6	

2. Solve the transportation problem:

	1	2	3	4	SUPPLY
I	21	16	25	13	11
II	17	18	14	23	13
III	32	27	18	41	19
DEMAND	6	10	12	15	

3. Four different jobs can be done on four different machines. The set up and take down time costs are assumed to be prohibitively high for change overs. The matrix below gives the cost in
rupees of processing job *i* on machine *j*.

		MACHINES			
		M1	M2	M3	M4
JOBS	J1	5	7	11	6
	J2	8	5	9	6
	J3	4	7	10	7
	J4	10	4	8	3

4. Solve the following transportation problem to minimize the total cost of transportation.

		Destination				Supply
		1	2	3	4	
Origin	1	14	56	48	27	70
	2	82	35	21	81	47
	3	99	31	71	63	93
Demand		70	35	45	60	

5. Find the starting solution of the transportation problem for the following by the all three methods

		Destination			
		D1	D2	D3	Supply
Origin	A	1	2	6	7
	B	0	4	2	12
	C	3	1	5	11
Demand		10	10	10	

6. Determine the basic feasible solution to the following transportation problem using all the 3 methods

		To				Supply
From		2	11	10	3	7	4
		1	4	7	2	1	8
		3	9	4	8	12	9
Demand		3	3	4	5	6	

7. Find the optimal transportation cost using least cost method for finding critical solution.

		MARKET					
		A	B	C	D	E	AVAILABILTY
FACTORY	P	4	1	2	6	9	100
	Q	6	4	3	5	7	120
	R	5	2	6	4	8	120
	DEMAND	40	50	70	90	90	

8. Solve the transportation problem and check the optimality

		To				Supply
		21	16	25	13	11
From		17	18	14	23	13
		32	27	18	41	19
Demand		6	10	12	15	

9. Find the initial transportation cost by
   (i) Least cost method
   (ii) North-west corner method
   (iii) Vogel's approximation method

		Destination			
		D1	D2	D3	Supply
	A	5	6	9	100
	B	3	5	10	75
Origin	C	6	7	6	50
	D	6	4	10	75
Demand		100	80	120	

10. Find the non-degenerate basic feasible solution for the following transportation problem using, Vogel's approximation method.

	To				Supply
	10	20	5	7	10
	13	9	12	8	20
From	4	5	7	9	30
	14	7	1	0	40
	3	12	5	19	50
Demand	60	60	20	10	

UNIT-III: SEQUENCING PROBLEM

Basic term used in sequencing-Processing n jobs through two machines-Processing n jobs through three machines- Processing two jobs through k machines.

2 – MARKS UNIVERSITY QUESTIONS

1. Describe the formulation of an assignment problem.
2. Give two differences of transportation problem and assignment problem.
3. Define unbalanced assignment problem.
4. Write any two assumptions usually made while dealing withsequencing problems
5. Write the assumptions to be made in a sequencing problem and give an example.
6. Write short notes on sequencing problem.
7. Define the minimum total elapsed time.
8. What is meant by "no passing rule"in a sequencing problem?
9. What is a sequencing problem?
10. Define ideal time.
11. What are the assumptions made to convert a 3 machine problem to a 2 machine problem?
12. State the principles in sequencing problem?

5 – MARKS UNIVERSITY QUESTIONS

1. Explain the steps in the Hungarian method used for solving assignment problem.
2. Solve the assignment problem

	A	B	C	D
I	1	4	6	3
II	9	7	10	9
III	4	5	11	7
IV	8	7	8	5

3. A company has 3 jobs on hand. Each of these must be processed through two departments, the sequential order for which is : Department A: Press shop Department B: Finishing. The table below lists the number of days required by each job in each department.

	Job 1	Job 2	Job 3
Department A	8	6	5
Department B	8	3	4

   Find the sequence in which the 3 jobs should be processed so as to take minimum time to finish all the 3 jobs
4. Explain the graphical method of solving the sequencing problem consists of two Jobs on n machines
5. There are five jobs, each of which is to be processed through two machines $M1$, $M2$ in the order $M1M2$. Processing hours are as follows:

	MACHINES				
ITEMS	A	B	C	D	E
I	9	7	4	5	11
II	8	8	6	7	12
III	7	6	7	8	10
IV	10	5	5	4	8

Find the optional sequence of jobs, total elapsed time and idle time on both the machines.

