FACULTY OF MANAGEMENT STUDIES

University of Delhi

Roll. No.

Management Science (Paper no: MBAFT 6202)

Time: 3 hour *Semester II examination- March/April 2018* Maximum Marks: 50

Answer any FOUR questions. All questions carry equal marks

1. An airline is contemplating whether to introduce a new sector- New Delhi to Goa to its operation. The airline planning division based on its analysis envisages that there would be three states of nature: Good returns, Average returns and Negative returns. The pay-off table is as follows:

Alternatives	Good returns	Average returns	Negative returns
Introduce new sector	60	30	-40
Do not introduce new sector	0	0	0
Probability	0.4	0.3	0.3

Chief of Marketing of the airline plans to gather additional information before taking final call. A reputed research agency has been approached to conduct additional survey on the new sector. Based on the past predictions, the predicting ability of research agency is given below:

Agency prediction	States of Nature		
	Good returns	Average returns	Negative returns
Good returns	0.7	0.2	0.1
Average returns	0.2	0.6	0.2
Negative returns	0.1	0.2	0.7
Prior probability	0.4	0.3	0.3

(i) Draw the Decision Tree.

(ii) Should the Airline launch the new route based on Expected Value criterion?

(iii) Should Chief of Marketing take the help of research agency?

(iv) Find EVPI and EVSI.

2. (a) Given below are details about activities of a project,

Activity	Immediate Predecessor	Optimistic Time	Most Likely Time	Pessimistic Time
A	-	1	3	5
B	-	1	2	3
C	A	1	2	3
D	A	2	3	4
E	B	3	4	11
F	C, D	3	4	5
G	D, E	1	4	6
H	F, G	2	4	5

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Find out,

(i) Probability of completing the project within 16 days.

(ii) 95^{th} percentile of project completion.

(b) The following table gives the list of activities and other details for a project.

Activity	Activity Description	Precedence	Normal time (weeks)	Crash time (weeks)	Normal Cost (₹)	Crash Cost (₹)
A	Design house and obtain financing	-	12	7	3000	5000
B	Lay foundation	A	8	5	2000	3500
C	Order materials	A	4	3	4000	7000
D	Build house	B, C	12	9	50000	71000
E	Select paint	B, C	4	1	500	1100
F	Select carpet	E	4	1	500	1100
G	Finish work	D, F	4	3	15000	22000

The indirect cost is ₹ 5,000 per day. Calculate the Optimal Total cost and Project duration.

3. A fast-food franchise located on a national highway is considering operating a drive-up window food-service operation. Assume that customer arrivals follow a Poisson probability distribution, with an arrival rate of 18 cars per hour, and that service times follow an exponential probability distribution. Arriving customers place orders at the service window, then they pay for and receive their orders. The following three service alternatives are being considered:
Option A: A single-channel operation in which one employee fills the order and takes the money from the customer. The average service time for this alternative is 2 minutes.
Option B: A single-channel operation in which one employee fills the order while a second employee takes the money from the customer. The average service time for this alternative is 1.5 minutes.
Option C: A two-channel operation with two service windows and two employees. The employee stationed at each window fills the order and takes the money from customers arriving at the window. The average service time for this alternative is 2 minutes for each channel.
Answer the following questions and recommend an alternative design for the fast-food franchise:

(i) What is the probability that no cars are in the system?

(ii) What is the average number of cars in the system?

(iii) What is the average time a car waits for service?

(iv) What is the probability that an arriving car will have to wait for service?

Note: *If you feel some data required for answering questions above are missing, make appropriate assumptions and state them clearly in your answer.*

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For, M/M/1 Queues

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

For, M/M/k Queues

$$P_0 = \frac{1}{\sum_{n=0}^{k-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n + \frac{1}{k!}\left(\frac{\lambda}{\mu}\right)^k \left(\frac{k\mu}{k\mu - \lambda}\right)}$$

$$L = \frac{\left(\frac{\lambda}{\mu}\right)^k \lambda\mu}{(k-1)!(k\mu - \lambda)^2} P_0 + \frac{\lambda}{\mu}$$

$$P_n = \frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} P_0, \text{ for } n = 1, 2, \cdots, k \quad P_n = \frac{\left(\frac{\lambda}{\mu}\right)^n}{k!\ k^{(n-k)}} P_0, \text{ for } n = k, k+1, \cdots$$

4. (a) A bank manager at *National Bank* has compiled the following table of transition probabilities for the customer's use of various outlets of the bank in the University campus:

Outlet	Main branch	Extension office	ATM
Main branch	0.7	0.1	0.2
Extension office	0.4	0.5	0.1
ATM	0.2	0.1	0.7

(i) Which outlet tends to have the highest "loyalty"? Why?

