INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

TUTORIALQUESTION BANK

Course Title	**OPERATIONS RESEARCH**
Course Code	**AME021**
Class	B.Tech
Semester	VIII
Year	2019-2020
Team of Instructors	Mr. C. Labesh Kumar, Assistant Professor, ME Mrs. T. Vanaja Assistant Professor , ME

COURSE OBJECTIVES

S.NO	Description
I	Formulate the mathematical model of real time problem for optimization.
II	Establish the problem formulation by using linear, dynamic programming, game theory and queuing models.
III	Apply stochastic models for discrete and continuous variables to control inventory.
IV	Visualize the computer based manufacturing simulation models.

COURSE OUTCOMES: (COs)

S.NO	Description
I	Formulate the mathematical model of real time problem for optimization, using Linear programming
II	Establish the problem formulation by using transportation, assignment models
III	Apply sequencing for flow and replacement for maintenance of machinesprogramming, game theory and queuing models.
IV	Formulate game theory model and apply stochastic models for discrete and continuous variables to control inventory.
V	Formulate queuing models and visualize dynamic programming and simulation models

COURSE LEARNING OUTCOMES: (CLOs)

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

S. No.	Outcomes
AME021.01	Understand the characteristics, phases, types of operation research models and its applications.
AME021.02	Visualize modeling principles scope, decision making, general methods for solving OR models.
AME021.03	Understand linear programming concept problem formulation and graphical models.
AME021.04	Understand simplex method and artificial variable techniques.
AME021.05	Comprehend two-phase method and Big-M method of linear programming.
AME021.06	Apply to build and solve transportation models of balanced.
AME021.07	Understand the degeneracy model problem of transportation, unbalanced type-aximization.
AME021.08	Apply to build assignment models for optimal solution.
AME021.09	Understand variants of assignment model and travelling salesman model.
AME021.10	Understand the flow shop sequencing model of ‘n’ jobs through two machines and three machines.
AME021.11	Comprehend job shop sequencing of two jobs through ‘m’ machines.
AME021.12	Understand the concept of replacement of items that deteriorate with time when money value is not counted
AME013.13	Understand the concept ofreplacement of items that deteriorate with time when money value is n counted .
AME021.14	Visualize the replacement of items that fail completely and group replacement.
AME021.15	Understand minmax (maximini) criterion, optimal strategy , solution od games with saddle point
AME021.16	Visualize dominance principle while solving game theory problem.
AME021.17	Apply to solve m * 2 , 2 *n model of games and graphical method.
AME021.18	Understand the concepts of deterministic inventory model and purchase inventory model with one price break and multiple price breaks.

AME021.19	Visualize stochastic inventory models – demand may be discrete variable or continuous variable.
AME021.20	Understand the concepts of waiting line model of single channel and multi server model.
AME021.21	Visualize dynamic programming concepts and models
AME021.22	Comprehend the simulation models, phases of simulation, application of simulation
AME021.23	Visualize the application of simulation for inventory and queuing problems.

S. No.	Question	Blooms Taxonomy Level	Course Outcomes	Course Learning Outcomes (CLOs)
	UNIT-I			
	Part A(Very Short Answer Questions)			
1	Explain scope of operations Research?	Understand	CO 1	AME021.01
2	State the applications of operations Research?	Remember	CO 1	AME021.02
3	List different characteristics of operations Research?	Remember	CO 1	AME021.02
4	Write about physical model of operations Research?	Understand	CO 1	AME021.02
5	Describe about simulation models of operations Research?	Understand	CO 1	AME021.03
6	Discuss the importance of operations Research in the decision making process?	Remember	CO 1	AME021.03
7	List out the principles of modeling.	Remember	CO 1	AME021.03
8	State the methods of solving OR models.	Understand	CO 1	AME021.03
9	Define model and explain its importance.	Remember	CO 1	AME021.03
10	Define feasible region?	Understand	CO 1	AME021.03
11	Explain general representation of LPP?	Remember	CO 1	AME021.03
12	Discuss objective function in brief?	Understand	CO 1	AME021.03
13	Describe optimal solution?	Remember	CO 1	AME021.03
14	Explain about decision variables?	Understand	CO 1	AME021.03
15	Describe about non- negativity constraints?	Remember	CO 1	AME021.03
16	Explain about constraints of a LPP?	Understand	CO 1	AME021.03
17	Define slack variables with examples?	Remember	CO 1	AME021.03
18	State surplus variables with examples?	Understand	CO 1	AME021.03
19	Explain about artificial variables?	Remember	CO 1	AME021.03
20	Explain computational steps of Big-M method	Remember	CO 1	AME021.03
	Part B (Long Answer Questions)			
1	What are the phases of Operations Research and briefly explain them?	understand	CO 1	AME021.03
2	Explain the main characteristics of Operations Research.		CO 1	AME021.03
3	What is a model? List the various classification schemes of Operations Research models.	Remember	CO 1	AME021.03
4	Describe the scope of Operations Research.	Understand	CO 1	AME021.03
5	Explain general methods for solving OR models	Understand	CO 1	AME021.03
6	Describe the terminology involved in formulating a linear programming problem?	Understand	CO 1	AME021.03
7	Explain applications of LPP in production management?	Remember	CO 1	AME021.03
8	Explain step by step procedure of graphical method of solving Linear Programming Problem.	Understand	CO 1	AME021.03
9	What are the limitations of graphical method?	Understand	CO 1	AME021.03
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	AME021.03