6. Solve the following sequencing problem when passing time is not allowed. Processing time (in hours) are given.

Job	1	2	3	4	5
M_1	3	8	5	7	4
M_2	4	10	6	5	8

7. Solve the following sequencing problem when passing time is not allowed. Processing time (in hours) are given

	MACHINE				
ITEM	A	B	C	D	E
I	9	7	4	5	11
II	8	8	6	7	12
III	7	6	7	8	10
IV	10	5	5	4	8

8. For the data given below determine the sequence that elapsed time for the five jobs (Time in hours)

		JOBS				
		A	B	C	D	E
MACHINES	1	5	4	8	7	6
	2	3	9	2	4	10

9. There are 5 jobs each of which must go through the two machines A and B in the order A – B. Processing times in hours are given below:

Jobs	1	2	3	4	5
Machine A	10	2	18	6	20
Machine B	4	12	14	16	8

Determine the sequence for the five jobs that will minimize the total elapsed time.

10. Five jobs are performed first on the machine M1 and then on machine M2. The time taken in hours by each job on each machine is given below:

Jobs	A	B	C	D	E
Time on M1	6	2	10	4	11
Time on M2	3	7	8	9	5

10 – MARKS UNIVERSITY QUESTIONS

1. Solve the following Assignment problem

	C_1	C_2	C_3	C_4
R_1	9	14	19	15
R_2	7	17	20	19
R_3	9	18	21	18
R_4	10	12	18	18
R_5	10	15	21	16

2. Processing time in hours for the jobs when allocated to different machines are indicated below assign the machines for the job so that total processing cost is minimum.

		MACHINES				
		M1	M2	M3	M4	M5
JOBS	J1	9	22	58	11	19
	J2	43	78	72	50	63
	J3	41	28	91	37	45
	J4	74	42	27	49	39
	J5	36	11	57	22	25

3. Consider a problem of assigning 5 jobs to 5 persons. The assignment cost are given at follows

		JOBS				
		1	2	3	4	5
PERSONS	A	8	4	2	6	1
	B	0	9	5	5	4
	C	3	8	9	2	6
	D	4	3	1	0	3
	E	9	5	8	9	5

4. The company has 4 machine to do 3 jobs each job be assigned to only one machine. The cost of each machine is given in the following table.

		M1	M2	M3	M4
JOBS	A	18	24	2	32
	B	8	13	17	19
	C	10	15	19	23

5. Assign 4 drugs 1,2,3,4 to vacant space A,B,C,D,E so that the distance travelled is minimized. The matrix given below shows the distance.

	M1	M2	M3	M4
A	4	7	3	7
B	8	2	5	5
C	4	9	6	9
D	7	5	4	8
E	6	3	5	4
F	6	8	7	3

6. A book binder has one printing press, one binding machine, and the manuscripts of a number of different books. The time required to perform the printing and binding operations for each book are shown below. Determine the order in which books should be processed, in order to minimize the total time required to turn out all the books:

BOOK	1	2	3	4	5	6
Printing time (hrs)	30	120	50	20	90	110
Binding time (hrs)	80	100	90	60	30	10

7. Determine the optimal sequence of jobs that minimizes the totalelapsed time based on the following information processing time on machines is given in hours and passing is not allowed:

Job	A	B	C	D	E	F	G
Machine M1	3	8	7	4	9	8	7
Machine M2	4	3	2	5	1	4	3
Machine M3	6	7	5	11	5	6	12

8. Explain the method of solving n jobs through 3 machines.

9. Use graphic method to find the minimum elapsed total time sequence of 2 Jobs and 5 machines when we are given the following information

		Machine				
Job1	Sequence	A	B	C	D	E
	Time in hrs.	2	3	4	6	2
Job2	Sequence	C	A	D	E	B
	Time in hrs.	4	5	3	2	6

10. Two jobs are to be processed on four machines a, b, c, and d.
    The technological order for these jobs on machines is as follows:

Job I	: a	b	c	d	Job II	: d	b	a	c
Time	: 4	6	7	3	Time	: 4	7	5	8

    Find the optimal sequence of jobs on each of the machines.

11. Use graphical method to minimize the time needed to process the following jobs on the machine shown. Find the job which should be done first. Also calculate the total time needed to complete both jobs.
12. Explain the procedure of solving a sequencing problem of a jobs on 3 machines.
13. Explain the sequencing problem of n jobs on m machines.
14. Determine the optimal solution sequence of the following sequencing problem.

