(b) The hotel management of a college is considering quotations from three vendors to whom it has to place orders for rice. Nellore provision stores quotes Rs. 120 per bag irrespective of the quantity ordered. Green and company will accept orders only for 800 or more bags but quotes a price of Rs. 108 per bag. Ponni Trading Company will accept orders only for 1000 or more bags at Rs. 100 per bag. Chamba and company will accept orders for 400 bags or more for a cost of Rs. 112 per bag. The total requirement of the 12 hostels for which the management buys is 3000 bags per semester (6 months). Inventory carrying costs are 20% of the unit cost and the ordering cost is Rs. 400 per order. Which vendor would you recommend for placing the orders and for what quantity per order?

———————

Reg. No. : .....

Code No. : 6366 **Sub. Code : HMAM 34**

M.Sc. (CBCS) DEGREE EXAMINATION, NOVEMBER 2013.

Third Semester

Mathematics

OPERATIONS RESEARCH

(For those who joined in July 2012 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. Which one of the following is IP?

   (a) Zero-one (b) Mixed zero-one

   (c) Pure integer (d) Mixed.

2. Bender's partitioning algorithm for ————————.

   (a) ILP (b) Zero-one problem

   (c) MILP (d) None of these.

3. The weighted graph is called the

(a) Tree (b) Path
(c) Network (d) Hamiltonian.

4. A path is flow augumenting if ————————.

(a) Its all arcs have capacity
(b) It's all arcs have negative capacity
(c) It's all arcs have additional capacity
(d) None of these.

5. The TSP is an ————————.

(a) Complete problem
(b) Non-NP problem
(c) NP-complete problem
(d) None of these.

6. For $n = 2$, the number of 2-city subtour elimination constraints is ————————.

(a) 20 (b) 15
(c) 40 (d) 60.

7. In $M/M/1/\infty/\infty$ model, expected waiting time in the system is

(a) $L_q + \frac{1}{\lambda}$ (b) $W_q + \frac{1}{\lambda}$

(c) $W_q + \frac{1}{\mu}$ (d) $L_q + \frac{1}{\mu}$

8. In $(M/M/C/N/\infty$ model), λ_e = ————————.

(a) $(1 - p_1)\lambda$ (b) $(1 - p_N)\lambda$
(c) $(1 - p_1)\mu$ (d) $(1 - p_N)\mu$.

9. In production consumption model, annual inventory carrying cost is ————————.

(a) $\frac{I_m}{2}$ (b) $\frac{I_m C_o}{2}$

(c) $\frac{I_m C_c}{2}$ (d) $\frac{I_m D}{2}$.

10. In continuous demand instantaneous replenishment model, TC^* = ————————.

(a) $\frac{DC_o}{Q} + \frac{QC_c}{2}$ (b) $\sqrt{\frac{2DC_o}{C_c}}$

(c) $\frac{QC_c}{2}$ (d) $\sqrt{2DC_oC_c}$

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Solve the following zero-one problem using implicit enumeration algorithm.

Maximize $4x_1 + 3x_2 - 2x_3$

Subject to $x_1 + x_2 + x_3 \leq 8$

$2x_1 - x_2 - x_3 \leq 4$

$x_1, x_2, x_3 = 0, 1.$

Or

(b) Solve the MILP : Maximize $2x_1 + 3x_2$

Subject to $3x_1 + 4x_2 \leq 10$

$x_1 + 3x_2 \leq 7$

$x_1 \geq 0$

$x_2 \geq 0$

and integer.

12. (a) Explain Kruskal's algorithm.

Or

(b) Explain Dijkstra's algorithm.

13. (a) Show that in a symmetric TSP, any three distinct cost elements $C(i, j)$, $C(j, k)$, $C(k, i)$ can be set to infinity without eliminating all minimum length tours.

Or

(b) Solve the 4-city TSP whose distance matrix is given in the following table :

City	1	2	3	4
1	–	12	10	14
2	12	–	13	8
3	10	13	–	12
4	14	8	12	–

14. (a) Customer arrive at a clinic at the rate of 8/hour (Poisson arrival) and the doctor can serve at the rate of 9/hour (exponential) :

(i) What is the probability that there are 10 customers in the system?

(ii) What is the expected number in the system?

