MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VI SEMESTER B. TECH (INDUSTRIAL AND PRODUCTION ENGINEERING)

END SEMESTER EXAMINATIONS, JUNE 2019

SUBJECT: OPERATIONS RESEARCH [MME 3211]
REVISED CREDIT SYSTEM

Time: 3 Hours   MAX. MARKS: 50

Instructions to Candidates:
- ❖ Answer **ALL** the questions.
- ❖ Use of normal distribution tables is permitted

1A. Explain with an example an Unbounded LP problem and how it is reflected in the Simplex table. **(2)**

1B. A company has 2 machines each capable of producing 2 products A and B. the production rate of each machine when processing the 2 products are **(3)**

	Production rate on machine (units/hour)		Profit/unit (Rs)
	I	II	
Product A	8	2	10
Product B	4	6	12
Max hours available per month	90	70	

Formulate the LPP. Do not solve.

1C. Solve the LPP whose formulation is given below using the Simplex method. **(5)**

$Maximise\ Z = 60x_1 + 150x_2$

$Subject\ to$

$x_1 + x_2 \le 24$

$5x_1 + 10x_2 \le 160$

$x2 \le 10$

$x_1, x_2 \ge 0$

2A. List four differences between CPM and PERT. **(2)**

2B. Products 1,2,3,4 and 5 are to be processed on a machine. The set-up costs in rupees per change depend upon the product presently on the machine and the set-up to be made and are given by the following data: **(3)**
$C_{12} = 16$, $C_{13} = 4$, $C_{14} = 12$, $C_{23} = 6$, $C_{34} = 5$, $C_{25} = 8$, $C_{35} = 6$, $C_{45} = 20$;
$C_{ij} = C_{ji}$,
$C_{ij} = \infty$ for all values of i and j not given in the data. Find the optimum sequence of products in order to minimize the total setup cost.

2C. An LPP for producing 4 products from resources is formulated as :　　　　　　**(5)**

$Max\ Z = 7x_1 + 6x_2 + 9x_3$　(Total Profit)

Subject to

$6x_1 + 8x_2 + 4x_3 \leq 96$　　Units of material

$2x_1 + x_2 + 2x_3 \leq 42$　　Machine hours

$5x_1 + 3x_2 + 2x_3 \leq 60$　　Assembly hours

$x_1, x_2, x_3 \geq 0$

The optimal simplex tableau (partial complete) for the above problem is given below:

			Cj	3	9	10	6	0	0
	Basis	Qty		X1	X2	X3	S1	S2	S3
6	X2	2		1/3			1/6	-1/3	0
9	X3	20		5/6			-1/12	2/3	0
0	S3	14		7/3			-1/3	-1/3	1
Z =			Zj						
			Cj – Zj						

a) Complete the Zj and the Cj – Zj in above tableau

b) Explain the optimal production plan and implication of implementing it.

c) Conduct sensitivity of RHS values and profit coefficients.

3A. Write the dual of the following LPP.　　　　　　**(2)**

$Max\ Z = 8x_1 + 8x_2 + 8x_3 + 12x_4$

Subject to

$30x_1 + 20x_2 + 25x_3 + 40x_4 \leq 480$

$25x_1 + 10x_2 + 7x_3 + 15x_4 \leq 250$

$4x_1 - x_2 = 0$

$x_3 \geq 5$

$x_1, x_2, x_3, x_4 \geq 0$

3B. Solve the following 2 person zero sum game and find the value of the game along with the　**(3)** strategies to be used by each player.

	Player B		
Player A	B1	B2	B3
A1	2	-1	4
A2	1	6	9
A3	5	2	7

3C. Given below is the transportation cost matrix for meeting the demands of 3 customers from 4 warehouses of a manufacturing company. Cost minimization is the objective. **(5)**

		Customer			Supply(units)
		1	2	3	
Warehouse	A	5	9	13	10
	B	20	5	9	10
	C	13	17	22	10
	D	9	13	17	10
	Demand(units)	9	17	9	

    a) Determine the optimal transportation schedule and the total cost.

    b) Find alternate solution if any.

4A. Given an account of information requirements and assumptions to formulate waiting line models. **(2)**

4B. (a) A typist at an office of a company receives on the average 20 letters per day for typing. The typist works 8 hours a day and it takes on the average 20 minutes to type a letter. The cost of a letter waiting to be mailed (opportunity cost) is 80 paise per hour and the cost of the equipment plus salary of the typist is Rs.45 per day. **(3)**

    (i) What is the typist's utilization rate?

    (ii) What is the average number of letters waiting to be typed?

    (iii) What is average waiting time needed to have a letter typed?

    (iv) What is the total daily cost of waiting letters to be mailed?

(b) In order to improve the typing service, the company has the choice to take lease of one of the   two models of an automated typewriter. The daily costs and the resulting increase in efficiency of the typist are given below:

Model	Additional cost/day	Increase in typist's efficiency
I	20	50%
II	25	75%

What action should the company take to minimize the total daily cost of waiting letters to be mailed?

4C. A project is divided into 7 activities whose time duration (in days) are given below. **(5)**

Activity	1 – 2	2 – 3	2 – 4	3 – 4	3 – 5	4 – 5	5 – 6
Duration (days)	2	7	9	4	10	5	4

    a) Construct the network incorporating above information. Calculate the two event times,

    b) Identify the critical path and four activity times for each activity.

    c) if the duration of the activity 3 – 5 can be reduced by three days, what will be the project completion time.

5A. A trip from Chandigarh to Delhi takes six hours by bus. A typical table of the bus service in **(5)**

both directions is given below.

Departure from Chandigarh	Chandigarh – Delhi Service line or route number	Arrival at Delhi
06.00	a	12.00
07.30	b	13.30
11.30	c	17.30
19.00	d	01.00
00.30	e	06.30

Arrival at Chandigarh	Delhi – Chandigarh Service line or route number	Delhi
11.30	1	05.30
15.00	2	09.00
21.00	3	15.00
00.30	4	18.30
06.00	5	00.00

The cost of providing this service by the transport company depends upon the time spent by the bus crew (driver and conductor) away from their places in addition to service times. There are five crew. There is a constraint that every crew should be provided with more than 4 hours of rest before the return trip again and should not wait for more than 24 hours for the return trip. The company has residential facilities for the crew at Chandigarh as well as Delhi. Suggest an optimal assignment of the crew.

5B List of activities for erecting a canteen in a factory is given below with other relevant **(5)** details. Job A must precede all others while job E must follow others. Apart from this, jobs can run concurrently.

Activity	Description	Normal Duration (days)	Normal Cost (Rs.)	Crash Duration (days)	Crash Cost (Rs.)
A	Lay foundation and build walls	5	3,000	4	4000
B	Tile roofing	6	1,200	2	2000
C	Install electricity	4	1,000	3	1800
D	Install plumbing	5	1,200	3	2000
E	Connect services to finish	3	1,600	3	1600

(i)   Draw the network and identify the critical path.
(ii)   Crash the network fully to find out minimum duration
(iii) If indirect costs are Rs.300 per day, determine time-cost trade-off for the project.