	Machine			
Job	A	B	C	D
J_1	8	3	4	7
J_2	9	2	5	5
J_3	6	4	5	8
J_4	12	5	1	9
J_5	7	1	2	3

15. Find the optimum sequence for the following sequencing problem

	JOBS							
	A	B	C	D	E	F	G	H
M1	14	26	17	11	9	26	18	15
M2	21	15	16	21	22	12	13	25

16. There are 5 jobs. Each of them is to be processed through three machines X, Y and Z in the order X Y Z. The processing time in hours is given below:

	PROCESS		
JOBS	X	Y	Z
1	3	4	8
2	9	5	9
3	6	1	5
4	5	2	7
5	4	3	10

UNIT –IV: GAME THEORY

2 – MARKS UNIVERSITY QUESTIONS

1. Define saddle point.
2. Define Mixed Strategy of a game.
3. Define rectangular games.
4. Find the value of the game. $\begin{bmatrix} 3 & -2 \\ -2 & 5 \end{bmatrix}$
5. Define pay off matrix.
6. Solve the game whose pay off matrix is given by

$$\begin{matrix} & \textit{Player } B \\ \textit{Player } A & \end{matrix} \begin{pmatrix} 1 & 7 & 3 & 4 \\ 5 & 6 & 4 & 5 \\ 7 & 2 & 0 & 3 \end{pmatrix}$$

7. Define value of the game.
8. Define fair game.
9. Define strictly determinable game.
10. What the use of dominance property.

5 – MARKS UNIVERSITY QUESTIONS

1. Determine which of the following two-person Zero-sum games are strictly determinable and fair. Give optimum strategies for each player in the case of strictly determinable games:

$$\begin{matrix} & \textit{PLAYER } B \\ \textit{PLAYER } A & \end{matrix} \begin{pmatrix} 0 & 2 \\ -1 & 4 \end{pmatrix}$$

2. Solve the following game without saddle point $\begin{matrix} & B \\ A & \end{matrix} \begin{pmatrix} 5 & 1 \\ 3 & 4 \end{pmatrix}$

3. Solve the game whose pay-off matrix is given by

$$\begin{matrix} & & \textit{PLAYER } B & & & & \\ & & B_1 & B_2 & B_3 & B_4 & B_5 \\ \textit{PLAYER } A & A_1 & & & & & \\ & A_2 & & & & & \end{matrix} \begin{pmatrix} 2 & -2 & 3 & 7 & 6 \\ 6 & 5 & 1 & 4 & 0 \end{pmatrix}$$

4. Use graphical method to solve $\begin{bmatrix} 2 & 7 \\ 3 & 5 \\ 11 & 2 \end{bmatrix}$

5. Solve the game

$$\begin{array}{c} \\ A_1 \\ A_2 \end{array} \begin{array}{c} \begin{array}{ccccc} B_1 & B_2 & B_3 & B_4 & B_5 \end{array} \\ \begin{pmatrix} 2 & -4 & 6 & -3 & 5 \\ -3 & 4 & -4 & 1 & 0 \end{pmatrix} \end{array}$$

6. Use dominance property to solve

$$\begin{array}{c} \\ PLAYER\ A \end{array} \begin{array}{c} \begin{array}{ccc} PLAYER\ B & & \end{array} \\ \begin{pmatrix} 3 & 3 & 4 \\ 4 & 12 & 2 \end{pmatrix} \end{array}$$

7. Solve the game

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array} \begin{array}{c} \begin{array}{ccc} B_1 & B_2 & B_3 \end{array} \\ \begin{pmatrix} 2 & -2 & 4 \\ 6 & 1 & 12 \\ -3 & 2 & 0 \end{pmatrix} \end{array}$$

10 – MARKS UNIVERSITY QUESTIONS

1. Reduce the following game by dominance and find the game value.

		PLAYER – B			
		I	II	III	IV
PLAYER-A	I	3	2	4	0
	II	3	4	2	4
	III	4	2	4	0
	IV	0	4	0	8

2. Solve the following using graphical method

$$\begin{array}{c} \\ A_1 \\ A_2 \end{array} \begin{array}{c} \begin{array}{ccccc} B_1 & B_2 & B_3 & B_4 & B_5 \end{array} \\ \begin{pmatrix} 2 & -2 & 3 & 7 & 6 \\ 6 & 5 & 1 & 4 & 0 \end{pmatrix} \end{array}$$

3. Solve the following game $\begin{bmatrix} 0 & -2 & -7 \\ 2 & 5 & 6 \\ 3 & -3 & 8 \end{bmatrix}$

4. Solve the game graphically

			B		
A	0	4	-8	-5	1
	1	5	8	-4	0

5. Solve the following game $\begin{matrix} & \\ Player\ A & \end{matrix}\begin{matrix} Player\ B \\ \begin{pmatrix} 3 & -1 & 1 & 2 \\ -2 & 3 & 2 & 3 \\ 2 & -2 & -1 & 1 \end{pmatrix} \end{matrix}$