(ii) What proportion of customers who banked at the main branch this time can be expected to bank at the extension office two periods later?

(iii) If the bank has 10,000 customers who use these outlets. In steady state, how many of them would use each of these three outlets in a given period?

(b) Virtual Tech operates its own power generating plant. The electricity generated by this plant supplies power to the university, institutes and to local businesses and residences in the Lucknow suburb city area. The plant burns three types of coal, which produces steam that drives the turbines that generate the electricity. The Environmental Protection Agency (EPA) requires that for each ton of coal burned, the emissions from the coal furnace smokestacks contain no more than 2,500 parts per million (ppm) of sulfur and no more than 2.8 kilograms (kg) of coal dust. However, the managers of the plant are concerned about the environment and want to keep these emissions to a minimum. The following table summarizes the amounts of sulfur, coal dust, and steam that result from burning a ton of each type of coal.

Coal	Sulfur (in ppm)	Coal Dust (in kg)	Pounds of Steam produced
1	1,100	1.7	24,000
2	3,500	3.2	36,000
3	1,300	2.4	28,000

The three types of coal can be mixed and burned in any combination. The resulting emission of sulfur or coal dust and the pounds of steam produced by any mixture are given as the weighted average of the values shown in the table for each type of coal. For example, if the coals are mixed to produce a blend that consists of 35% of coal 1, 40% of coal 2, and 25% of coal 3, the sulfur emission (in ppm) resulting from burning one ton of

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this blend is:

$$0.35 \text{ X } 1{,}100 + 0.40 \text{ X } 3{,}500 + 0.25 \text{ X } 1{,}300 = 2{,}110$$

The manager of this facility wants to select a blend of coal to burn while considering the following goals presented as objectives:

Objective 1: Minimize sulfur emissions.
Objective 2: Minimize coal dust emissions.
Objective 3: Maximize the pounds of steam produced.

(i) Formulate an optimization model for this problem.
(ii) Propose a preemptive approach to find the best possible value for each objective in the problem. (Do not solve)

(a) United Courier Service (UCS) uses large quantities of packaging materials at its four distribution hubs. After screening potential suppliers, UCS identified six vendors that can provide packaging materials that will satisfy its quality standards. UCS asked each of the six vendors to submit bids to satisfy annual demand at each of its four distribution hubs over the next year. The following table lists the bids received (in millions of rupees). UCS wants to ensure that each of the distribution hubs is serviced by a different vendor. Which bids should UES accept, and which vendors should UES select to supply each distribution hub? (Formulate an optimization model, solve using appropriate algorithm)

Bidder	Distribution Hub			
	1	2	3	4
Martin Products	190	175	125	230
Sulabh Materials	150	235	155	220
Group4 Containers	210	225	135	260
Grip Furnishings	170	185	190	280
Lucky Decors	220	190	140	240
DMJ Burns	270	200	130	260

) A substantial part of a logistics company's freight traffic moves as a trailer-on-flatcars (i.e. with truck trailers travelling most of the way on railroad flatcars). The required number of truckloads to be shipped between warehouses in known. In one such instance, data for 5 warehouses is given in the following table (number of truckloads).

	W1	W2	W3	W4	W5
W1	-	22	8	96	18
W2	33	-	61	19	50
W3	55	80	-	57	12
W4	92	26	13	-	21
W5	1	26	11	64	

The company can use either its own trailer at unit cost of ₹ 35,000 (one way between any pair of warehouses) or rent trailers from railroad company at unit cost ₹ 40,000 (one way between any pair of warehouses). Rented trailers can be left anywhere, but the

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logistics company wishes to balance the number of its own trailers available at every point (warehouse). That is, the number of company trailers inbound at any point should be equal the number outbound. If necessary, trailers may be returned empty from one point to another at unit cost ₹ 10.000 (one way between any pair of warehouses) to meet this requirement.

Develop an optimization model to find a minimum total cost shipping plan. Discuss if your model is a (single commodity) network flow problem. If, yes how (identify the arcs, flow, capacity etc.)?

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