11	Explain the structure of an LPP with example?	Remember	CO 1	AME021.03
12	Discuss the algorithm of simplex method to solve an LPP?	Remember	CO 1	AME021.03
13	Explain assumptions to solve LPP using simplex?	Understand	CO 1	AME021.03
14	Solve the following problem by Simplex method Maximize Z = 5x1 + 3x2 subject to constraints 3x1 + 5x2 ≤ 15 5x1 + 2x2 ≤ 10 and x1, x2 ≥ 0	Understand	CO 1	AME021.03
15	Solve the following problem by Simplex method Maximize Z = x1 + 3x2 +2 x3 subject to constraints 3 x_1 + x_2 + 3 x_3 ≤ 7 - 2 x_1 + 4 x^2 ≤ 12 - 4x^1 + 3 x_2 + 8x_3 ≤ 10 and x1, x2 ≥ 0	Remember	CO 1	AME021.03
16	Describe step-by-step procedure to solve LPP by BIG-M method?	Remember	CO 1	AME021.03
17	Explain the term artificial variables? Why do we need them?	Remember	CO 1	AME021.03
18	Describe Two-phase Simplex method	Remember	CO 1	AME021.03
19	Use big –M method to solve the following Maximize Z = 8x1 + 5x2 Subjective to constraints 2x_1+ 4 x_2 ≤ 45 3x_1+ 2x_2 ≤ 40 x_1 + x_2 ≥ 30 x_1, x_2 ≥ 0.	Remember	CO 1	AME021.03
20	Solve the following LP Problem by two phase method Maximize Z = 5x1 - 2x2 + 3x3 Subject to constraints 2x1 + 2x2 - x3 ≥ 2, 3x1 - 4x2 ≤ 3, x2 +3x3 ≤ 5 x1, x2 , x3 ≥ 0	Understand	CO 1	AME021.03
Part C(Critical Analytical Questions)				
1	Solve the following LP problem graphically. Maximize Z = 2x_1 + x_2 Subjective to constraints x_1+ 2 x_2 ≤ 10 x_1+ x_2 ≤ 6 x_1 - x_2 ≤ 2 x_1 - 2 x_2 ≤ 1 x_1, x_2 ≥ 0.	Understand	CO 1	AME021.03
2	SolvethefollowingLPproblemusing Simplexmethod. Maximize Z = 6 x_1 + 8 x_2 subject to constraints x_1 + x_2≤ 10 2 x_1 + 3 x_2≤ 25 2x_1 + 5 x_2≤ 35 and x_1, x_2 ≥ 0	Understand	CO 1	AME021.03
3	SolvethefollowingLPP bytwo-phase method Minimize Z = 3 x_1 + 4 x_2 subject to constraints 2 x_1 + 3 x_2≥ 8 5 x_1 + 2 x_2≥ 12 and x_1, x_2 ≥ 0		CO 1	AME021.03
4	SolvethefollowingLPPbyBig-M (penalty) method Minimize Z = 5 x_1 + 3 x_2 subject to constraints 2 x_1 + 4 x_2≤ 12 2 x_1 + 2 x_2≤ 10 5x_1 + 2 x_2≤ 10 and x_1, x_2 ≥ 0	Remember	CO 1	AME021.03
5	SolvethefollowingLPPbyBig-Mmethod Maximize Z = 4 x_1 + 5 x_2+ x3 subject to constraints x_1 + x_2 + x_3 = 10 2x_1 - x_2≥ 1 2 x_1 + 3x_2+ x3 ≤ 40 x_1, x_2 , x_3 ≥ 0	Understand	CO 1	AME021.03

UNIT – II

Part A(Very Short Answer Questions)

