**INSTITUTE OF AERONAUTICAL ENGINEERING**

**(Autonomous)**

Dundigal, Hyderabad - 500 043

## MECHANICAL ENGINEERING

## TUTORIAL QUESTION BANK

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|---|---|---|---|---|
| **Course Title** | **OPTIMIZATION TECHNIQUES** | | | |
| **Course Code** | AMEB12 | | | |
| **Programme** | B.Tech | | | |
| **Semester** | IV | | | |
| **Course Type** | Core | | | |
| **Regulation** | IARE - R18 | | | |
| **Course Structure** | Lectures | Tutorials | Practical | Credits |
| | 3 | 1 | - | 4 |
| **Course Coordinator** | **Dr. Paidi Raghavulu, Professor, ME** | | | |
| **Course Faculty** | Mrs. T Vanaja Assistant Professor , ME | | | |

### COURSE OBJECTIVES (COs):

| **The course should enable the students to:** | |
|---|---|
| I | Formulate the mathematical model of real time problems and optimize with LLP techniques. |
| II | Establish the problem formulation and optimization by using transportation, assignment models. |
| III | Apply Sequencing and replacement models for optimized decisions |
| IV | Apply Game theory, Inventory models for effective operational control. |
| V | Visualize application of Waiting line, Dynamic programming, Simulation models in real time applications.. |

### COURSE OUTCOMES (COs):

| | |
|---|---|
| CO 1 | Formulate the mathematical model of real time problems and optimize with LLP techniques. |
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| CO 3 | Apply Sequencing and replacement models for optimized decisions. |
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| CO 5 | Visualize application of Waiting line, Dynamic programming, Simulation models in real time applications.. |

**COURSE LEARNING OUTCOMES (CLOs):**

Students, who complete the course, will have demonstrated the asking to do the following:

| | |
|---|---|
| AMEB12.01 | Understand the characteristics, phases, types of operation research models and its applications. |
| AMEB12.02 | Visualize modeling principles scope, decision making, general methods for solving OR models. |
| AMEB12.03 | Understand linear programming concepts, problem formulation and graphical models. |
| AMEB12.04 | Understand simplex method and artificial variable techniques. |
| AMEB12.05 | Comprehend two-phase method and Big-M method of linear programming. |
| AMEB12.06 | Apply to build and solve transportation models of balanced . |
| AMEB12.07 | Understand the degeneracy model problem of transportation, unbalanced type-maximization. |
| AMEB12.08 | Apply to build assignment models for optimal solution. |
| AMEB12.09 | Understand variants of assignment model and travelling salesman model. |
| AMEB12.10 | Understand the flow shop sequencing model of 'n' jobs through two machines and three machines. |
| AHSB11.11 | Solving the linear differential equations using Laplace transform. |
| AHSB11.12 | Understand the concept of Laplace transforms to the real-world problems of electrical circuits, harmonic oscillators, optical devices, and mechanical systems |
| AMEB12.11 | Comprehend job shop sequencing of two jobs through 'm' machines. |
| AMEB12.12 | Understand the concept of replacement of items that deteriorate with time when money value is not counted |
| AMEB12.13 | Understand the concept of replacement of items that deteriorate with time when money value is n counted . |
| AMEB12.14 | Visualize the replacement of items that fail completely and group replacement. |
| AMEB12.15 | Understand minimax (maximini) criterion, optimal strategy , solution od games with saddle point |
| AMEB12.16 | Visualize dominance principle while solving game theory problem. |
| AMEB12.17 | Apply to solve m * 2 , 2 *n model of games and graphical method. |
| AMEB12.18 | Understand the concepts of deterministic inventory model and purchase inventory model with one price break and multiple price breaks. |
| AMEB12.19 | Visualize stochastic inventory models – demand may be discrete variable or continuous variable. |
| AMEB12.20 | Understand the concepts of waiting line model of single channel and multi server model. |
| AMEB12.21 | Visualize dynamic programming concepts and models |
| AMEB12.22 | Comprehend the simulation models, phases of simulation, application of simulation |
| AMEB12.23 | Visualize the application of simulation for inventory and queuing problems. |

**3= High; 2 = Medium; 1 = Low**

| S. No. | Question | Blooms Taxonomy Level | Course Outcomes | Course Learning Outcomes |
|---|---|---|---|---|
| | **MODULE – 1**<br>**DEVELOPMENT OF O.R AND ALLOCATION** | | | |
| | **Part –A (Short Answer Questions)** | | | |
| 1 | Explain scope of operations Research? | Understand | CO 1 | AMEB12.01 |
| 2 | State the applications of operations Research? | Remember | CO 1 | AMEB12.01 |
| 3 | List different characteristics of operations Research? | Remember | CO 1 | AMEB12.01 |
| 4 | Write about physical model of operations Research? | Understand | CO 1 | AMEB12.01 |
| 5 | Describe about simulation models of operations Research? | Understand | CO 1 | AMEB12.01 |
| 6 | Discuss the importance of operations Research in the decision making process? | Remember | CO 1 | AMEB12.02 |
| 7 | List out the principles of modeling. | Remember | CO 1 | AMEB12.02 |
| 8 | State the methods of solving OR models. | Understand | CO 1 | AMEB12.02 |
| 9 | Define model and explain its importance. | Remember | CO 1 | AMEB12.02 |
| 10 | Define feasible region? | Understand | CO 1 | AMEB12.03 |
| 11 | Explain general representation of LPP? | Remember | CO 1 | AMEB12.03 |
| 12 | Discuss objective function in brief? | Understand | CO 1 | AMEB12.03 |
| 13 | Describe optimal solution? | Remember | CO 1 | AMEB12.03 |
| 14 | Explain about decision variables? | Understand | CO 1 | AMEB12.03 |
| 15 | Describe about non- negativity constraints? | Remember | CO 1 | AMEB12.04 |
| 16 | Explain about constraints of a LPP? | Understand | CO 1 | AMEB12.04 |
| 17 | Define slack variables with examples? | Remember | CO 1 | AMEB12.04 |
| 18 | State surplus variables with examples? | Understand | CO 1 | AMEB12.04 |
| 19 | Explain about artificial variables? | Remember | CO 1 | AMEB12.05 |
| 20 | Explain computational steps of Big-M method | Remember | CO 1 | AMEB12.05 |
| | **Part B (Long Answer Questions)** | | | |
| 1 | What are the phases of Operations Research and briefly explain them? | understand | CLO 1 | AMEB12.04 |
| 2 | Explain the main characteristics of Operations Research. | | CLO 1 | AMEB12.04 |
| 3 | What is a model? List the various classification schemes of Operations Research models. | Remember | CLO 1 | AMEB12.04 |
| 4 | Describe the scope of Operations Research. | Understand | CO 1 | AMEB12.02 |
| 5 | Explain general methods for solving OR models | Understand | CO 1 | AMEB12.02 |
| 6 | Describe the terminology involved in formulating a linear programming problem? | Understand | CO 1 | AMEB12.03 |
| 7 | Explain applications of LPP in production management? | Remember | CO 1 | AMEB12.03 |
| 8 | Explain step by step procedure of graphical method of solving Linear Programming Problem. | Understand | CO 1 | AMEB12.03 |
| 9 | What are the limitations of graphical method? | Understand | CO 1 | AMEB12.03 |
| 10 | A firm manufactures two types of products A and B and sells them at a profit of Rs 2 on type A and Rs 3 on type B. Each product is processed on two machines G and H. Type A requires one minute of processing time on G and two minutes on H; type B requires one minute on G and one minute on H. The machine G is available for not more than 6 hour 40 minutes while machine H is available for 10 hours during any working day. Formulate the problem as a linear programming problem and find the optimum solution graphically. | Understand | CO 1 | AMEB12.03 |
| 11 | Explain the structure of an LPP with example? | Remember | CO 1 | AMEB12.04 |

