

Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/MBA (NEW)/SEM-3(FT)/MB-302/2011-12**

**2011**

**OPERATIONS RESEARCH**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

**GROUP – A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

i) If in the simplex algorithm, the basis column of the final simplex table contains an artificial variable, the problem has

- a) degenerate solution      b) infeasible solution  
c) unbounded solution      d) multiple solution.

ii) In an assignment problem involving four workers and three jobs, the total number of assignments possible is

- a) 4                                      b) 3  
c) 7                                      d) 12.



- iii) Hungarian method is used in
  - a) Transportation problem
  - b) Assignment problem
  - c) Simplex problem
  - d) Dual simplex problem.
- iv) Degeneracy in transportation problems occurs when
  - a) at optimality, the total cost is 0
  - b) in finding an initial solution, a row and a column requirement are simultaneously satisfied
  - c) there are two or more filled cells with the same smallest negative value in a closed path for an incoming basic variable
  - d) total supply is greater than total demand
  - e) total demand is greater than the total supply.
- v) A transition probability describes
  - a) the probability of a success in repeated, independent trials
  - b) the probability a system in a particular state now will be in a specific state next period
  - c) the probability of reaching an absorbing state
  - d) none of these.
- vi) The general purpose system simulation language
  - a) requires programme writing
  - b) doesn't require programme writing
  - c) requires predefined coding form
  - d) needs a set of equations to describe a system.



vii) Which statement of the following is *not* related to Markov process ?

- a) State transition matrix
- b) Perfect information
- c) Steady-state condition
- d) Brand switching problem.

viii) In decision theory, which of the following criterion is *not* considered ?

- a) Maximax regret criterion
- b) Laplace criterion
- c) Minimin criterion
- d) EMV criterion.

ix) An ISO-profit line represents

- a) an infinite number of solutions all of which yield the same profit
- b) an infinite number of solutions all of which yield the same cost
- c) an infinite number of optimal solution
- d) A boundary of the feasible region.



x) A transportation problem is a balanced transportation problem iff

- a) total demand and total supply are equal and number of sources is equal to the number of destinations
- b) total demand equals to the total supply irrespective of the number of sources and destinations
- c) number of sources matches with the number of destinations
- d) the corresponding basic feasible solution is to be degenerate.

xi) In an  $( M / M / 1 ) : ( \infty / \text{FIFO} )$  model, the average number of customers  $E ( n )$  is given by

- a)  $\frac{\rho^2}{1+\rho}$
- b)  $\frac{\rho}{(1-\rho)}$
- c)  $\frac{\rho^2}{(1-\rho)}$
- d)  $\frac{\rho}{1+\rho}$ .

xii) Variables that indicate the distance a target is from the level achieved are called

- a) goal variables
- b) target variables
- c) deviation variables
- d) preemptive variables.



**GROUP – B**

**( Short Answer Type Questions )**

Answer any *three* of the following.  $3 \times 5 = 15$

2. Suppose a media specialist has to decide how to allocate advertising in three media vehicles. Let  $x_i$  be the number of messages carried in the media,  $i = 1, 2, 3$ . The unit costs of a message in the three media are Rs. 1000, Rs. 750 and Rs. 500 respectively. The total budget available for the campaign is Rs. 2,00,000 in a year. The first media is a monthly magazine and it is desired to advertise not more than one insertion in one issue. At least six messages should appear in the second media. The number of messages in the third media should strictly lie between 4 and 8. The expected effective audience for unit message in the media vehicles is shown below :

Vehicle	Expected effective audience
1	80,000
2	60,000
3	45,000

Formulate this problem as an LPP model to determine the optimum allocation that would maximize total effective audience.



3. A firm produces two products — X and Y. Product X sells for a net profit of Rs. 80 per unit while the same for Y is Rs. 40 per unit. The goal of the firm is to earn Rs. 900 in the next week while the management desires to sell 17 units of X and 15 units of Y. Formulate this problem as a goal programming model.
4. A project consists of four major jobs for which four contractors have submitted tenders. The tender amounts quoted in thousands of rupees are given in the following matrix. Find the assignment which minimizes total cost of the project. Each contractor has to be assigned one job only.