6. Solve the following game and determine the strategies $\begin{bmatrix} 7 & -1 & 7 \\ 10 & -2 & -5 \\ -9 & 5 & 6 \end{bmatrix}$

UNIT –V:PERT/CPM NETWORKS:

2– MARKS QUESTIONS

1. What is a Network?
2. Define dummy Activity
3. Write two differences between PERT and CPM
4. Define the optimistic time estimate (To)
5. Explain the three time estimates used in the PERT.
6. What are the main assumptions under in PERT computations?
7. Define optimistic time estimate
8. Define most likely time estimate.
9. Define pessimistic time estimate.
10. Write down the formulae for expected duration and expected variance of each activity.
11. Write down the formulae for computing Earliest start, Earliest finish, Latest start, Latest finish of an activity of a prject.

5– MARKS QUESTIONS

1. Draw a network for the following project.
   i) A is the start event and K is the end event.
   ii) J is the successor event to F.
   iii) C and D are the successor events to B
   iv) D is the preceding event to G
   v) E and F occur after event
   vi) E precedes F
   vii) C restraints the occurrence of G and G which precede H
   viii) H precedes J
   ix) K succeeds event J
2. Draw the network for the project whose activities and their procedure relationship are given below

Activity	A	B	C	D	E	F	G	H	I	J	K
procedure	–	–	–	A	B	B	C	D	E	H,I	F,G

3. Calculate the earliest start, earliest finish, latest start and latest finish of each activity of the project given below and determine the Critical path of the project.

Activity	1-2	1-3	1-5	2-3	2-4	3-4	3-5	3-6	4-6	5-6
Duration (in weeks)	8	7	12	4	10	3	5	10	7	4

4. Distinguish between CPM and PERT.

5. Construct the network for the project whose activities and their precedence relationships are A<C,D,I;B<G,F;D<G,F;F<H,K;G,H<J;I,J,K<E
6. Explain the following terms:
   (i) Activity
   (ii) Dangling
   (iii) Dummy activity
   (iv) Activity on arrow diagram
   (v) Activity on node diagram
   (vi) Network of a project.
7. What are different types of floats associated with an activity in a CPM model? What are their uses?
8. Write down the stepwise procedure fir determine the critical path of a project.

10 – MARKS QUESTIONS

1. Distinguish between PERT and CPM
2. The utility data for a network are given below. Determine the total, free floats and identity the critical path.

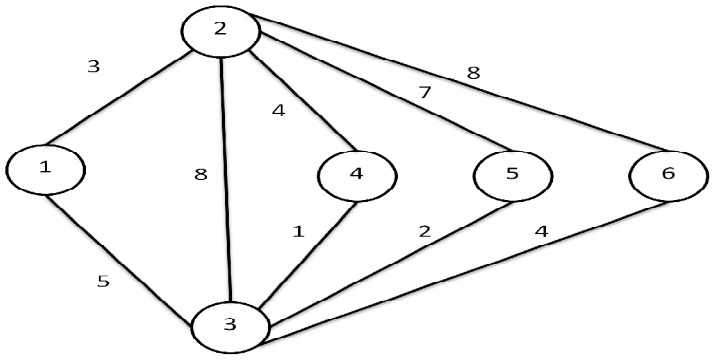
Activity	0-1	1-2	1-3	2-4	2-5	3-4	3-6	4-7	5-7	6-7
Duration	2	8	10	6	3	3	7	5	2	8

3. Draw the network of the project whose activities and precedence relationship are given below

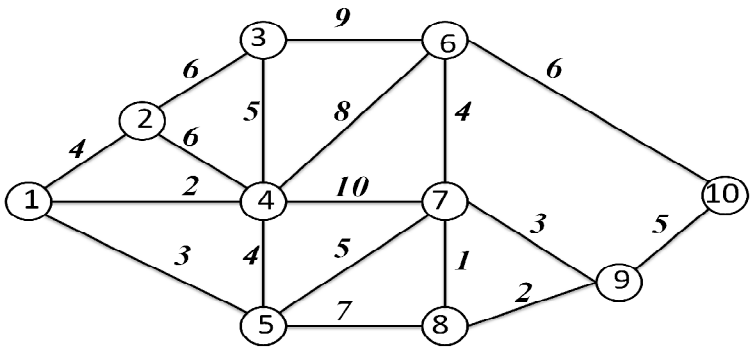
Activities	P	Q	R	S	T	U
Predecessor	--	--	--	P,Q	P,R	Q,R