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| 12 | Discuss the algorithm of simplex method to solve an LPP? | Remember | CO 1 | AMEB12.04 |
| 13 | Explain assumptions to solve LPP using simplex? | Understand | CO 1 | AMEB12.04 |
| 14 | Solve the following problem by Simplex method<br>Maximize Z = 5x1 + 3x2 subject to constraints<br>$3x1 + 5x2 \leq 15$<br>$5x1 + 2x2 \leq 10$<br>and $x1, x2 \geq 0$ | Understand | CO 1 | AMEB12.04 |
| 15 | Solve the following problem by Simplex method<br>Maximize Z = x1 + 3x2 +2 x3 subject to constraints<br>$3x_1 + x_2 + 3x_3 \leq 7$<br>$-2x_1 + 4x^2 \leq 12$<br>$-4x^1 + 3x_2 + 8x_3 \leq 10$<br>and $x1, x2 \geq 0$ | Remember | CO 1 | AMEB12.04 |
| 16 | Describe step-by-step procedure to solve LPP by BIG-M method? | Remember | CO 1 | AMEB12.05 |
| 17 | Explain the term artificial variables? Why do we need them? | Remember | CO 1 | AMEB12.05 |
| 18 | Describe Two-phase Simplex method | Remember | CO 1 | AMEB12.05 |
| 19 | Use big –M method to solve the following<br>Maximize Z = 8x1 + 5x2 Subjective to constraints<br>$2x_1 + 4x_2 \leq 45$<br>$3x_1 + 2x_2 \leq 40$<br>$x_1 + x_2 \geq 30$<br>$x_1, x_2 \geq 0$. | Remember | CO 1 | AMEB12.05 |
| 20 | Solve the following LP Problem by two phase method<br>Maximize Z = 5x1 - 2x2 + 3x3 Subject to constraints<br>$2x1 + 2x2 - x3 \geq 2,$<br>$3x1 - 4x2 \leq 3,$<br>$x2 + 3x3 \leq 5$<br>$x1, x2, x3 \geq 0$ | Understand | CO 1 | AMEB12.05 |

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| **Part C( Critical Analytical Questions)** | | | | |
| 1 | Solve the following LP problem graphically.<br><br>Maximize $Z = 2x_1 + x_2$ Subjective to constraints<br>$x_1 + 2x_2 \leq 10$<br>$x_1 + x_2 \leq 6$<br>$x_1 - x_2 \leq 2$<br>$x_1 - 2x_2 \leq 1$<br>$x_1, x_2 \geq 0$. | Understand | CO 1 | AMEB12.03 |
| 2 | Solve the following LPproblem using Simplex method.<br>Maximize $Z = 6x_1 + 8x_2$ subject to constraints<br>$x_1 + x_2 \leq 10$<br>$2x_1 + 3x_2 \leq 25$<br>$2x_1 + 5x_2 \leq 35$<br>and $x_1, x_2 \geq 0$ | Understand | CO 1 | AMEB12.04 |
| 3 | Solve the following LPP by two-phase method<br>Minimize $Z = 3x_1 + 4x_2$ subject to constraints<br>$2x_1 + 3x_2 \geq 8$<br>$5x_1 + 2x_2 \geq 12$<br>and $x_1, x_2 \geq 0$ | Understand | CO 1 | AMEB12.04 |
| 4 | Solve the following LPP by Big-M ( penalty) method<br>Minimize $Z = 5x_1 + 3x_2$ subject to constraints<br>$2x_1 + 4x_2 \leq 12$<br>$2x_1 + 2x_2 \leq 10$<br>$5x_1 + 2x_2 \leq 10$<br><br>and $x_1, x_2 \geq 0$ | Remember | CO 1 | AMEB12.05 |
| 5 | Solve the following LPP by Big-M method<br>Maximize $Z = 4x_1 + 5x_2 + x3$ subject to constraints<br>$x_1 + x_2 + x_3 = 10$<br>$2x_1 - x_2 \geq 1$<br>$2x_1 + 3x_2 + x3 \leq 40$<br>$x_1, x_2, x_3 \geq 0$ | Understand | CO 1 | AMEB12.05 |

## UNIT – II

## TRANSPORTATION AND ASSIGNMENT PROBLEM

**Part A(Very Short Answer Questions)**

| S. No. | Question | Blooms Taxonomy Level | Course Outcomes | Course Learning Outcomes |
|---|---|---|---|---|
| 1 | Explain mathematical model of a transportation problem? | Understand | CO 2 | AMEB12.06 |
| 2 | What are different methods of solving transportation problems to get basic feasible solution? | Remember | CO 2 | AMEB12.06 |
| 3 | Why is LCM is optimal than NWCR in solving transportation problem? | Understand | CO 2 | AMEB12.06 |
| 4 | Why does Vogel's approximation method provide a good initial feasible solution? | Remember | CO 2 | AMEB12.06 |
| 5 | What are the methods to test for optimality in transportation problem? | Understand | CO 2 | AMEB12.06 |
| 6 | Describe balanced problem in transportation? | Understand | CO 2 | AMEB12.06 |
| 7 | Explain MODI method in brief? | Understand | CO 2 | AMEB12.06 |
| 8 | What is degeneracy in transportation problem? | Remember | CO 2 | AMEB12.07 |
| 9 | Define unbalance problem in transportation? | Remember | CO 2 | AMEB12.07 |
| 10 | Explain how the unbalanced problem is solved? | Remember | CO 2 | AMEB12.07 |
| 11 | Explain constraints of a transportation problem? | Remember | CO 2 | AMEB12.07 |
| 12 | What is assignment problem? | Understand | CO 2 | AMEB12.08 |
| 13 | Explain applications of assignment problem? | Remember | CO 2 | AMEB12.08 |
| 14 | Give the mathematical representation of an assignment problem | Understand | CO 2 | AMEB12.08 |

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| 15 | Discuss the method of solving assignment problems? | Understand | CO 2 | AMEB12.08 |
| 16 | Explain an algorithm to solve an assignment problem? | Understand | CO 2 | AMEB12.08 |
| 17 | Describe Hungarian method? | Remember | CO 2 | AMEB12.08 |
| 18 | Explain Principle of dominance? | Remember | CO 2 | AMEB12.09 |
| 19 | Explain unbalanced assignment problem? | Understand | CO 2 | AMEB12.09 |
| 20 | Discuss travelling sales man problem? | Remember | CO 2 | AMEB12.09 |

**Part B (Long Answer Questions)**

| | | | | |
|---|---|---|---|---|
| 1 | Discuss different methods of finding initial basic feasible solution. | Remember | CO 2 | AMEB12.06 |
| 2 | Explain Practical Steps Involved in Solving minimization type Transportation Problems. | | CO 2 | AMEB12.06 |
| 3 | A Company has three plants at locations A,B and C which supply to warehouses located at D,E,F,G and H. monthly plant capacities are 800,500 and 900 respectively. Monthly warehouse requirements are 400, 500,400 and 800 units respectively. Unit transportation cost in rupees is given below. | Understand | CO 2 | AMEB12.06 |

| | | Ware houses | | | | |
|---|---|---|---|---|---|---|
| | | D | E | F | G | H |
| Plant | A | 5 | 8 | 6 | 6 | 3 |
| | B | 4 | 7 | 7 | 6 | 5 |
| | C | 8 | 4 | 6 | 6 | 4 |