Contractors	Jobs			
	$J_1$	$J_2$	$J_3$	$J_4$
$C_1$	15	29	35	20
$C_2$	21	27	33	17
$C_3$	17	25	37	15
$C_4$	14	31	39	21



5. A company manufactures 30 items per day. The sale of these items depends on demand, which has the following distribution :

Sales ( unit ) :	27	28	29	30	31	32
Probability :	0.10	0.15	0.20	0.35	0.15	0.05

The production cost and sale price of each unit is Rs. 40 and Rs. 50 respectively. Any unsold product is to be disposed of at a loss of Rs. 15 per unit. There is a penalty of Rs. 5 per unit if the demand is not met. Using the following random numbers estimate total profit/loss for the company for the next 10 days :

10, 99, 65, 99, 55, 15, 78, 12, 20, 19.

6. Solve the following transportation problem by North-West Corner Method ( NWCM ) :

	Warehouse <sub>1</sub> (W <sub>1</sub> )	Warehouse <sub>2</sub> (W <sub>2</sub> )	Warehouse <sub>3</sub> (W <sub>3</sub> )	Supply (S <sub>i</sub> )
Plant <sub>1</sub> (P <sub>1</sub> )	7	6	9	20
Plant <sub>2</sub> (P <sub>2</sub> )	5	7	3	28
Plant <sub>3</sub> (P <sub>3</sub> )	4	5	8	17
Demand (D <sub>i</sub> )	21	25	19	65



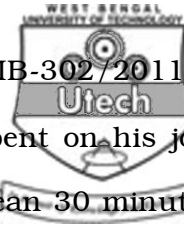
**GROUP – C**

**( Long Answer Type Questions )**

Answer any *three* of the following.  $3 \times 15 = 45$

7. a) Arrivals at a telephone booth are considered to be Poisson with an average of 10 minutes between one arrival and the next. The length of the phone call is assumed to be distributed exponentially with mean 3 minutes. (i) What is the probability that a person arriving at booth will have to wait ? (ii) What is the average length of the queue that forms from time to time ? (iii) The telephone department will install a second booth when convinced that an arrival would expect to have to wait at least three minutes for the phone. By how much must the flow of arrivals be increased in order to justify the second booth ?
- b) In a supermarket, the average arrival rate of customers is 10 every 30 minutes, following Poisson process. The average time taken by a cashier to list and calculate the customer's purchase is two and a half minutes following exponential distribution. What is the probability that the queue length exceeds six ? What is the expected time spent by a customer in the system ?





c) A T.V. mechanic finds that the time spent on his jobs has an exponential distribution with mean 30 minutes, if he repairs sets in the order in which they come in. If the arrival of sets is approximately Poisson with an average rate of 10 per eight-hour day, what is the mechanic's expected idle time each day ? How many jobs are ahead of the average set just brought in ?

8. a) A salesman has to visit each of the five cities *A*, *B*, *C*, *D* and *E*. The distances ( in hundred miles ) between the five cities are as follows :

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
<i>A</i>	—	7	6	8	4
<i>B</i>	7	—	8	5	6
<i>C</i>	6	8	—	9	7
<i>D</i>	8	5	9	—	8
<i>E</i>	4	6	7	8	—

If the salesman starts from city *A* and has to come back to city *A*, which route should he select so that the total distance travelled is minimum ?



- b) Kothari Car Rental company rents car from three centres, viz., X, Y & Z. Customers return cars to each of the centres according to the following probabilities. 8

From \ To	X ( State 1 )	Y ( State 2 )	Z ( State 3 )
X ( State 1 )	0·0	0·4	0·6
Y ( State 2 )	0·8	0·0	0·2
Z ( State 3 )	0·8	0·2	0·0

Kothari Company is planning to build a maintenance facility at one of the three centres. Which centre would you recommend for this purpose ? State, why so ?