4. If there are5 activities P,Q,R,S and T such that PQR has no immediate predecessors that S and T has immediate predecessors
5. Write down the steps involved Floyd's Algorithm and generate final distance,

   precedence matrix and shortest path for node 1-6



6. Consider a distance network as show in the figure. Find the minimum spanning tree for this method using Prims algorithm



7. Calculate the TF, FF, IF for the following project who's activities are given below

Activities	1-2	1-3	1-5	2-3	2-4	3-4	3-5	3-6
Duration	8	7	12	4	10	3	5	10

8. Calculate the TF, FF, IF for the following project who's activities are given below

Activities	0-1	1-2	1-3	2-4	2-5	3-4	3-6	4-7	5-7	6-7
Duration	3	8	12	6	3	3	8	5	3	8

9. 3 time estimate (in months) of all activities of a project are as given below.

Activities		1-2	2-3	2-4	3-4	4-5	5-6
Estimated	t_0	0.8	3.7	6.2	2.1	0.8	0.9

duration	t_m	1	5.6	6.6	2.7	3.4	1.0
	t_p	1.2	9.9	15.4	6.1	3.6	1.1

a) Find the expected duration and standard deviation of activity

b) Construct the project networks

c) Determine the critical path, expected project length and expected variance of the project

d) What is the probability that the project will be completed

i) Two month later than expected

ii) Not more than 3 months earlier than expected

iii) What due date has about 90% chances?

10. Construct the network for the project who's activities (in weeks) are given below.
Compute (a) Expected duration of each activities,
(b) Expected variance of each activities,
(c) Expected variance of project length.

Activities		**1-2**	**2-3**	**2-4**	**3-5**	**4-5**	**4-6**	**5-7**	**6-7**	**7-8**	**7-9**	**8-10**	**9-10**
Estimated duration	t_0	3	1	2	3	1	3	4	6	2	1	4	3
	t_m	4	2	3	4	3	5	5	7	4	2	6	5
	t_p	5	3	4	5	5	7	6	8	6	3	8	7

11. A Project consists of a following activities and time estimates.

Activities		**1-2**	**2-3**	**1-4**	**2-5**	**2-6**	**3-6**	**4-7**	**5-7**	**6-7**
Estimated duration	t_0	3	2	6	2	5	3	3	1	2
	t_m	15	14	30	8	17	15	27	7	8
	t_p	6	5	12	5	11	6	9	4	5

(a) Draw the network
(b) What is the probability that the project will be completed in 27 days.

12. The 3 estimate for the activity of a project are given below,

Activities		**1-2**	**1-3**	**1-4**	**2-5**	**3-5**	**4-6**	**5-6**
Estimated duration	t_0	5	1	2	3	1	2	1
	t_m	6	1	4	6	1	2	4
	t_p	7	7	12	15	1	8	7

(a) Find critical path
(b) Project duration or Expected project duration
(c) Expected variance

13. Following data is pertaining to have normal time and crash time

Jobs	Normal		Crash	
	Time	Cost	Time	Cost
1-2	8	100	6	200
1-3	4	150	2	350
2-4	2	50	1	90
2-5	10	100	5	400
3-4	5	100	1	200
4-5	3	80	1	100

(a) If indirect cost is Rs. 100/- day. Find the least schedule (optimum duration)
(b) What is minimum duration?

14. The following time cost table time in days cost in Rupees applies to a project. Use it to arrive at the network associated with completing the project in minimum time at minimum cost.

Activities	Normal		Crash	
	Time	Cost	Time	Cost
1-2	8	100	6	200
1-3	4	150	2	350
1-4	2	50	1	90
2-4	10	100	5	400

3-4	5	100	1	200
3-5	3	80	1	100
4-5	3	900	2	1600

15. A maintenance foreman has given following estimate of time and cost of jobs in a maintenance job. Overhead cost is Rs. 25 per hour. Find
    (a) The normal duration of the project and associated cost.
    (b) The minimum duration of the project optimum duration and associated cost.
    (c) The least duration of the project and its cost.
    (d) If all the activities are crashed what will be the projet duration and the corresponding cost.

Jobs	Predecessors	Normal		Crash	
		Time	Cost	Time	Cost
A	-	8	80	6	100
B	A	7	40	4	94
C	A	12	100	5	184
D	A	9	70	5	102
E	B,C,D	6	50	6	50