Determine an optimum distribution for the company in order to minimize the total transportation cost.

| | | | | |
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| 4 | A company has factories at $F_1$, $F_2$ and $F_3$ that supply products to ware houses at $W_1$, $W_2$ and $W_3$ .The weekly capacities of the factories are 200,160 and 90 units. The weekly warehouse requirements are 180,120 and 150/units respectively. The unit shipping costs in rupees are as follows. Find the optimal solution. | Remember | CO 2 | AMEB12.06 |

| | $W_1$ | $W_2$ | $W_3$ | Supply |
|---|---|---|---|---|
| $F_1$ | 16 | 20 | 12 | 200 |
| $F_2$ | 14 | 8 | 18 | 160 |
| $F_3$ | 27 | 24 | 16 | 90 |
| Demand | 180 | 120 | 150 | 450 |

| | | | | |
|---|---|---|---|---|
| 5 | Find the optimal solution of the following transportation problem for which costs elements, factory capacity and warehouse requirements are provided. | Understand | CO 2 | AMEB12.06 |

| | Warehouse | | | | Factory capacity |
|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | W4 | |
| Factoty -$F_1$ | 19 | 30 | 50 | 10 | 7 |
| Factory -$F_2$ | 70 | 30 | 40 | 60 | 9 |
| Factory-$F_3$ | 40 | 8 | 70 | 20 | 18 |
| Warehouse requirements | 15 | 8 | 7 | 14 | 34 |

| | | | | |
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| 6 | Define degeneracy? How the Degeneracy during initial stage of transportation problem solving is resolved? | Remember | CO 2 | AMEB12.0 |
| 7 | Discuss the process of optimality test of transportation problem. | Remember | CO 2 | AMEB12.0 |
| 8 | Find optimum solution for the following transportation problem for which the profit elements, supply and demands are as shown below. | Understand | CO 2 | AMEB12.0 |

| | | To | | | | |
|---|---|---|---|---|---|---|
| | | D1 | D2 | D3 | D4 | Available |
| | O1 | 10 | 0 | 20 | 11 | 15 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | From | O2 | 1` | 7 | 9 | 20 | 25 | | | |
| | | | O3 | 12 | 14 | 16 | 18 | 5 | | | |
| | | | Demand | 10 | 15 | 25 | 10 | | | | |
| 9 | The company has three plants A, B and C and three warehouses X, Y and Z. Number of units available at plants is 60, 70 and 80 respectively. Demand at X, Y and Z are 50, 80 and 80 respectively. Unit costs of transportation are as follows:<br><br>What would be your optimal transportation plan? Give minimum distribution cost. | | | | | | | | Remember | CO 2 | AMEB12.0 |

| | X | Y | Z |
|---|---|---|---|
| A | 8 | 7 | 3 |
| B | 3 | 8 | 9 |
| C | 11 | 3 | 5 |

| 10 | A company has three plants at locations A,B and C which supply to warehouses located at D, E, F, G and H. monthly plant capacities are 800, 500 and 900 units respectively. Monthly warehouse requirements are 400, 500, 400 and 800 units respectively. Unit transportation costs in (Rs. )are as given below.<br><br>Determine an optimum distribution for the company in order to minimize the total transportation cost. | Understand | CO 2 | AMEB12.0 |
|---|---|---|---|---|

| | | To | | | | |
|---|---|---|---|---|---|---|
| | | D | E | F | G | H |
| From | A | 5 | 8 | 6 | 6 | 3 |
| | B | 4 | 7 | 7 | 6 | 5 |
| | C | 8 | 4 | 6 | 6 | 4 |

| 11 | Explain briefly the Steps involved in solving assignment Problem.. | Understand | CO 2 | AMEB12.0 |
|---|---|---|---|---|
| 12 | Explain the line drawing procedure that has to be adapted while solving assignment problem. | | CO 2 | AMEB12.0 |
| 13 | Solve the following assignment problem to minimize the total time of the operator; | Remember | CO 2 | AMEB12.0 |

| | Jobs | | | | |
|---|---|---|---|---|---|
| Operator | 1 | 2 | 3 | 4 | 5 |
| 1 | 6 | 2 | 5 | 2 | 6 |
| 2 | 2 | 5 | 8 | 7 | 7 |
| 3 | 7 | 8 | 6 | 9 | 8 |
| 4 | 6 | 2 | 3 | 4 | 5 |
| 5 | 9 | 3 | 8 | 9 | 7 |
| 6 | 4 | 7 | 4 | 6 | 8 |

| 14 | Different machines can do any of the five required jobs, with different profits resulting from each assignment as shown in the adjusting table. Find out maximum profit possible through optimal assignment. | Remember | CO 2 | AMEB12.0 |
|---|---|---|---|---|

| **Jobs** | **Machines** | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| 1 | 30 | 37 | 40 | 28 | 40 |
| 2 | 40 | 24 | 27 | 21 | 36 |
| 3 | 40 | 32 | 33 | 30 | 35 |
| 4 | 25 | 38 | 40 | 36 | 36 |
| 5 | 29 | 62 | 41 | 34 | 39 |