9. a) A wholesaler of sports goods has an opportunity to buy 5,000 pairs of skis that have been declared surplus by the Govt. The wholesaler will pay Rupees 50 per pair and can obtain Rupees 100 a pair by selling skis to retailers. The price is well established, but the wholesaler is in doubts as to just how many pairs he will be able to sell. Any skis that are left over, he can sell to discount outlets at Rupees 20 a pair. After a careful consideration of the historical data, the wholesaler assigns probabilities to the demand as follows :

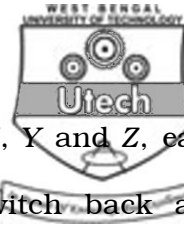


Retailer's Demand	Probability
1000 pairs	0.6
3000 pairs	0.3
5000 pairs	0.1

- i) Compute the conditional monetary and expected monetary values.
  - ii) Compute the expected profit with a predicting device
  - iii) Compute the EVPI.
- b) A newspaper boy has the following probabilities of selling a magazine :

No. of copies sold	Probability
10	0.10
11	0.15
12	0.20
13	0.25
14	0.30

Cost of a copy is 30 paise and sale price is 50 paise. He cannot return unsold copies. How many copies should be order ?



10. a) In a small town with three advocates X, Y and Z, each advocate knows that some clients switch back and forth, depending on which advocate is available at the time the client needs one. There are no new clients in the current legal market; however, none of the old clients are leaving the area. During a slack period, the three advocates collected data which identified the clients, each advocate had seen during the preceding year. Tables given below summarize the results of the study, and the manner in which clients were gained or lost respectively. Construct the state-transition matrix that describes the problem at hand.

Data summary — client activity.

Advocate	Clients as of 1·1·2005	Change during year		Clients as of 1·1·2006
		Gain	Loss	
X	400	75	50	425
Y	500	50	150	400
Z	500	100	25	575



Gain-Loss summary :

Advocate	Client as of 1.1.2005	Gains			Losses			Clients as of 1.1.2006
		From X	From Y	From Z	To X	To Y	To Z	
X	400	0	50	25	0	50	0	425
Y	500	50	0	0	50	0	100	400
Z	500	0	100	0	25	0	0	575

- b) An airline company has drawn up a new flight schedule involving five-flights. To assist in allocating five pilots to the flights, it has asked them to state their preference scores by each flight a number out of 1 to 10. The higher the number, the greater is the preference. Certain of these flights are unsuitable to some pilots owing to their domestic reasons. These have been marked with a ( X ) sign.

		Flight Number				
		$F_1$	$F_2$	$F_3$	$F_4$	$F_5$
Pilots	A	8	2	X	5	4
	B	10	9	2	8	4
	C	5	4	9	6	X
	D	3	6	2	8	7
	E	5	6	10	4	3

What should be the allocation of the pilots to flights in order to meet as many preference as possible ?



11. a) Three mobile companies Vodafone, Airtel and Aircel are the competitors in a city and holding a market share as 50%, 30% and 20% respectively on July 1, 2009. A study by marketing research firm disclosed the following :

Every month Vodafone retains 60% of its customers, loses 20% to Airtel and 20% to Aircel. Airtel retains 70% of its customers, loses 20% to Vodafone and 10% to Aircel. Aircel retains 50% of its customers, loses 30% to Vodafone and 20% to Airtel.

Assuming that the above brand switching behaviour does not change,

- i) What market share shall be held by each firm on July 1, 2010 ?
- ii) What will be the equilibrium market share of each brand ?



- b) An investor is given the following investment alternatives and percentage rate of return :

	States of Nature ( Market Conditions )		
	Low	Medium	High
Regular shares	7%	10%	15%
Risky shares	- 10%	12%	25%
Property	- 12%	18%	30%

Over the past 300 days, 150 days have been medium market conditions and 60 days have had high market increases. On the basis of these data, state the optimum investment strategy for investment.

12. a) The research department of HLL has recommended to the manufacturing department to launch a shampoo of three different types. The marketing manager has to decide one of the types of shampoo to be launched under the following estimated pay-offs for various level of sales.

Types of shampoo	Estimated level of sales in units		
	15000	10000	5000
Egg	30	10	10
Clinic	40	15	5
Deluxe	55	20	3

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What will be the marketing manager's decision depending upon

- i) Laplace's criterion
  - ii) Regret criterion
  - iii) Hurwicz's criterion (  $\alpha = 0.6$  ) ?
- b) Solve the following by branch and bound method :

$$\text{Maximize } z = 3x_1 + 2.5x_2$$

$$\text{Subject to } x_1 + 2.5x_2 \geq 20$$

$$3x_1 + 2x_2 \geq 50$$

where  $x_1, x_2$  are non-negative integers.

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