INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**Optimization Techniques**
Course Code	:	AHS012
Class	:	V Semester
Branch	:	CSE/IT/EEE
Year	:	2019 – 2020
Course Coordinator	:	Mr. R M Noorullah, Associate Professor, Department of CSE

OBJECTIVES:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

S. No.	Question	Blooms Taxonomy Level	Course Learning Outcomes
	UNIT-I **Short Answer Questions**		
1	Identify scope of Operations research.	Understand	AHS012.01
2	Illustrate applications of Operations research.	Understand	AHS012.01
3	List characteristics of Operations research?	Remember	AHS012.01
4	Summarize methodology of Operations research.	Understand	AHS012.01
5	Classify phases of Operations research	Understand	AHS012.01
6	List Operations research models.	Remember	AHS012.01
7	Summarize advanced models of Operation research.	Understand	AHS012.01
8	Identify limitations of Operation research.	Understand	AHS012.01
9	Classify probabilistic models of Operation research.	Understand	AHS012.01
10	List simulation models of Operation research.	Remember	AHS012.01
11	Illustrate analytical models of Operation research.	Understand	AHS012.01
12	List applications of Operations Research Techniques.	Remember	AHS012.01
13	Summarize importance of Operation research in the decision making process?	Understand	AHS012.01
14	List purposes of mathematical model.	Remember	AHS012.02
15	Describe general representation of LPP.	Understand	AHS012.02
16	List objective functions of Operations Research in brief.	Understand	AHS012.02
17	Describe non degenerate basic feasible solution with an example.	Understand	AHS012.02

18	List non- negativity constraints with an example.	Understand	AHS012.02
19	List constraints of a LPP with an example.	Understand	AHS012.02
20	Classify slack variables with examples.	Remember	AHS012.03
21	Classify surplus variables with examples.	Remember	AHS012.03
22	List artificial variables with an illustration.	Understand	AHS012.03
23	Describe basic feasible solution with an example.	Remember	AHS012.03
24	Describe optimal solution with an illustration.	Remember	AHS012.03
25	Describe feasible region with an example.	Remember	AHS012.03
26	List basic and non basic variables with an example.	Remember	AHS012.03
	Long Answer Questions		
1	List out terminologies involved in formulating a linear programming problem?	Understand	AHS012.02
2	Define Operations Research. List characteristics of Operations Research.	Understand	AHS012.01
3	Explain methodology involved in Operations Research while solving problems by using different models.	Understand	AHS012.01
4	A farmer has 100 acre farm. He can sell all tomatoes, lettuce, or radishes he can raise. The price he can obtain is Rs 1.00 per kg for tomatoes, Rs 0.75 a head for lettuce and Rs 2.00 per kg for radishes. The average yield per acre is 2000 kg of tomatoes, 3000 heads of lettuce and 1000 kgs of radishes. Fertilizer is available at Rs 0.50 per kg and the amount required per acre is 100 kgs each for tomatoes and lettuce, and 50 kgs for radishes. Labor required for sowing and harvesting per acre is 5 man-days for tomatoes and radishes, and 6 man-days for lettuce. A total of 400 man-days of labor are available at Rs 20.00 per man-day. Formulate this as a Linear-Programming model to maximize the farmer's total profit.	Understand	AHS012.02
5	Write step-by-step procedure to solve LPP by BIG-M method with an example.	Understand	AHS012.03
6	Explain the algorithm of simplex method to solve an LPP with an example.	Remember	AHS012.02
7	What are various methods involved in solving problems with artificial variables? Explain steps involved in two phase method.	Understand	AHS012.03
8	List various Operations Research models with their applications.	Understand	AHS012.01
9	What are the assumptions to solve LPP using simplex?	Understand	AHS012.02
10	Explain limitations of Operations Research.	Understand	AHS012.01
11	List various definitions involved in Linear Programming Problem.	Remember	AHS012.02
12	Explain step by step procedure to solve Linear Programming Problem by using Graphical Method with an example.	Understand	AHS012.02
13	Solve the following LPP by using graphical method Maximize $Z=3x1+4x2$ Subject to $x1+x2\leq 450$ $x1+2x2\leq 600$ where $x1, x2 \geq 0$	Understand	AHS012.02
14	Solve the following LPP by using graphical method Maximize $Z=2x1+3x2$ Subject to $x1+x2\leq 30$ $x2\geq 3$ $x2\leq 12$ $x1- x2\geq 0$ $0\leq x1\leq 20$ where $x1, x2 \geq 0$	Understand	AHS012.02
15	Solve the following LPP by using graphical method Minimize $Z= - x1+2x2$ Subject to $-x1+3x2\leq 10$ $x1+x2\leq 6$ $x1- x2\leq 2$ where $x1, x2 \geq 0$	Understand	AHS012.02