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| 15 | A typical assignment problem, presented in the classic manner. Here there are five machines to be assigned to five jobs. The numbers in the matrix indicate the cost of doing each job with each machine. Jobs with costs of M are allowed assignments. The problem is to find the minimum cost matching of machines to jobs.<br>CO 2 J2 J3 J4 J5<br>M1 CO 2 8 6 12 1<br>M2 CO 2 12 7 M 10<br>M3 CO 2 M 5 14 M<br>M4 CO 2 M 12 16 15<br>M5 CO 2 17 14 M 13 | Remember | CO 2 | AMEB12.0 |
| 16 | The profits after assigning the machines to jobs are given as follows.<br>J1 J2 J3 J4 J5 J6<br>M1 5 3 7 6 5 3<br>M2 7 6 1 4 2 8<br>M3 **6** 2 4 3 4 5<br>M4 4 6 4 7 3 8<br>Solve the problem to maximize the profits. | Remember | CO 2 | AMEB12.08 |
| 17 | A salesman has to visit five cities A, B, C, D, E. The intercity distances are tabulated below.<br>A B C D E<br>A - 12 24 25 15<br>B 6 - 16 18 7<br>C 10 11 - 18 12<br>D 14 17 22 - 16<br>E 12 13 23 25 -<br>Find the shortest route covering all the cities. | Remember | CO 2 | AMEB12.09 |
| 18 | The assignment cost of assigning any one operator to any one machine is given in the following table.<br>Operators: I II III IV<br>Machine A 10 5 13 15<br>B 3 9 18 3<br>C 10 7 3 2<br>D 5 11 9 7<br>Solve the optimal assignment by Hungarian method | Understand | CO 2 | AMEB12.09 |
| 19 | A company has 5jobs to be done. The following matrix shows the return in rupees on assigning ith (i = 1,2,3,4,5) machine to the jth job (j =A, B, C, D, E). Assign the five jobs to the five machines so as to maximize the total expected profit<br>Jobs: A B C D E<br>Machine 1 5 11 10 12 4<br>Machine 2 2 4 6 3 5<br>Machine 3 3 12 5 14 6<br>Machine 4 6 14 4 11 7<br>Machine 5 7 9 8 12 5 | Maxi assign | CO 2 | AMEB12.09 |
| 20 | The modification of a plant layout of a factory, four machines M1, M2, M3, and M4 are tio be installed in a machine shop. Because of limited space, machine M2 cannot be placed at location A. the cost of placing of machine I ( in hundred rupees is shown below) | Understand | CO 2 | AMEB12.09 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Location | | | | | | |
| | | | A | B | C | D | E | | |
| | | Machine M1 | 9 | 11 | 15 | 10 | 11 | | |
| | | Machine M2 | 12 | 9 | - | 10 | 9 | | |
| | | Machine M3 | - | 11 | 14 | 11 | 7 | | |
| | | Machine M4 | 14 | 8 | 12 | 7 | 8 | | |
| | Find the optimal assignment schedule. | | | | | | | | |
| | **Part C ( Critical Analytical Questions)** | | | | | | | | |
| 1 | Find the optimum solution to the Transportation problem , supply and demand and cost elements are<br><br>Warehouse: $W_1$, $W_2$, $W_3$, W4; supply<br>Factory -$F_1$: 14, 25, 45, 5; 6<br>Factory -$F_2$: 65, 25, 35, 55; 9<br>Factory-$F_3$: 35, 3, 65, 15; 16<br>Demand: 15, 8, 7, 14; 34 | | | | | | | Understand | CO 2 | AMEB12.09 |
| 2 | Find the optimum solution for the transportation problem whose cost matrix is as given below:<br><br>Destination: $D_1$, $D_2$, $D_3$; supply<br>Warehouse-1: 4, 3, 2; 10<br>Warehouse-2: 2, 5, 0; 13<br>Warehouse-3: 3, 8, 6; 12<br>Demand: 8, 5, 4 | | | | | | | Understand | CO 2 | AMEB12.09 |
| 3 | Find the minimum cost assignment for the following problem, explaining each step.<br><br>**Worker** \| **Job**: I, II, III, IV, V<br>A: 6, 5, 8, 11, 16<br>B: 1, 13, 16, 1, 10<br>C: 16, 11, 8, 8, 8<br>D: 9, 14, 12, 10, 16<br>E: 10, 13, 11, 8, 16 | | | | | | | Remember | CO 2 | AMEB12.09 |
| 4 | A marketing manager wants to assign four regions to four different salesmen. Sales differ in their efficiency and territories also differ in their potentiality. An estimated sales (in lakhs) by different salesmen in the four territories are given below in the table.<br><br>**Salesmen** \| **Territories**: 45, 60, 70, 80<br>A: 6, 5, 8, 11<br>B: 20, 32, 42, 74<br>C: 25, 37, 47, 55<br>D: 40, 35, 30, 30 | | | | | | | Understand | CO 2 | AMEB12.09 |
| 5 | A salesman estimates that the following would be the cost on his route, visiting the six cities as shown in the table below:<br><br>To city: A1, A2, A3, A4, A5<br>From city<br>A1: ∞, 20, 23, 27, 29<br>A2: 21, ∞, 19, 26, 31<br>A3: 26, 28, ∞, 15, 36<br>A4: 25, 16, 25, ∞, 23 | | | | | | | Remember | CO 2 | AMEB12.09 |

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| | | | A5 | 23 | 40 | 23 | 31 | ∞ | |

## UNIT – III
## SEQUENCING AND REPLACEMENT

**Part A(Very Short Answer Questions); MID – I**

| | | | | |
|---|---|---|---|---|
| 1 | Define sequencing? | Remember | CO 2 | AMEB12.10 |
| 2 | Discuss the importance of sequencing. | Understand | CO 2 | AMEB12.10 |
| 3 | State general representation of sequencing? | Remember | CO 2 | AMEB12.10 |
| 4 | Explain the terminology of sequencing techniques in operations research? | Remember | CO 2 | AMEB12.10 |
| 5 | Explain various sequencing models. | Understand | CO 2 | AMEB12.11 |
| 6 | Describe applications of sequencing? | Understand | CO 2 | AMEB12.11 |
| 7 | What are the conditions to be satisfied to convert a ‘n’ jobs 3 machine problem into ‘n’ jobs 2 machine problem? Explain the method clearly? | Understand | CO 2 | AMEB12.11 |
| 8 | What are the assumptions made in sequencing problem? | Understand | CO 2 | AMEB12.11 |
| 9 | Give the justification of Johnson’s rule for sequencing n jobs x 2 machines | Remember | CO 2 | AMEB12.11 |
| 10 | What are the advantages of sequencing? | | CO 2 | AMEB12.11 |
| | **Part B (Long Answer Questions)** | | CO 2 | |
| 1 | Discuss about the terminology and notations followed in sequencing solution. | Remember | CO 3 | AMEB12.10 |
| 2 | Discuss various types of sequencing models. | Remember | CO 3 | AMEB12.10 |
| 3 | Explain Johnson’s algorithm for processing ‘n’ jobs through two machines for a given machine order. | Remember | CO 3 | AMEB12.10 |
| 4 | Explain step by step procedure for processing ‘n’ jobs through three machines mentioning conditions. | Remember | CO 3 | AMEB12.10 |
| 5 | There are five jobs, each of which must go through the two machines A and B in the order BA. Processing times are given in below table<br><br>Processing times (hours)<br>Job: 1 2 3 4 5 6<br>Time for A: 3 4 5 2 1 6<br>Time for B: 8 7 6 9 10 9<br><br>Determine a sequence for five jobs that will minimize the elapsed time. Calculate the total idle time for the machines in this period. | Understand | CO 3 | AMEB12.10 |
| 6 | Describe the steps in processing Two jobs through ‘m’ machine graphical method briefly. | Remember | CO 3 | AMEB12.11 |
| 7 | Discuss the situations involving complex sequential problems. | Understand | CO 3 | AMEB12.11 |
| 8 | Find the sequence that minimizes the total time required in forming the following jobs on three machine in the order ABC and also find idle time of each machine<br><br>Job: **1 2 3 4 5 6** | Remember | CO 3 | AMEB12.11 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Machine **A** | 8 | 3 | 7 | 2 | 5 | 1 | | | |
| | | Machine **B** | 3 | 4 | 5 | 2 | 1 | 6 | | | |
| | | Machine **C** | 8 | 7 | 6 | 9 | 10 | 9 | | | |
| 9 | Describe the step by step procedure of graphical method for processing two jobs through 'm' machines | | | | | | | | Remember | CO 3 | AMEB12.11 |
| 10 | Use graphical method to minimize the time. Time required to process the following jobs on the machines shown,, i.e.,Foreach machine find the job<br>JOB-1 Sequence A B C D E<br>Time 3 4 2 6 2<br>JOB-2 Sequence B C A D E<br>Time 5 4 3 2 6<br>which should be done first. Also calculate the total time elapsed to complete both the jobs. | | | | | | | | Understand | CO 3 | AMEB12.11 |
| | **Part C (Critical Analytical Questions)** | | | | | | | | | | |
| 1 | We have five jobs each of which must go through two machines in the order BA, processing times are given in the table below<br>Job No. 1 2 3 4 5<br>Machine A 10 2 18 6 20<br>Machine B 4 12 14 16 8<br>Determine a sequence for the five jobs that will minimize the total elapsed time. Also compute idle times for each of the machine | | | | | | | | Understand | CO 3 | AMEB12.10 |
| 2 | Automobile repair center has six cars for repair. The repair consists of two steps procedure viz. dent removing and painting. The time estimates are as follows:<br>Car Number 1 2 3 4 5 6<br>Time estimate (dent removing) 16 10 11 13 8 18<br>Time Estimate (painting) 15 9 15 11 12 14<br>Determine a sequence for the six cars that will minimize the total elapsed time. Also compute idle times for each of the machine and prepare Gantt chart | | | | | | | | Understand | CO 3 | AMEB12.10 |
| 3 | Find the sequence that minimizes the total time required in forming the following jobs on three machine in the order ACB and also find idle time of each machine and idle time of each machine. | | | | | | | | Understand | CO 3 | AMEB12.10 |
| | | | Job | | | | | | | | |
| | | | **1** | **2** | **3** | **4** | **5** | **6** | | | |
| | | Machine **A** | 8 | 3 | 7 | 2 | 5 | 1 | | | |
| | | Machine **B** | 3 | 4 | 5 | 2 | 1 | 6 | | | |
| | | Machine **C** | 8 | 7 | 6 | 9 | 10 | 9 | | | |
| 4 | Explain step by step Procedure to solve by graphical method to minimize the time required to process the two jobs on 'n" machines | | | | | | | | Remember | CO 3 | AMEB12.11 |