S. No.	Question	Blooms Taxonomy Level	Course Outcomes	Course Learning Outcomes (CLOs)
1	Explain mathematical model of a transportation problem?	Understand	CO 2	AME021.06
2	What are different methods of solving transportation problems to get basic feasible solution?	Remember	CO 2	AME021.07
3	Why is LCM is optimal than NWCR in solving transportation problem?	Understand	CO 2	AME021.06
4	Why does Vogel's approximation method provide a good initial feasible solution?	Remember	CO 2	AME021.08
5	What are the methods to test for optimality in transportation problem?	Understand	CO 2	AME021.07
6	Describe balanced problem in transportation?	Understand	CO 2	AME021.08
7	Explain MODI method in brief?	Understand	CO 2	AME021.07
8	What is degeneracy in transportation problem?	Remember	CO 2	AME021.09
9	Define unbalance problem in transportation?	Remember	CO 2	AME021.08
10	Explain how the unbalanced problem is solved?	Remember	CO 2	AME021.09
11	Explain constraints of a transportation problem?	Remember	CO 2	AME021.09
12	What is assignment problem?	Understand	CO 2	AME021.09
13	Explain applications of assignment problem?	Remember	CO 2	AME021.08
14	Give the mathematical representation of an assignment problem	Understand	CO 2	AME021.09
15	Discuss the method of solving assignment problems?	Understand	CO 2	AME021.08
16	Explain an algorithm to solve an assignment problem?	Understand	CO 2	AME021.09
17	Describe Hungarian method?	Remember	CO 2	AME021.06
18	Explain Principle of dominance?	Remember	CO 2	AME021.07
19	Explain unbalanced assignment problem?	Understand	CO 2	AME021.07
20	Discuss travelling sales man problem?	Remember	CO 2	AME021.07
Part B (Long Answer Questions)				
1	Discuss different methods of finding initial basic feasible solution.	Remember	CO 2	AME021.08
2	Explain Practical Steps Involved in Solving minimization type Transportation Problems.		CO 2	AME021.07
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. <table><tr><td></td><td></td><td colspan="5">Ware houses</td></tr><tr><td></td><td></td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td></tr><tr><td rowspan="3">Plant</td><td>A</td><td>5</td><td>8</td><td>6</td><td>6</td><td>3</td></tr><tr><td>B</td><td>4</td><td>7</td><td>7</td><td>6</td><td>5</td></tr><tr><td>C</td><td>8</td><td>4</td><td>6</td><td>6</td><td>4</td></tr></table> Determine an optimum distribution for the company in order to minimize the total transportation cost.	Understand	CO 2	AME021.08
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. <table><tr><td></td><td>W_1</td><td>W_2</td><td>W_3</td><td>Supply</td></tr><tr><td>F_1</td><td>16</td><td>20</td><td>12</td><td>200</td></tr><tr><td>F_2</td><td>14</td><td>8</td><td>18</td><td>160</td></tr><tr><td>F_3</td><td>27</td><td>24</td><td>16</td><td>90</td></tr><tr><td>Demand</td><td>180</td><td>120</td><td>150</td><td>450</td></tr></table>	Remember	CO 2	AME021.09

5	Find the optimal solution of the following transportation problem for which costs elements, factory capacity and warehouse requirements are provided. Warehouse / Fact W_1 W_2 W_3 W4 / capa 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	Understand	CO 2	AME021.09
6	Define degeneracy? How the Degeneracy during initial stage of transportation problem solving is resolved?	Remember	CO 2	AME021.09
7	Discuss the process of optimality test of transportation problem.	Remember	CO 2	AME021.09
8	Find optimum solution for the following transportation problem for which the profit elements, supply and demands are as shown below. To: D1 D2 D3 D4 Available From O1: 10 0 20 11 15 From O2: 1` 7 9 20 25 From O3: 12 14 16 18 5 Demand: 10 15 25 10	Understand	CO 2	AME021.09
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: X Y Z A: 8 7 3 B: 3 8 9 C: 11 3 5 What would be your optimal transportation plan? Give minimum distribution cost.	Remember	CO 2	AME021.08
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. To: D E F G H From A: 5 8 6 6 3 From B: 4 7 7 6 5 From C: 8 4 6 6 4 Determine an optimum distribution for the company in order to minimize the total transportation cost.	Understand	CO 2	AME021.08
11	Explain briefly the Steps involved in solving assignment Problem..	Understand	CO 2	AME021.09

