Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institute of Manipal University, Manipal

VI SEMESTER B.TECH (INDUSTRIAL & PRODUCTION ENGINEERING)

END SEMESTER EXAMINATION, APRIL/MAY 2017

SUBJECT: OPERATIONS RESEARCH (**MME 3211**)

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data if any may be suitably assumed.
- Use of Normal tables is allowed.

1A. Briefly list the Model-Building Process in Operations Research. **2**

1B. Solve the following game **3**

		Player B					
		1	**2**	**3**	**4**	**5**	**6**
Player A	**1**	4	2	0	2	1	1
	2	4	3	1	3	2	2
	3	4	3	7	-5	1	2
	4	4	3	4	-1	2	2
	5	4	3	3	-2	2	2

1C. A company manufactures three products, P1, P2 and P3. The details of machine hours, labour hours, selling price and product cost are summarized in the table. The company wants to limit the production volume per week of the product P3 to utmost 35 units. Formulate the above details as an LPP. **5**

	Product			Maximum available hours per week
	Machine hours required			
	P1	P2	P3	
Machine 1	4	6	3	500
Machine 2	3	--	2	300
Machine 3	5	7	8	600
Labour	3	2	4	200
Selling price/unit (Rs.)	500	400	550	
Product cost/unit (Rs.)	350	280	390	

2A. Briefly explain the elements of a Queuing System. **2**

2B. Solve the LPP given below graphically.

$$MaxZ = 20x_1 + 15x_2$$
$$S.t.$$
$$3x_1 + 4x_2 \le 60$$
$$4x_1 + 3x_2 \le 60$$
$$x_1 \le 10$$
$$x_2 \le 12$$
$$x_1, x_2 \ge 0$$

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2C. A LPP is formulated as given:

$$MaxZ = 75x_1 + 125x_2 + 150x_3$$
$$S.t.$$
$$x_1 + x_2 + x_3 \le 500$$
$$x_1 + x_2 \le 150$$
$$x_1 - x_2 - x_3 \le 100$$
$$x_1, x_2, x_3 \ge 0$$

Given below incomplete Simplex tableau. Complete the tableau and determine if it is optimal, if not find the optimal solution.
Conduct sensitivity analysis with respect to the profit coefficients and the Resources.

	Cj	75	125	150	0	0	0	Quantity
	Basic Variables	X1	X2	X3	S1	S2	S3	
150	X3	1	1		1			500
0	S2	1	1		0			150
0	S3	2	0		1			600
	zj							
	cj-zj							

5

3A. What are the limitations of using the Simplex method for solving an assignment problem? **2**

3B. The activities and other details of a research project are shown in the table.

a) Draw the network for the project and determine the project duration and its critical path.
b) Determine the probability of the completion of the project in 37 days.
c) When should the activities be started so as to obtain a confidence level of 99% for completion of the project?

Activity	**Preceding activity**	**Times**		
		Pessimistic	**Optimistic**	**Most likely**
A	None	8	4	6
B	A	8	6	10
C	A	10	8	18
D	B	9	9	9
E	C	4	10	4
F	A	5	5	5
G	D,E,F	10	8	6

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3C. A company has four warehouses and six stores. The warehouses have a surplus of 5, 6, 2, and 9 units of a certain product, while the stores have a requirement of 4,4,6,2,4, and 2 units of the product respectively. Cost of shipping one unit of commodity from Warehouse i to store j in rupees is given in the matrix below.

		Stores					
		1	**2**	**3**	**4**	**5**	**6**
Plants	**1**	9	12	9	6	9	10
	2	7	3	7	7	5	5
	3	6	5	9	11	3	11
	4	6	8	11	2	2	10

Determine the optimal transportation schedule and total cost at the optimum. Use transportation algorithm.

5

4A. A company has trained five sales persons in the past three months, whom it wants to assign to three sales regions: North, West and South. It has been estimated that increases in sales (in lakhs of rupees) over the next year in each region, if each were allocated different number of salesmen, are as indicated below:

Sales persons	**Region**		
	North	**West**	**South**
0	0	0	0
1	61	36	66
2	86	61	86
3	106	91	96
4	121	126	116
5	136	166	146

Use Dynamic Programming to determine which allocation would maximize the increase in sales.

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4B. A factory operates 8 hours every day and has 240 working days in the year. It buys a large number of small machines which can be serviced by its maintenance engineer at a cost of ` 4 per hour for the labour and spare parts. The machines can, alternatively, be serviced by the supplier at an unusual contract price of ` 20,000 including the labour and spare parts needed. The supplier undertakes to send a repairman as soon as a call is made but in no case more than one repairman is sent. The service times of the maintenance engineer and the supplier's repairman are both exponentially distributed with respective means of 1.7 and 1.5 days. The machine breakdowns occur randomly and follow a Poisson distribution, with an average of 2 in 5 days. Each hour that a machine in out of order, it costs the company ` 8. Which servicing alternative would you advise it to opt for?

4

5A. The following table gives the activities in a construction project and other relevant information.

Activity	Immediate Predecessors	Time (days)		Direct Cost (`)	
		Normal	Crash	Normal	Crash
A	--	4	3	60	90
B	--	6	4	150	250
C	--	2	1	38	60
D	A	5	3	150	250
E	C	2	2	100	100
F	A	7	5	115	175
G	D,B,E	4	2	100	240

(i) Draw the network and determine the critical path and the duration of the project.

(ii) Crash the activities four times and determine the cost of the project. **5**

5B. An army maintenance organization is responsible for the maintenance of a fleet of vehicles with operational units. The maintaining unit is interested in keeping a good state of the fleet, the efficiency of providing maintenance service as also the reliability of the serviced fleet. A study to find out the number of vehicles requiring service and the rate at which the vehicles were being serviced was ordered by the higher authorities. The results of this study over a period of 30 days are given below:

Vehicles arrival for service		
Number of vehicles arriving for service	Frequency of arrival	Probability
0	1	0.03
1	5	0.05
2	10	0.50
3	6	0.30
4	2	0.10
5	2	0.02

Service completed		
Number of vehicles who service is completed	Frequency of arrival for service	Probability
0	2	0.10
1	6	0.30
2	12	0.50
3	4	0.05
4	2	0.03
5	2	0.02

At present the organization has only one maintenance team which is exclusively earmarked for the vehicles are serviced on first come first serviced basis.

Simulate the arrival and service pattern at the maintenance facility of the army unit over a ten days period.

Determine the following:

(i) Average service rate per day.

(ii) Average rate of arrival per day.

(iii) Backlog of vehicles per day. **5**