<table>
<tr><td>5</td><td>Using graphical method , calculate the minimum time needed to process job-1 and job-2 on five machines A, B, C, D, E, ie. for each machine find the job which should be done first . also calculate the total time needed to complete both the jobs.
<table>
<tr><td>JOB-1</td><td>Sequence</td><td>A</td><td>C</td><td>B</td><td>D</td><td>E</td></tr>
<tr><td></td><td>Time (hours)</td><td>6</td><td>8</td><td>4</td><td>12</td><td>4</td></tr>
<tr><td>JOB-2</td><td>Sequence</td><td>B</td><td>C</td><td>A</td><td>D</td><td>E</td></tr>
<tr><td></td><td>Time (hours)</td><td>5</td><td>4</td><td>3</td><td>2</td><td>6</td></tr>
</table></td><td>Understand</td><td>CO 3</td><td>AMEB12.11</td></tr>
<tr><td colspan="5">Part A(Very Short Answer Questions); MID – II</td></tr>
<tr><td>1</td><td>What is the need for a replacement?</td><td>Remember</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>2</td><td>Define individual replacement policy?</td><td>Remember</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>3</td><td>Write about ‘replacement policy of items which deteriorate with time’.</td><td>Understand</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>4</td><td>What is replacement problem?</td><td>Understand</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>5</td><td>Give some examples for replacement situations.</td><td>Understand</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>6</td><td>Give the examples of group replacement concept.</td><td>Understand</td><td>CO 3</td><td>AMEB12.14</td></tr>
<tr><td>7</td><td>Explain different types of replacement problems?</td><td>Understand</td><td>CO 3</td><td>AMEB12.14</td></tr>
<tr><td>8</td><td>State the examples of group replacement concept.</td><td>Remember</td><td>CO 3</td><td>AMEB12.14</td></tr>
<tr><td>9</td><td>Describe individual replacement policy.</td><td>Remember</td><td>CO 3</td><td>AMEB12.14</td></tr>
<tr><td>10</td><td>What is group replacement policy?</td><td>Understand</td><td>CO 3</td><td>AMEB12.14</td></tr>
<tr><td colspan="5">Part B (Long Answer Questions)</td></tr>
<tr><td>1</td><td>Explain the importance of replacement analysis.</td><td>Understand</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>2</td><td>Describe with examples the failure mechanism of items.</td><td>Remember</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>3</td><td>Write about ‘replacement policy of items which deteriorate with time’.</td><td>Understand</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>4</td><td>Discuss the replacement policy of items whose maintenance cost increases with time and money value is constant.</td><td>Remember</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>5</td><td>A machine owner finds from his past records that the costs per year of maintainingn a machine whose purchase price is Rs. 6000 are given below.
<table>
<tr><td>Year</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>Maintenance ( Rs)</td><td>1000</td><td>1200</td><td>1400</td><td>1800</td><td>2300</td><td>2800</td><td>3400</td><td>4000</td></tr>
<tr><td>Resale price (Rs)</td><td>3000</td><td>1500</td><td>750</td><td>375</td><td>200</td><td>200</td><td>2000</td><td>200</td></tr>
</table>
determine at what age a replacement is due?</td><td>Understand</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>6</td><td>Machine A costs Rs:45,000 and it’s operating costs are estimated to be Rs:1,000 for the first year increasing by Rs:10,000 per year in the second year and subsequent years .Machine B costs Rs:50,000 and operating cost are Rs:2,000 for the first year and increasing by Rs:4,000 in the second and subsequent years. If at present we have a machine of type A, should we replace it with B? If so when? Assume both machines have no resale value and these future costs are not discounted?</td><td>Understand</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>7</td><td>Let the value of the money be assumed be 10% per year and suppose that the machine A is replaced after every three years whereas machine B is replaced every six years .The yearly cost in (Rs) of both the machines are given below.
<table>
<tr><td>Year</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>Machine A</td><td>1000</td><td>200</td><td>400</td><td>1000</td><td>200</td><td>400</td></tr>
<tr><td>Machine B</td><td>1700</td><td>100</td><td>200</td><td>300</td><td>400</td><td>500</td></tr>
</table>
Determine which Machine should be purchased?</td><td>Remember</td><td>CO 3</td><td>AMEB12.13</td></tr>
<tr><td>8</td><td>A firm is considering the replacement of a machine, whose cost price is</td><td>Understand</td><td>CO 3</td><td>AMEB12.13</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| | Rs.12, 200 and its scrap value is Rs.200. From experience the running (Maintenance and operating) costs are found to be as follows.<br><br>Year: 1 \| 2 \| 3 \| 4 \| 5 \| 6 \| 7 \| 8<br>Running cost (Rs): 200 \| 500 \| 800 \| 1200 \| 1800 \| 2500 \| 3200 \| 4000<br><br>When the machine should be replaced. | | | |
| 9 | Explain briefly individual replacement policy and Group replacement of items that fail completely (suddenly) | Remember | CO 3 | AMEB12.14 |
| **10** | The management of a large hotel is considering the periodic replacement of light bulbs fitted in it's room .There are 500 rooms in the hotel and each room has 6 bulbs. The management is now following the policy of replacing the bulbs as they fail at the total cost of Rs:3 per bulb .The management feels that this cost can be reduced to Rs:1 by adopting the group replacement method. On the basis of the information given below, evaluate the alternative and make a recommendation to the management. | Understand | CO 3 | AMEB12.14 |
| | **Part C (Critical Analytical Questions)** | | | |
| 1 | A manufacturer is offered two machines A and B. A is priced at Rs 5000 and running costs are estimated at Rs 800 for each of the first five years, increasing by Rs. 200 per year in the sixth and subsequent years. Machine B, which has the same capacity as A, costs Rs 2500 but will have running costs of Rs 1200 per year for six years, increasing by Rs 200 per year thereafter. If money is worth 10% per year, which machine should be purchased? (Assume that machines will eventually soldl for scrap at a negligible price.) | Remember | CO 3 | AMEB12.14 |
| 2 | The data collected in running a Machine the cost of which is Rs:60,000 are given below<br><br>1 \| 2 \| 3 \| 4 \| 5<br>Resale value(Rs): 42,000 \| 30,000 \| 20,400 \| 14,400 \| 9,650<br>Cost of Spares(Rs): 4,000 \| 4,270 \| 4,880 \| 5,700 \| 6,800<br>Cost of Labour: 14,000 \| 16,000 \| 18,000 \| 21,000 \| 25,000<br>Find the time when the machine should be replaced? | Understand | CO 3 | AMEB12.13 |
| 3 | A manual stamper currently valued at RS 1000 is expected to last 2 years and costs Rs 4000 per year to operate. An automatic stamper which can be purchased for Rs 3000 will last for 4 years and can be operated at an annual cost of Rs 3000. If money carries the rate of interest 10% per year, determine which stamper should be purchased. | Remember | CO 3 | AMEB12.13 |
| 4 | A factory has a large number of bulbs all of which must be in working condition. The morality<br>of the bulbs is given in the following table.<br><br>week: 1 \| 2 \| 3 \| 4 \| 5 \| 6<br>Proportion of bulbs failing during the week: 0.1 \| 0.15 \| 0.25 \| 0.35 \| 0.12 \| 0.03<br>If a bulb fails in service, it costs Rs3.50 to replace but if all bulbs are replaced at a time it costs Rs 1.20 each. Find the optimum group replacement policy. ( Assume 1000 bulbs are available initially). | Remember | CO 3 | AMEB12.13 |
| 5 | There are 1000 bulbs in use, and it costs Rs 10 to replace an individual bulb which has burn out. If all the bulbs were replaced simultaneously it would cost Rs 4 per bulb. It is proposed to replace all bulbs at fixed intervals of time, whether or not they have burn out, and to continue replacing burnt out bulbs as and when they fail. At what intervals all the bulbs should be replaced. At what group replacement price per bulb would a policy of strictly individual replacement becime preferable to the adopted policy. | Understand | CO 3 | AMEB12.13 |
| | **UNIT – IV**<br>**THEORY OF GAMES AND INVENTORY** | | | |