<table>
<tr><td>12</td><td>Explain the line drawing procedure that has to be adapted while solving assignment problem.</td><td></td><td>CO 2</td><td>AME021.09</td></tr>
<tr><td>13</td><td>Solve the following assignment problem to minimize the total time of the operator;
<table>
<tr><td></td><td colspan="5">Jobs</td></tr>
<tr><td>Operator</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>1</td><td>6</td><td>2</td><td>5</td><td>2</td><td>6</td></tr>
<tr><td>2</td><td>2</td><td>5</td><td>8</td><td>7</td><td>7</td></tr>
<tr><td>3</td><td>7</td><td>8</td><td>6</td><td>9</td><td>8</td></tr>
<tr><td>4</td><td>6</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>5</td><td>9</td><td>3</td><td>8</td><td>9</td><td>7</td></tr>
<tr><td>6</td><td>4</td><td>7</td><td>4</td><td>6</td><td>8</td></tr>
</table></td><td>Remember</td><td>CO 2</td><td>AME021.09</td></tr>
<tr><td>14</td><td>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.
<table>
<tr><td rowspan="2">Jobs</td><td colspan="5">Machines</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>1</td><td>30</td><td>37</td><td>40</td><td>28</td><td>40</td></tr>
<tr><td>2</td><td>40</td><td>24</td><td>27</td><td>21</td><td>36</td></tr>
<tr><td>3</td><td>40</td><td>32</td><td>33</td><td>30</td><td>35</td></tr>
<tr><td>4</td><td>25</td><td>38</td><td>40</td><td>36</td><td>36</td></tr>
<tr><td>5</td><td>29</td><td>62</td><td>41</td><td>34</td><td>39</td></tr>
</table></td><td>Remember</td><td>CO 2</td><td>AME021.08</td></tr>
<tr><td>15</td><td>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.</td><td>Remember</td><td>CO 2</td><td>AME021.08</td></tr>
<tr><td>16</td><td>The profits after assigning the machines to jobs are given as follows.
Solve the problem to maximize the profits.
<table>
<tr><td></td><td>J1</td><td>J2</td><td>J3</td><td>J4</td><td>J5</td><td>J6</td></tr>
<tr><td>M1</td><td>5</td><td>3</td><td>7</td><td>6</td><td>5</td><td>3</td></tr>
<tr><td>M2</td><td>7</td><td>6</td><td>1</td><td>4</td><td>2</td><td>8</td></tr>
<tr><td>M3</td><td>6</td><td>2</td><td>4</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>M4</td><td>4</td><td>6</td><td>4</td><td>7</td><td>3</td><td>8</td></tr>
</table></td><td>Remember</td><td>CO 2</td><td>AME021.09</td></tr>
<tr><td>17</td><td>A salesman has to visit five cities A, B, C, D, E. The intercity distances are tabulatedbelow.
<table>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>A</td><td>-</td><td>12</td><td>24</td><td>25</td><td>15</td></tr>
<tr><td>B</td><td>6</td><td>-</td><td>16</td><td>18</td><td>7</td></tr>
<tr><td>C</td><td>10</td><td>11</td><td>-</td><td>18</td><td>12</td></tr>
<tr><td>D</td><td>14</td><td>17</td><td>22</td><td>-</td><td>16</td></tr>
<tr><td>E</td><td>12</td><td>13</td><td>23</td><td>25</td><td>-</td></tr>
</table>
Find the shortest route covering all the cities.</td><td>Remember</td><td>CO 2</td><td>AME021.08</td></tr>
</table>

18	The assignment cost of assigning any one operator to any one machine is given in the following table. Solve the optimal assignment by Hungarian method	Understand	CO 2	AME021.07
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	Maxi assign	CO 2	AME021.09
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) Find the optimal assignment schedule.	Understand	CO 2	AME021.09

Machine	Operators			
	I	II	III	IV
A	10	5	13	15
B	3	9	18	3
C	10	7	3	2
D	5	11	9	7

	Jobs				
	A	B	C	D	E
Machine 1	5	11	10	12	4
Machine 2	2	4	6	3	5
Machine 3	3	12	5	14	6
Machine 4	6	14	4	11	7
Machine 5	7	9	8	12	5

	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

Part C (Critical Analytical Questions)

1	Find the optimum solution to the Transportation problem , supply and demand and cost elements are	Understand	CO 2	AME021.07
2	Find the optimum solution for the transportation problem whose cost matrix is as given below:	Understand	CO 2	AME021.07
3	Find the minimum cost assignment for the following problem, explaining each step.	Remember	CO 2	AME021.08

	Warehouse				supply
	W_1	W_2	W_3	W4	
Factory -F_1	14	25	45	5	6
Factory -F_2	65	25	35	55	9
Factory-F_3	35	3	65	15	16
Demand	15	8	7	14	34

	Destination			supply
	D_1	D_2	D_3	
Warehouse-1	4	3	2	10
Warehouse-2	2	5	0	13
Warehouse-3	3	8	6	12
Demand	8	5	4	

	Job

		I	II	III	IV	V			
	A	6	5	8	11	16			
	B	1	13	16	1	10			
	C	16	11	8	8	8			
	D	9	14	12	10	16			
	E	10	13	11	8	16			
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. **Salesmen** / **Territories**: 45, 60, 70, 80 A: 6, 5, 8, 11 B: 20, 32, 42, 74 C: 25, 37, 47, 55 D: 40, 35, 30, 30						Understand	CO 2	AME021.09
5	A salesman estimates that the following would be the cost on his route, visiting the six cities as shown in the table below: From city / To city: A1, A2, A3, A4, A5 A1: ∞, 20, 23, 27, 29 A2: 21, ∞, 19, 26, 31 A3: 26, 28, ∞, 15, 36 A4: 25, 16, 25, ∞, 23 A5: 23, 40, 23, 31, ∞						Remember	CO 2	AME021.08
	UNIT – III **Part A(Very Short Answer Questions); MID – I**								
1	Define sequencing?						Remember	CO 3	AME021.11
2	Discuss the importance of sequencing.						Understand	CO 3	AME021.12
3	State general representation of sequencing?						Remember	CO 3	AME021.11
4	Explain the terminology of sequencing techniques in operations research?						Remember	CO 3	AME021.11
5	Explain various sequencing models.						Understand	CO 3	AME021.12
6	Describe applications of sequencing?						Understand	CO 3	AME021.13
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 3	AME021.13
8	What are the assumptions made in sequencing problem?						Understand	CO 3	AME021.12
9	Give the justification of Johnson’s rule for sequencing n jobs x 2 machines						Remember	CO 3	AME021.12
10	What are the advantages of sequencing?						Remember	CO 3	AME021.14
	Part B (Long Answer Questions)								
1	Discuss about the terminology and notations followed in sequencing solution.						Remember	CO 3	AME021.12
2	Discuss various types of sequencing models.						Remember	CO 3	AME021.12
3	Explain Johnson’s algorithm for processing ‘n’ jobs through two machines for a given machine order.						Remember	CO 3	AME021.12
4	Explain step by step procedure for processing ‘n’ jobs through three machines mentioning conditions.						Remember	CO 3	AME021.13