16	Solve the following LPP by using Simplex method Maximize Z=3x1+4x2 Subject to x1+x2≤450 x1+2x2≤600 where x1, x2 ≥ 0	Understand	AHS012.02
17	Solve the following LPP by using Big M method Minimize Z=12x1+20x2 Subject to 6x1+8x2≥100 7x1+12x2≥120 where x1, x2 ≥ 0	Understand	AHS012.03
18	Solve the following LP Problem by two phase simplex method Maximize Z=5x1+3x2 Subject to 2x1+x2≤1 x1+4x2≥6 where x1, x2 ≥ 0	Understand	AHS012.02
19	Solve the following LPP by using Simplex method Maximize Z=12x1+15x2+14x3 Subject to -x1 + x2≤0 -x2+2x3≤0 x1+x2+x3≤100 where x1, x2, x3 ≥ 0	Understand	AHS012.02
20	Solve the following LPP by using Simplex method Minimize Z=x1-3x2+3x3 Subject to 3x1 -x2+2x3≤7 2x1+4x2≥ -12 -4x1+3x2+8x3≤10 where x1, x2, x3 ≥ 0	Understand	AHS012.02
	Analytical Questions		
1	Solve the following LP problem graphically Maximize $z = 2x_1 + x_2$ Subject to $x_1 + 2x_2 \le 10$, $x_1 + x_2 \le 6$, $x_1 - x_2 \le 2$, $x_1 - 2x_2 \le 1$ where $x_1, x_2 \ge 0$	Understand	AHS012.02
2	Solve the following LP problem using Simplex method. Maximize $Z = 2x_1 + 5x_2$ $x_1 + 4x_2 \le 24$, $3x_1 + x_2 \le 21$, $x_1 + x_2 \le 9$, where $x_1, x_2 \ge 0$	Understand	AHS012.02
3	Solve the following LPP by using Simplex method Minimize Z=x1 - 3x2+3x3 Subject to 3x1 - x2+2x3≤7 2x1+4x2 ≥ - 12 - 4x1+3x2+8x3≤10 where x1, x2, x3 ≥ 0	Understand	AHS012.02
4	Solve the following LPP by using Big-M method Maximize Z=3x1 - x2 Subject to 2x1 + x2≤2 x1+3x2 ≥3 x2≤4 where x1, x2 ≥ 0	Understand	AHS012.03