| | | | | |
|---|---|---|---|---|
| | **Part A (Very Short Answer Questions)** | | | |
| 1 | Define a player. | Understand | CO 4 | AMEB12.15 |
| 2 | Explain a strategy. | Remember | CO 4 | AMEB12.15 |
| 3 | Define a pure strategy | Understand | CO 4 | AMEB12.15 |
| 4 | Define a two-person zero-sum game. | Remember | CO 4 | AMEB12.15 |
| 5 | Describe n-person zero-sum game. | Understand | CO 4 | AMEB12.15 |
| 6 | What are the characteristics of a two-person zero-sum game? | Understand | CO 4 | AMEB12.15 |
| 7 | Discuss a mixed strategy. | Remember | CO 4 | AMEB12.16 |
| 8 | What is the advantage of a mixed strategy over a pure strategy? | Understand | CO 4 | AMEB12.16 |
| 9 | state the principle of dominance. | Remember | CO 4 | AMEB12.16 |
| 10 | Describe a mixed strategy. | Understand | CO 4 | AMEB12.17 |
| 11 | Explain 2× n game mode;? | Remember | CO 4 | AMEB12.17 |
| 12 | Define inventory | Understand | CO 4 | AMEB12.18 |
| 13 | What is the necessity of maintaining inventory? | Remember | CO 4 | AMEB12.18 |
| 14 | Explain different types of variables used in inventory? | Understand | CO 4 | AMEB12.18 |
| 15 | What are the different types of inventory models? | Remember | CO 4 | AMEB12.18 |
| 16 | Why many organizations hold safety stocks as part of their inventory. | Understand | CO 4 | AMEB12.18 |
| 17 | What is a reorder point? | Understand | CO 4 | AMEB12.18 |
| 18 | What is the EOQ.? | Remember | CO 4 | AMEB12.18 |
| 19 | Explain discrete probabilistic demand model | Understand | CO 4 | AMEB12.19 |
| 20 | Describe safety stock and Reorder point | Remember | CO 4 | AMEB12.19 |
| | **Part B (Long Answer Questions)** | | | |
| 1 | Explain two person zero sum game and n person game? | Remember | CO 4 | AMEB12.15 |
| 2 | Define pay of matrix and types of strategies in game theory? | Remember | CO 4 | AMEB12.15 |
| 3 | For the given payoff matrix, Find the solution of the game to the player A and B. what is the saddle point? What is the value of game.what strategies should A and B play in order to get the optimum benefit of the play? | Understand | CO 4 | AMEB12.15 |
| 4 | Solve the following game; | Understand | CO 4 | AMEB12.15 |
| 5 | Discuss the step by step procedure of application of Principle of dominance for solving game theory problem. | Remember | CO 4 | AMEB12.16 |
| 6 | Solve the following 2x2 game without saddle point | Understand | CO 4 | AMEB12.16 |

| | | Player B | | | | | |
|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** |
| Player A | 1 | 8 | 3 | 7 | 2 | 5 | 1 |
| | 2 | 3 | 4 | 5 | 2 | 1 | 6 |
| | 3 | 8 | 7 | 6 | 9 | 10 | 9 |

| | Y1 | Y2 | Y3 |
|---|---|---|---|
| X1 | 4 | 20 | 6 |
| X2 | 18 | 12 | 10 |

Find the value of game and strategies of players.