<table>
<tr><td>5</td><td>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
<table><tr><td></td><td colspan="6">Processing times (hours)</td></tr><tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>Time for A</td><td>3</td><td>4</td><td>5</td><td>2</td><td>1</td><td>6</td></tr><tr><td>Time for B</td><td>8</td><td>7</td><td>6</td><td>9</td><td>10</td><td>9</td></tr></table>
Determine a sequence for five jobs that will minimize the elapsed time. Calculate the total idle time for the machines in this period.</td><td>Understand</td><td>CO 3</td><td>AME021.12</td></tr>
<tr><td>6</td><td>Describe the steps in processing Two jobs through ‘m’ machine graphical method briefly.</td><td>Remember</td><td>CO 3</td><td>AME021.14</td></tr>
<tr><td>7</td><td>Discuss the situations involving complex sequential problems.</td><td>Understand</td><td>CO 3</td><td>AME021.14</td></tr>
<tr><td>8</td><td>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
<table><tr><td></td><td colspan="6">Job</td></tr><tr><td></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>8</td><td>3</td><td>7</td><td>2</td><td>5</td><td>1</td></tr><tr><td>Machine B</td><td>3</td><td>4</td><td>5</td><td>2</td><td>1</td><td>6</td></tr><tr><td>Machine C</td><td>8</td><td>7</td><td>6</td><td>9</td><td>10</td><td>9</td></tr></table></td><td>Remember</td><td>CO 3</td><td>AME021.14</td></tr>
<tr><td>9</td><td>Describe the step by step procedure of graphical method for processing two jobs through ‘m’ machines</td><td>Remember</td><td>CO 3</td><td>AME021.13</td></tr>
<tr><td>10</td><td>Use graphical method to minimize the time. Time required to process the following jobs on the machines shown,, i.e.,Foreach
<table><tr><td rowspan="2">JOB-1</td><td>Sequence</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>Time</td><td>3</td><td>4</td><td>2</td><td>6</td><td>2</td></tr><tr><td rowspan="2">JOB-2</td><td>Sequence</td><td>B</td><td>C</td><td>A</td><td>D</td><td>E</td></tr><tr><td>Time</td><td>5</td><td>4</td><td>3</td><td>2</td><td>6</td></tr></table>machine find the job which should be done first. Also calculate the total time elapsed to complete both the jobs.</td><td>Understand</td><td>CO 3</td><td>AME021.13</td></tr>
<tr><td colspan="5">Part C (Critical Analytical Questions)</td></tr>
<tr><td>1</td><td>We have five jobs each of which must go through two machines in the order BA, processing times are given in the table below
<table><tr><td>Job No.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Machine A</td><td>10</td><td>2</td><td>18</td><td>6</td><td>20</td></tr><tr><td>Machine B</td><td>4</td><td>12</td><td>14</td><td>16</td><td>8</td></tr></table>
Determine a sequence for the five jobs that will minimize the total elapsed time. Also compute idle times for each of the machine</td><td>Understand</td><td>CO 3</td><td>AME021.14</td></tr>
<tr><td>2</td><td><table><tr><td>Car Number</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>Time estimate (dent removing)</td><td>16</td><td>10</td><td>11</td><td>13</td><td>8</td><td>18</td></tr><tr><td>Time Estimate</td><td>15</td><td>9</td><td>15</td><td>11</td><td>12</td><td>14</td></tr></table></td><td>Understand</td><td>CO 3</td><td>AME021.14</td></tr>
</table>

	(painting)			

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:

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

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	AME021.13

	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	AME021.13
5	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.	Understand	CO 3	AME021.13

JOB-1	Sequence	A	C	B	D	E
	Time (hours)	6	8	4	12	4
JOB-2	Sequence	B	C	A	D	E
	Time (hours)	5	4	3	2	6

Part A(Very Short Answer Questions)

1	What is the need for a replacement?	Remember	CO 3	AME021.12
2	Define individual replacement policy?	Remember	CO 3	AME021.13
3	Write about 'replacement policy of items which deteriorate with time'.	Understand	CO 3	AME021.14
4	What is replacement problem?	Understand	CO 3	AME021.11
5	Give some examples for replacement situations.	Understand	CO 3	AME021.13
6	Give the examples of group replacement concept.	Understand	CO 3	AME021.11
7	Explain different types of replacement problems?	Understand	CO 3	AME021.12
8	State the examples of group replacement concept.	Remember	CO 3	AME021.12
9	Describe individual replacement policy.	Remember	CO 3	AME021.12
10	What is group replacement policy?	Understand	CO 3	AME021.11