Or

(b) Patients visit a dentist at the rate of 8/hour and the service times are 11/hr. Find the expected waiting time in the system. If the dentist wishes to have a finite queue length model, find N for which time in the system is less than 15 minutes.

15. (a) Consider the production – consumption inventory model with back orders. The data are D = 10000/year, P = 16000/year, C_o = 350/set up, C_c = 3.6/unit/year and D = 100 unit/year. Find the batch quantity Q and the total cost.

Or

(b) Shankar has to supply 10,000 bearings per day to an automobile manufacturer. He begins a production run every 10.5 day. The carrying cost is 2 paise per bearing per year and the set up cost is Rs. 18. What should be his optimal production rate to meet the demand?

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Solve the following MILP problem using the branch and bound algorithm.

Minimize $8x + 4y_1 + 3y_2$

Subject to $4x + 6y_1 + 2y_2 \geq 13$

$3x + 2y_1 + 5y_2 \geq 15$

$x \geq 0$

$y_1, y_2 \geq 0$

and integer.

Or

(b) Solve the following linear integer programming problem using Gomory cutting plane algorithm.

Maximize $8x_1 + 6x_2 - x_3$

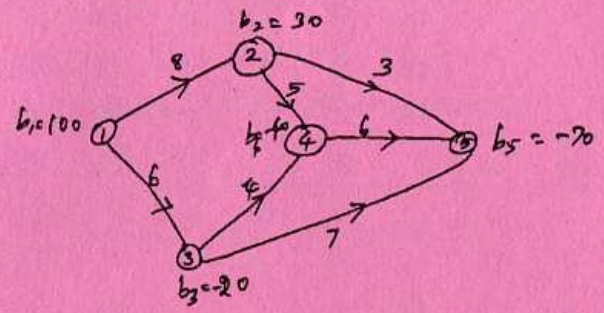
Subject to $8x_1 + 6x_2 - 2x_3 \leq 13$

$x_1 + x_2 - x_3 \leq 4$

$x_1, x_2, x_3 \geq 0$

and integer.

17. (a) The data for a minimum cost flow problem is shown in the figure :



Find the minimum cost flow and the associated cost.

Or

(b) You are given a network with 5 nodes and 11 arcs.

Arc	Distance	Arc	Distance	Arc	Distance
1-2	5	3-2	5	5-3	5
2-1	10	4-3	20	3-5	10
1-4	10	4-5	10	4-2	10
2-3	10	5-4	10		

Find the shortest path from 1 to 5 using Dijkstra's algorithm.

18. (a) You are given a 10 – city TSP with the distance matrix given in the following table :

–	11	8	18	13	20	26	30	33	34
11	–	7	10	9	7	8	13	15	14
8	7	–	10	10	15	19	20	25	23
18	18	10	–	21	11	15	11	27	20
13	9	10	21	–	13	9	20	17	18
20	7	15	11	13	–	6	12	15	9
26	8	19	15	9	–	–	12	8	7
30	13	20	11	20	12	12	–	15	7
33	15	25	27	17	15	8	15	–	10
34	14	23	20	18	19	7	7	10	–

What is your solution to the TSP? If you are giving an approximate solution, what is the % deviation from your lower bound?

Or

(b) A person starting from City 1 wants to visit each of the n cities once and only once and return to the starting point in as short a time as possible. In addition he has to reach city ($k = 2$ to n) during the time interval (a_k, b_k). Formulate this TSP with time windows as on integer – programming problem. Compute the number of variables and constraints.

19. (a) Explain ($M / M / 1 / \infty / \infty$ model).

Or

(b) Explain ($M / M / C / \infty / \infty$ model).

20. (a) Consider a two-item inventory problem with the data given in the following table :

	Item 1	Item 2
Annual demand	10,000	15,000
Ordering cost	Rs. 200/order	Rs. 250/order
Carrying cost	Rs. 4/unit/year	Rs. 5/unit/year
Item cost	Rs. 10/unit	Rs. 20/unit

(i) Find the economic order quantity for each product separately.

(ii) Owing to a liquidity problem, the company requires that average yearly investment in the inventory for the two product taken together be less than or equal to Rs. 15,000. Is the answer found in part (i) consistent with this added constraints?

Or