5	Solve the following LPP by using Two Phase simplex method Maximize Z=5x1 - 4x2+3x3 Subject to 2x1 +x2 - 6x3=20 6x1+5x2+10x3≤ 76 8x1 - 3x2+6x3≤50 where $x_1, x_2, x_3 \geq 0$	Understand	AHS012.03
6	A firm produces three types of biscuits A, B, C it packs them in arrestments of two sizes 1 and 11. The size 1 contains 20 biscuits of type A, 50 of type B and 10 of type C. the size 11 contains 10 biscuits of the A, 80 of type B and 60 of type C. A buyer intends to buy at least 120 biscuits of type A, 740 of type B and 240 of type C. Determine the least number of packets he should buy. Solve the problem by using Simplex method and also verify result graphically.	Understand	AHS012.02
7	Solve the following LP problem by two phase method. Maximize $z = 5x_1 + 8x_2$ Subject to $3x_1 + 2x_2 \geq 3$ $x_1 + 4x_2 \geq 0$ $4x_1 + x_2 \leq 0$ $5x_1 + x_2 \geq 0$ where $x_1, x_2 \geq 0$	Understand	AHS012.03
8	Solve the following LP problem graphically Maximize $z = -x_1 + 2x_2$ S.T $x_1 - x_2 \leq -1$, $-0.5x_1 - x_2 \leq 2$, $x_1, x_2 \geq 0$	Understand	AHS012.02
9	Solve the following LP Problem by graphical method Maximize Z=5x1+3x2 Subject to 2x1+x2≤1 x1+4x2≥6 where $x_1, x_2 \geq 0$	Understand	AHS012.02
10	Solve the following LP problem by simplex method. Maximize $z = -x_1 + 2x_2$ S.T $x_1 - x_2 \leq -1$, $-0.5x_1 - x_2 \leq 2$, $x_1, x_2 \geq 0$	Understand	AHS012.02

UNIT – II
Short Answer Questions

S. No.	Question	Blooms Taxonomy Level	Course Learning Outcomes
1	Summarize mathematical model of a transportation problem.	Understand	AHS012.04
2	List methods to solve transportation problems to get Basic feasible solution?	Remember	AHS012.04
3	Why is LCM is optimal than NWCR in solving transportation problem?	Understand	AHS012.04
4	Why does Vogel's approximation method provide a good initial feasible solution than other methods?	Remember	AHS012.04
5	List methods to test for optimality in transportation problem.	Remember	AHS012.04
6	What is degeneracy in transportation problem?	Remember	AHS012.04
7	List assumptions used in solving transportation problem.	Understand	AHS012.04
8	What is unbalance problem in transportation model.	Understand	AHS012.04
9	Define feasible, basic feasible and optimal solution in transportation model.	Understand	AHS012.04
10	Define constraints of a transportation problem?	Understand	AHS012.04
11	Define an assignment problem.	Remember	AHS012.05
12	List out the applications of assignment problem?	Understand	AHS012.05

13	Give the mathematical representation of an assignment problem.	Understand	AHS012.05
14	What is the difference between assignment problem and travelling salesman problem?	Remember	AHS012.06
15	Discuss the method of solving assignment problems?	Understand	AHS012.05
16	Show that an assignment problem is a special case of a transportation problem?	Understand	AHS012.06
17	Describe an algorithm to solve an assignment problem?	Understand	AHS012.05
18	Draw flowchart for Hungarian method.	Remember	AHS012.05
19	How to solve unbalanced assignment problem.	Understand	AHS012.05
20	List variants in transportation problem.	Remember	AHS012.04
	Long Answer Questions		
1	Explain mathematical model of a transportation problem with an example.	Understand	AHS012.04
2	What are different methods of solving transportation problems to get basic feasible solution? Explain steps involved in VAM method.	Remember	AHS012.04
3	Why is LCM is optimal than NWCR in solving transportation problem? Explain with an example.	Understand	AHS012.04
4	Why does Vogel's approximation method provide a good initial feasible solution than other methods? Explain with an example.	Remember	AHS012.04
5	What are the methods to test for optimality in transportation problem? Explain steps involved in MODI method.	Remember	AHS012.05
6	What is degeneracy in transportation problem? Explain how it will be solved.	Remember	AHS012.05
7	Write about travelling sales man problem? List various types.	Understand	AHS012.06
8	Explain unbalance problem in transportation? Write procedure to solve it.	Understand	AHS012.04
9	Explain steps involved in formulation and solution of Transportation models.	Understand	AHS012.04
10	Explain steps involved in finding initial basic feasible solution by using NWCM method.	Understand	AHS012.04
11	What is assignment problem? Explain mathematical representation of an assignment problem.	Remember	AHS012.05
12	Explain steps involved in the Hungarian Method for solution of assignment problem.	Understand	AHS012.05
13	List methods to find optimal solution of transportation problem. Explain steps involved in u-v method.	Understand	AHS012.04
14	What is the difference between assignment problem and travelling salesman problem? Explain with an example.	Remember	AHS012.06
15	Discuss the method of solving unbalanced assignment problem with an example.	Understand	AHS012.05
16	Show that an assignment problem is a special case of a transportation problem? Explain with an illustration.	Understand	AHS012.05
17	How to solve Maximization problems by using assignment problem? Explain with an example.	Understand	CAHS012.06
18	Represent mathematically travelling salesman problem.	Remember	AHS012.06
19	Write the unbalanced assignment problem?	Understand	AHS012.05
20	Explain about mathematical representation and assumptions made in transportation problem with an example.	Understand	AHS012.04
	Analytical Questions		
1	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 800,500and900respectively.Monthly warehouse requirements are400,500,400and800unitsrespectively.Unittransportation cost in rupees are given below. Determine an optimum distribution for the company in order to minimize the total transportation cost by NWCR.	Understand	AHS012.04