Part B (Long Answer Questions)

1	Explain the importance of replacement analysis.	Understand	CO 3	AME021.12
2	Describe with examples the failure mechanism of items.	Remember	CO 3	AME021.14
3	Write about 'replacement policy of items which deteriorate with time'.	Understand	CO 3	AME021.14
4	Discuss the replacement policy of items whose maintenance cost increases with time and money value is constant.	Remember	CO 3	AME021.14
5	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.	Understand	CO 3	AME021.13

Year	1	2	3	4	5	6	7	8
Maintenance (Rs)	1000	1200	1400	1800	2300	2800	3400	400

	Resale price (Rs)	3000	1500	750	375	200	200	2000	2(		
	determine at what age a replacement is due?										
6	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?									Understand	CO 3	AME021.13
7	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. Year 1 2 3 4 5 6 Machine A 1000 200 400 1000 200 400 Machine B 1700 100 200 300 400 500 Determine which Machine should be purchased?									Remember	CO 3	AME021.13
8	A firm is considering the replacement of a machine, whose cost price is Rs.12, 200 and its scrap value is Rs.200. From experience the running (Maintenance and operating) costs are found to be as follows. Year 1 2 3 4 5 6 7 8 Running cost (Rs) 200 500 800 1200 1800 2500 3200 4000 When the machine should be replaced.									Understand	CO 3	AME021.14
9	Explain briefly individual replacement policy and Group replacement of items that fail completely (suddenly)									Remember	CO 3	AME021.14
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	AME021.13
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	AME021.14
2	The data collected in running a Machine the cost of which is Rs:60,000 are given below 1 2 3 4 Resale value(Rs) 42,000 30,000 20,400 14,400 9,650 Cost of Spares(Rs) 4,000 4,270 4,880 5,700 6,800 Cost of Labour 14,000 16,000 18,000 21,000 25,000 Find the time when the machine should be replaced?									Understand	CO 3	AME021.14
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									Remember	CO 3	AME021.14

	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.			
4	A factory has a large number of bulbs all of which must be in working condition. The morality of the bulbs is given in the following table. week: 1 | 2 | 3 | 4 | 5 | 6 Proportion of bulbs failing during the week: 0.1 | 0.15 | 0.25 | 0.35 | 0.12 | 0.03 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	AME021.13
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	AME021.13
	UNIT – IV			
	Part A (Very Short Answer Questions)			
1	Define a player.	Understand	CO 4	AME021.15
2	Explain a strategy.	Remember	CO 4	AME021.16
3	Define a pure strategy	Understand	CO 4	AME021.15
4	Define a two-person zero-sum game.	Remember	CO 4	AME021.16
5	Describe n-person zero-sum game.	Understand	CO 4	AME021.17
6	What are the characteristics of a two-person zero-sum game?	Understand	CO 4	AME021.18
7	Discuss a mixed strategy.	Remember	CO 4	AME021.16
8	What is the advantage of a mixed strategy over a pure strategy?	Understand	CO 4	AME021.16
9	state the principle of dominance.	Remember	CO 4	AME021.15
10	Describe a mixed strategy.	Understand	CO 4	AME021.17
11	Explain 2× n game mode;?	Remember	CO 4	AME021.16
12	Define inventory	Understand	CO 4	AME021.16
13	What is the necessity of maintaining inventory?	Remember	CO 4	AME021.17
14	Explain different types of variables used in inventory?	Understand	CO 4	AME021.18
15	What are the different types of inventory models?	Remember	CO 4	AME021.19
16	Why many organizations hold safety stocks as part of their inventory.	Understand	CO 4	AME021.16
17	What is a reorder point?	Understand	CO 4	AME021.16
18	What is the EOQ.?	Remember	CO 4	AME021.18
19	Explain discrete probabilistic demand model	Understand	CO 4	AME021.18
20	Describe safety stock and Reorder point	Remember	CO 4	AME021.18
	Part B (Long Answer Questions)			
1	Explain two person zero sum game and n person game?	Remember	CO 4	AME021.19
2	Define pay of matrix and types of strategies in game theory?	Remember	CO 4	AME021.18
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? Player B: **1** | **2** | **3** | **4** | **5** | **6** Player A 1: 8 | 3 | 7 | 2 | 5 | 1 Player A 2: 3 | 4 | 5 | 2 | 1 | 6 Player A 3: 8 | 7 | 6 | 9 | 10 | 9	Understand	CO 4	AME021.18