B

a. $A\begin{bmatrix} 5 & 1 \\ 3 & 4 \end{bmatrix}$

B

b. $A\begin{bmatrix} 2 & 5 \\ 7 & 3 \end{bmatrix}$

<table>
<tr><td>7</td><td>Using the dominance property obtain the optimal strategy for both the players and determine the value of game. The payoff matrix for player A is given
<table>
<tr><td rowspan="2">Player-A</td><td colspan="5">Player-B</td></tr>
<tr><td></td><td>I</td><td>II</td><td>III</td><td>IV</td><td>V</td></tr>
<tr><td></td><td>I</td><td>2</td><td>4</td><td>3</td><td>8</td><td>4</td></tr>
<tr><td></td><td>II</td><td>5</td><td>6</td><td>8</td><td>7</td><td>8</td></tr>
<tr><td></td><td>III</td><td>6</td><td>7</td><td>9</td><td>8</td><td>7</td></tr>
<tr><td></td><td>IV</td><td>4</td><td>2</td><td>8</td><td>4</td><td>3</td></tr>
</table></td><td>Remember</td><td>CO 4</td><td>AMEB12.16</td></tr>
<tr><td>8</td><td>Two breakfast food manufacturers ABC and XYZ are competing for an increased market share. The pay off matrix, shown in the following table describes the increase in market share for ABC and decrease in market share of XYZ
<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="4">ABC</td></tr>
<tr><td>Give coupon</td><td>Decrease price</td><td>Maintain present strategy</td><td>Increase advertising</td></tr>
<tr><td rowspan="3">XYZ</td><td>Give coupons</td><td>8</td><td>3</td><td>7</td><td>2</td></tr>
<tr><td>Decrease price</td><td>3</td><td>4</td><td>5</td><td>2</td></tr>
<tr><td>Increase advertising</td><td>8</td><td>7</td><td>6</td><td>9</td></tr>
</table></td><td>Understand</td><td>CO 4</td><td>AMEB12.16</td></tr>
<tr><td>9</td><td>Explain process for solving 2 × n game graphically.</td><td>Remember</td><td>CO 4</td><td>AMEB12.17</td></tr>
<tr><td>10</td><td>Solve the following game by graphical method. Find the value of the game? and strategies of player A , B.
<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="5">Player B</td></tr>
<tr><td>B1</td><td>B2</td><td>B3</td><td>B4</td><td>Probability</td></tr>
<tr><td rowspan="2">Player A</td><td>A1</td><td>2</td><td>2</td><td>3</td><td>-2</td><td>P1</td></tr>
<tr><td>A2</td><td>4</td><td>3</td><td>2</td><td>6</td><td>P2</td></tr>
</table></td><td>Remember</td><td>CO 4</td><td>AMEB12.18</td></tr>
<tr><td>11</td><td>Explain the various costs are involved in inventory problems with suitable examples and how they are inter-related.</td><td>Remember</td><td>CO 4</td><td>AMEB12.18</td></tr>
<tr><td>12</td><td>What is EOQ? Discuss step by step the development of EOQ formula.</td><td>Remember</td><td>CO 4</td><td>AMEB12.18</td></tr>
<tr><td>13</td><td>A dealer supplies you the following information with regards to an product that he deals in annual demand =10,000 units, ordering cost Rs.10/order, Price Rs.20/unit. Inventory carrying cost is 20% of the value of inventory per year. The dealer is considering the possibility of allowing some back orders to occurs. He has estimated that the annual cost of back orderingwill be 25% of the value of inventory.<br>a. What should be the optimum no of units he should buy in 1lot?<br>b. What qty of the product should be allowed to be backordered<br>c. What would be the max qty of inventory at any time of year<br>Would you recommend to allow backordering? If so what would be the annual cost saving by adopting the policy of backordering.</td><td>Understand</td><td>CO 4</td><td>AMEB12.18</td></tr>
<tr><td>14</td><td>Find the most economic batch quantity of a product on a machine if the production rate of the item on the machine is 300 pieces per day and the</td><td>Understand</td><td>CO 4</td><td>AMEB12.18</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| | demand is uniform at the rate of 150 pieces/day. The set up cost is Rs.300 per batch and the cost of holding one item in inventory is Rs.0.81/per day. How will the batch quantity vary if the machine production rate was infinite? | | | |
| 15 | The annual demand of a product is 10,000 units. Each unit costs Rs 100 if the orders are placed in quantities below 200 units. For orders above 200 or above, however the price is Rs 95. The annual inventory holding cost is 10% of the value of the item and the ordering cost is Rs 5/order. Find the economic lot size. | Remember | CO 4 | AMEB12.18 |
| 16 | The production department of a company required 3,600kg of raw material for manufacturing a particular item per year. It has been estimated that the cost of placing an order is Rs.36 and the cost of carrying inventory is 25% of the investment in the inventories, the price is Rs.10/kg. help the purchase manager to determine and ordering policy for raw material, determine optimal lot size. | Understand | CO 4 | AMEB12.18 |
| 17 | Monthly demand for an item is 200 units. Ordering cost is Rs 3350, inventory carrying charge is 24% of the purchase price per year. The purchase prices are<br>$P_1$ = Rs 10 for purchasing $Q_1 < 500$<br>$P_2$ = Rs 9.25 for purchasing $500 \leq Q_2 < 750$<br>$P_3$ = Rs 8.75 for purchasing $750 \leq Q_3$<br>Determine optimum purchase quantity. If the order cost is reduced to Rs 100 per order, compute the optimum purchase quantity. | Remember | CO 4 | AMEB12.18 |
| 18 | Discuss the significance of stochastic models in inventory control of production system? | Remember | CO 4 | AMEB12.19 |
| 19 | What are inventory models? Enumerate various types of inventory models and describe them briefly. | Remember | CO 4 | AMEB12.19 |
| 20 | A shop is about to order some heaters for a forecast spell of cold weather. The shop pays Rs.1000 for each heater and during the cold spell they sell for Rs2000 each. The demand for the heater declines after the cold spell is ones and any unsold units are sold at Rs.500 previous experience suggests the likely demand for heater is as follows.<br><br>Demand: 10 \| 20 \| 30 \| 40 \| 50<br>Probability: 0.20 \| 0.30 \| 0.30 \| 0..10 \| 0.10<br><br>How many heaters should the shop owner buy? | Understand | CO 4 | AMEB12.19 |
| | **Part C (Critical Analytical Questions)** | | | |
| 1 | Solve the following 3 * 3 game. find the value of the game and strategies of player A andB.<br><br>Player B: **1** \| **2** \| **3**<br>Player A: 1 (2, 4, 5); 2 (10, 4, 9); 3 (4, 5, 6) | Remember | CO 4 | AMEB12.15 |
| 2 | Using the dominance property obtain the optimal strategy for both the players and determine the value of game. The payoff matrix for player A is given<br><br>Player-A \| Player-B: I \| II \| III \| IV \| V<br>I: 2 \| 4 \| 3 \| 8 \| 4<br>II: 5 \| 6 \| 8 \| 7 \| 8<br>III: 6 \| 7 \| 9 \| 8 \| 7<br>IV: 4 \| 2 \| 8 \| 4 \| 3 | Understand | CO 4 | AMEB12.16 |

| | | | | |
|---|---|---|---|---|
| 3 | Solve the following 2*3 game graphically;<br><br>Player B: I, II, III<br>Player A: I (1, 3, 11); II (8, 5, 2) | Remember | CO 4 | AMEB12.17 |
| 4 | A manufacturer uses Rs 10,000 worth of an item during the year. He has estimated the ordering costs as Rs 25 per order and carrying costs as 12.5% of average inventory value. Find the optimal order size, number of orders per year, time period per order and total cost. | Understand | CO 4 | AMEB12.18 |
| 5 | A newspaper boy buys papers for 3 rupees and sells them for 5 rupees each. He can not return unsold newspapers. Daily demand has the following distribution.<br><br>No. of customers: 23, 24, 25, 26, 27, 28, 29, 30, 31, 32<br>Probability: 0.01, 0.03, 0.06, 0.10, 0.20, 0.25, 0.15, 0.10, 0.05, 0.05<br><br>If each days demand is independent of the previous day's, how many papers should he order each day? | Understand | CO 4 | AMEB12.19 |

## MODULE - V
## AITING LINES, DYNAMIC PROGRAMMIMG AND SIMULATION

### Part A (Very Short Answer Questions)

| | | | | |
|---|---|---|---|---|
| 1 | What are the characteristics of a waiting line system? | Understand | CO 5 | AMEB12.19 |
| 2 | Define a waiting a line. | Understand | CO 5 | AMEB12.19 |
| 3 | Discuss waiting line applications. | Remember | CO 5 | AMEB12.19 |
| 4 | Define customer and server. | Understand | CO 5 | AMEB12.19 |
| 5 | Expand FIFO and LIFO. | Remember | CO 5 | AMEB12.19 |
| 6 | ExplainFILO and SIRO | Understand | CO 5 | AMEB12.19 |
| 7 | What are the fundamental components of a queuing process? | Remember | CO 5 | AMEB12.19 |
| 8 | Who developed the technique called dynamic programming? | Understand | CO 5 | AMEB12.19 |
| 9 | What is Several queues-one service station queuing model? | Remember | CO 5 | AMEB12.19 |
| 10 | Define state variable and decision variable. | Understand | CO 5 | AMEB12.19 |
| 11 | what are thr Conditions for Single Channel Queueing Model? | Understand | CO 5 | AMEB12.19 |
| 12 | What are the Limitations of Single Channel Queueing Model? | Remember | CO 5 | AMEB12.19 |
| 13 | What is ( M/M/S): (∞/FCFS) queueing model? | Understand | CO 5 | AMEB12.19 |
| 14 | Explain arrivaldistribution and inter-arrivaldistribution | Remember | CO 5 | AMEB12.19 |
| 15 | Define simulation | Understand | CO 5 | AMEB12.19 |
| 16 | What are the types of simulation? | Remember | CO 5 | AMEB12.19 |
| 17 | Explain the phases of simulation? | Understand | CO 5 | AMEB12.19 |
| 18 | What are the major limitations of simulation? | Remember | CO 5 | AMEB12.19 |
| 19 | Explain the advantages of simulation? | Understand | CO 5 | AMEB12.19 |
| 20 | What are the disadvantages of simulation? | Remember | CO 5 | AMEB12.19 |
| | **Part B (Long Answer Questions)** | | | CO 5 |
| 1 | Define the terms Balking, Reneging, Jockeying. | Remember | CO 5 | AMEB12.19 |
| 2 | Explain the terms single server and multiple server queue length and finite and infinite queue length. | Remember | CO 5 | AMEB12.19 |
| 3 | Define simulation why simulation uses. Give one application area when | Understand | CO 5 | AMEB12.19 |