<table>
<tr><td>4</td><td>Solve the following game;
<table><tr><td></td><td>Y1</td><td>Y2</td><td>Y3</td></tr><tr><td>X1</td><td>4</td><td>20</td><td>6</td></tr><tr><td>X2</td><td>18</td><td>12</td><td>10</td></tr></table>Find the value of game and strategies of players.</td><td>Understand</td><td>CO 4</td><td>AME021.19</td></tr>
<tr><td>5</td><td>Discuss the step by step procedure of application of Principle of dominance for solving game theory problem.</td><td>Remember</td><td>CO 4</td><td>AME021.19</td></tr>
<tr><td>6</td><td>Solve the following 2x2 game without saddle point
a. $A\begin{bmatrix} 5 & 1 \\ 3 & 4 \end{bmatrix}$ (B)
b. $A\begin{bmatrix} 2 & 5 \\ 7 & 3 \end{bmatrix}$ (B)</td><td>Understand</td><td>CO 4</td><td>AME021.19</td></tr>
<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="6">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>I</td><td>2</td><td>4</td><td>3</td><td>8</td><td>4</td></tr><tr><td>II</td><td>5</td><td>6</td><td>8</td><td>7</td><td>8</td></tr><tr><td>III</td><td>6</td><td>7</td><td>9</td><td>8</td><td>7</td></tr><tr><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>AME021.19</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>AME021.18</td></tr>
<tr><td>9</td><td>Explain process for solving 2 × n game graphically.</td><td>Remember</td><td>CO 4</td><td>AME021.19</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>AME021.19</td></tr>
<tr><td>11</td><td>Explain the various costs are involved in inventory problems with suitable</td><td>Remember</td><td>CO 4</td><td>AME021.18</td></tr>
</table>

<table>
<tr><td></td><td>examples and how they are inter-related.</td><td></td><td></td><td></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>AME021.18</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.
a. What should be the optimum no of units he should buy in 1lot?
b. What qty of the product should be allowed to be backordered
c. What would be the max qty of inventory at any time of year
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>AME021.18</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 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?</td><td>Understand</td><td>CO 4</td><td>AME021.17</td></tr>
<tr><td>15</td><td>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.</td><td>Remember</td><td>CO 4</td><td>AME021.17</td></tr>
<tr><td>16</td><td>The production department of a company required 3,600kg of raw materialformanufacturing 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.</td><td>Understand</td><td>CO 4</td><td>AME021.18</td></tr>
<tr><td>17</td><td>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
P_1 = Rs 10 for purchasing $Q_1 < 500$
P_2 = Rs 9.25 for purchasing $500 \leq Q_2 < 750$
P_3 = Rs 8.75 for purchasing $750 \leq Q_3$
Determine optimum purchase quantity. If the order cost is reduced to Rs 100 per order, compute the optimum purchase quantity.</td><td>Remember</td><td>CO 4</td><td>AME021.18</td></tr>
<tr><td>18</td><td>Discuss the significance of stochastic models in inventory control of production system?</td><td>Remember</td><td>CO 4</td><td>AME021.18</td></tr>
<tr><td>19</td><td>What are inventory models? Enumerate various types of inventory models
and describe them briefly.</td><td>Remember</td><td>CO 4</td><td>AME021.18</td></tr>
<tr><td>20</td><td>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 asfollows.
<table><tr><td>Demand</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td></tr><tr><td>Probability</td><td>0.20</td><td>0.30</td><td>0.30</td><td>0..10</td><td>0.10</td></tr></table>
How many heaters should the shop owner buy?</td><td>Understand</td><td>CO 4</td><td>AME021.18</td></tr>
<tr><td colspan="5">Part C (Critical Analytical Questions)</td></tr>
<tr><td>1</td><td>Solve the following 3 * 3 game. find the value of the game and strategies of player A andB.</td><td>Remember</td><td>CO 4</td><td>AME021.19</td></tr>
</table>