| | | | | |
|---|---|---|---|---|
| | this technique is used in practice. | | | |
| 4 | Explain what factors must be considered when designing simulation experiment. | Remember | CO 5 | AMEB12.19 |
| 5 | Discuss briefly the types of simulations? | Remember | CO 5 | AMEB12.19 |
| 6 | A road transport company has one reservation clerk on duty at a time. He handles information of bus schedules and makes reservations customers arrive at a rate of 8 per hour and the clerk can, on an average, service 12 customers per hour. After starting your assumptions determine.<br>a. What is the average number of customer waiting for the service of the clerk<br>b. What is the average time a customer has to wait before being used? | Remember | CO 5 | AMEB12.19 |
| 7 | Consider a single semen queuing system with poisons input and exponential service times. Suppose that mean arrival rate is 3 calling units per hour, the expected service time is 0.25 hours and the maximum permissible calling units is the system is two. Derive the steady state probability distribution of the number of calling units in the system. And then calculate the expected number in the system. | Understand | CO 5 | AMEB12.19 |
| 8 | A super market has two girls ringing up sales at the counters. If the service time for each customer is exponential with mean 4 minutes, and if people arrive 3 in a poison fashion at the 10/hour.<br>a. What is the probability of having to wait for the service.<br>b. What is the expected percentage of idle time for each girl?<br>c. C. find the average length and average number of units in the system. | Remember | CO 5 | AMEB12.19 |
| 9 | Explain the application of Queuing systems? | Remember | CO 5 | AMEB12.19 |
| 10 | In a departmental store one cashier is there to serve the customers. And the customers pick up their needs by themselves the arrival rate is 9 customers for every 5 minutes and the cashier can serve 10 customers in 5 minutes. Assuming poisons arrival rate and exponential distribution for service rate. Find following:<br>a. Average number of customers in the system<br>b. Average number of customers in the queue of average queue length?<br>c. Average time a customer spends in the systems<br>d. Average time a customer waits before being served. | Understand | CO 5 | AMEB12.19 |
| 11 | Explain the advantages and disadvantages of simulation? | Understand | CO 5 | AMEB12.19 |
| 12 | A television repairman finds that the time spent on his jobs has an exponential distribution with a mean of 30 minutes. If he repairs the sets in the order in which they came in, and if the arrival of sets follows a Poisson distribution with an approximate average rate of 10 per 8hour day, what is the repairman's expected idle time each day? How many jobs are ahead of the average, set just brought in? | | CO 5 | AMEB12.19 |
| 13 | What is simulation? Discuss application of simulation? | Understand | CO 5 | AMEB12.19 |
| 14 | Discuss the advantages and disadvantages of simulation. | Understand | CO 5 | AMEB12.19 |
| 15 | Explain briefly steps of simulation process. | Understand | CO 5 | AMEB12.19 |
| 16 | Explain types of simulation. | Understand | CO 5 | AMEB12.19 |
| 17 | Explain Monte Carlo simulation. | Remember | CO 5 | AMEB12.19 |
| 18 | what is simulation and discuss the What types of simulation? | Understand | CO 5 | AMEB12.19 |
| 19 | Explain computer simulation? | Understand | CO 5 | AMEB12.19 |
| 20 | write the applications of simulation. | Understand | CO 5 | AMEB12.19 |
| CO 5 | **Part C (Critical Analytical Questions)** | | | |
| 1 | Customers arrive at box office windows being manned by a single individual, according to a Poisson input process with a mean rate of 20/hr. the time required to serve a customer has an exponential distribution with a mean of 90 sec. Find the average waiting time of customers. Also determine the average number of customers in the system and average queue length. | Understand | CO 5 | AMEB12.19 |
| 2 | At a certain petrol pump, customers arrive according to a poisson process with an average time of 5 minutes between arrivals. The service time is exponentially distributed with mean time of minutes. On the basis of information find out | Remember | CO 5 | AMEB12.19 |

<table>
<tr><td></td><td>a. What would be the average queue length?<br>b. What would be the average number of customers in the queueing system?<br>c. What is the average time spent by a car in the petrol pump?<br>d. What is the average waiting time of a car before receiving petrol?</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>A company manufactures around 200 mopeds. Depending upon the availability of raw materials and other conditions. The daily production has been varying from 196 mopeds to 204 mopeds. Whose probability distribution are given below:
<table>
<tr><td>Production per day</td><td>196</td><td>197</td><td>198</td><td>199</td><td>200</td><td>201</td><td>202</td><td>203</td><td>204</td></tr>
<tr><td>Probability</td><td>0.05</td><td>0.09</td><td>0.12</td><td>0.14</td><td>0.20</td><td>0.15</td><td>0.11</td><td>0.08</td><td>0.06</td></tr>
</table>
Finished mopeds are transported to a lorry that can accommodate only 200 mopeds. Random numbers are 82,89,78,24,53,61,18,45,04,23,50,77,54 and 10. Simulate the mopeds waiting.</td><td>Remember</td><td>CO 5</td><td>AMEB12.19</td></tr>
<tr><td>4</td><td>A bakery keeps stock of a popular brand of cake. Previous experience show the daily demand pattern for the item with associated probabilities as givenbelow:
<table>
<tr><td>Daily damand (number)</td><td>0</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td></tr>
<tr><td>Probability</td><td>0.01</td><td>0.20</td><td>0.15</td><td>0.50</td><td>0.12</td><td>0.02</td></tr>
</table>
use the following sequence of random numbers to simulate the demand for next 10days.<br>Random numbers: 25,39,65,76,12,05,73,89,19,49<br>Also estimate the daily average demand for the cakes on the basis of the simulated data.</td><td>Understand</td><td>CO 5</td><td>AMEB12.20</td></tr>
<tr><td>5</td><td>Explain in detail application of simulation for inventory models.</td><td>Under stand</td><td>CO 5</td><td>AMEB12.20</td></tr>
</table>

Prepared by:

Dr. Paidi Raghavulu, Professor, ME **HOD (Mechanical Engineering)**

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<tr><td>4</td><td></td><td>Remember</td><td>7</td></tr>
<tr><td>5</td><td>a) Explain types simulation models<br>b) b) Describe the steps involved in Monte-Carlo simulation.</td><td>Understand</td><td>9</td></tr>
<tr><td>6</td><td></td><td>Remember</td><td>10</td></tr>
<tr><td>7</td><td>)Explain in detail the application of simulation in queuing problem.</td><td>Understand</td><td>10</td></tr>
<tr><td></td><td>)Explain in detail the application of simulation in queuing problem. Explain advantages and disadvantages of simulation.</td><td></td><td></td></tr>
</table>

**Preparedby:** Mr. A. Somaiah, AssistantProfessor
Ms. T. Vanaja, Assistant Professor

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**HOD, MECHANICAL ENGINEERING**