	<table><tr><td colspan="2"></td><td colspan="3">Player B</td></tr><tr><td colspan="2"></td><td>**1**</td><td>**2**</td><td>**3**</td></tr><tr><td rowspan="3">Player A</td><td>1</td><td>2</td><td>4</td><td>5</td></tr><tr><td>2</td><td>10</td><td>4</td><td>9</td></tr><tr><td>3</td><td>4</td><td>5</td><td>6</td></tr></table>			
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 <table><tr><td rowspan="2">Player-A</td><td colspan="6">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>I</td><td>2</td><td>4</td><td>3</td><td>8</td><td>4</td></tr><tr><td>II</td><td>5</td><td>6</td><td>8</td><td>7</td><td>8</td></tr><tr><td>III</td><td>6</td><td>7</td><td>9</td><td>8</td><td>7</td></tr><tr><td>IV</td><td>4</td><td>2</td><td>8</td><td>4</td><td>3</td></tr></table>	Understand	CO 4	AME021.19
3	Solve the following 2*3 game graphically; <table><tr><td colspan="2"></td><td colspan="3">Player B</td></tr><tr><td colspan="2"></td><td>I</td><td>II</td><td>III</td></tr><tr><td rowspan="2">Player A</td><td>I</td><td>1</td><td>3</td><td>11</td></tr><tr><td>II</td><td>8</td><td>5</td><td>2</td></tr></table>	Remember	CO 4	AME021.19
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	AME021.19
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. <table><tr><td>No. of customers</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td><td>32</td></tr><tr><td>Probability</td><td>0.01</td><td>0.03</td><td>0.06</td><td>0.10</td><td>0.20</td><td>0.25</td><td>0.15</td><td>0.10</td><td>0.05</td><td>0.05</td></tr></table> If each days demand is independent of the previous day's, how many papers should he order each day?	Understand	CO 4	AME021.19
	UNIT – V **Part A (Very Short Answer Questions)**			
1	What are the characteristics of a waiting line system?	Understand	CO 5	AME021.21
2	Define a waiting a line.	Understand	CO 5	AME021.21
3	Discuss waiting line applications.	Remember	CO 5	AME021.21
4	Define customer and server.	Understand	CO 5	AME021.21
5	Expand FIFO and LIFO.	Remember	CO 5	AME021.21
6	Explain FILO and SIRO	Understand	CO 5	AME021.21
7	What are the fundamental components of a queuing process?	Remember	CO 5	AME021.21
8	Who developed the technique called dynamic programming?	Understand	CO 5	AME021.21
9	What is Several queues-one service station queuing model?	Remember	CO 5	AME021.21
10	Define state variable and decision variable.	Understand	CO 5	AME021.21
11	what are the Conditions for Single Channel Queuing Model?	Understand	CO 5	AME021.21
12	What are the Limitations of Single Channel Queuing Model?	Remember	CO 5	AME021.21
13	What is (M/M/S): (∞/FCFS) queuing model?	Understand	CO 5	AME021.21
14	Explain arrival distribution and inter-arrival distribution	Remember	CO 5	AME021.21
15	Define simulation	Understand	CO 5	AME021.21

16	What are the types of simulation?	Remember	CO 5	AME021.21
17	Explain the phases of simulation?	Understand	CO 5	AME021.21
18	What are the major limitations of simulation?	Remember	CO 5	AME021.21
19	Explain the advantages of simulation?	Understand	CO 5	AME021.21
20	What are the disadvantages of simulation?	Remember	CO 5	AME021.21
Part B (Long Answer Questions)				
1	Define the terms Balking, Reneging, Jockeying.	Remember	CO 5	AME021.22
2	Explain the terms single server and multiple server queue length and finite and infinite queue length.	Remember	CO 5	AME021.22
3	Define simulation why simulation uses. Give one application area when this technique is used in practice.	Understand	CO 5	AME021.21
4	Explain what factors must be considered when designing simulation experiment.	Remember	CO 5	AME021.22
5	Discuss briefly the types of simulations?	Remember	CO 5	AME021.22
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. a. What is the average number of customer waiting for the service of the clerk b. What is the average time a customer has to wait before being used?	Remember	CO 5	AME021.22
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	AME021.22
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. a. What is the probability of having to wait for the service. b. What is the expected percentage of idle time for each girl? c. C. find the average length and average number of units in the system.	Remember	CO 5	AME021.22
9	Explain the application of Queuing systems?	Remember	CO 5	AME021.22
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: a. Average number of customers in the system b. Average number of customers in the queue of average queue length? c. Average time a customer spends in the systems d. Average time a customer waits before being served.	Understand	CO 5	AME021.22
11	Explain the advantages and disadvantages of simulation?	Understand	CO 5	AME021.23
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	AME021.23
13	What is simulation? Discuss application of simulation?	Understand	CO 5	AME021.20
14	Discuss the advantages and disadvantages of simulation.	Understand	CO 5	AME021.22
15	Explain briefly steps of simulation process.	Understand	CO 5	AME021.23
16	Explain types of simulation.	Understand	CO 5	AME021.23
17	Explain Monte Carlo simulation.	Remember	CO 5	AME021.23

<table>
<tr><td>18</td><td>what is simulation and discuss the What types of simulation?</td><td>Understand</td><td>CO 5</td><td>AME021.03</td></tr>
<tr><td>19</td><td>Explain computer simulation?</td><td>Understand</td><td>CO 5</td><td>AME021.23</td></tr>
<tr><td>20</td><td>write the applications of simulation.</td><td>Understand</td><td>CO23</td><td>AME021.23</td></tr>
<tr><td colspan="5">Part C (Critical Analytical Questions)</td></tr>
<tr><td>1</td><td>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.</td><td>Understand</td><td>CO 5</td><td>AME021.23</td></tr>
<tr><td>2</td><td>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
a. What would be the average queue length?
b. What would be the average number of customers in the queueing system?
c. What is the average time spent by a car in the petrol pump?
d. What is the average waiting time of a car before receiving petrol?</td><td>Remember</td><td>CO 5</td><td>AME021.22</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>AME021.23</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></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></tr>
</table>
use the following sequence of random numbers to simulate the demand for next 10days.
Random numbers: 25,39,65,76,12,05,73,89,19,49
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>AME021.22</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>AME021.22</td></tr>
</table>

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