	D	E	F	G	H
A	5	8	6	6	3
B	4	7	7	6	5
C	8	4	6	6	4

<table>
<tr><td>2</td><td>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>W1</td><td>W2</td><td>W3</td><td>Supply</td></tr>
<tr><td>F1</td><td>16</td><td>20</td><td>12</td><td>200</td></tr>
<tr><td>F2</td><td>14</td><td>8</td><td>18</td><td>160</td></tr>
<tr><td>F3</td><td>26</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></td><td>Understand</td><td>AHS012.04</td></tr>
<tr><td>3</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>Understand</td><td>AHS012.05</td></tr>
<tr><td>4</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>Jobs</td><td colspan="5">Machines</td></tr>
<tr><td></td><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>Understand</td><td>AHS012.05</td></tr>
<tr><td>5</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 disallowed assignments. The problem is to find the minimum cost matching of machines to jobs.
<table>
<tr><td></td><td>J1</td><td>J2</td><td>J3</td><td>J4</td><td>J5</td></tr>
<tr><td>M1</td><td>M</td><td>8</td><td>6</td><td>12</td><td>1</td></tr>
<tr><td>M2</td><td>15</td><td>12</td><td>7</td><td>M</td><td>10</td></tr>
<tr><td>M3</td><td>10</td><td>M</td><td>5</td><td>14</td><td>M</td></tr>
<tr><td>M4</td><td>12</td><td>M</td><td>12</td><td>16</td><td>15</td></tr>
<tr><td>M5</td><td>18</td><td>17</td><td>14</td><td>M</td><td>13</td></tr>
</table></td><td>Understand</td><td>AHS012.05</td></tr>
<tr><td>6</td><td>A salesman has to visit five cities A, B, C, D, E. The intercity distances are tabulated below.
<table>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>A</td><td>-</td><td>12</td><td>24</td><td>25</td></tr>
<tr><td>B</td><td>6</td><td>-</td><td>16</td><td>18</td></tr>
<tr><td>C</td><td>10</td><td>11</td><td>-</td><td>18</td></tr>
<tr><td>D</td><td>14</td><td>17</td><td>22</td><td>-</td></tr>
<tr><td>E</td><td>12</td><td>13</td><td>23</td><td>25</td></tr>
</table>
Find the shortest route covering all the cities.</td><td>Understand</td><td>AHS012.06</td></tr>
<tr><td>7</td><td>The assignment cost of assigning any one operator to any one machine is given in the following table.</td><td>Understand</td><td>AHS012.05</td></tr>
</table>

	<table><tr><td rowspan="2">Machine</td><td colspan="4">Operators</td></tr><tr><td></td><td>I</td><td>II</td><td>III</td><td>IV</td></tr><tr><td></td><td>A</td><td>10</td><td>5</td><td>13</td><td>15</td></tr><tr><td></td><td>B</td><td>3</td><td>9</td><td>18</td><td>3</td></tr><tr><td></td><td>C</td><td>10</td><td>7</td><td>3</td><td>2</td></tr><tr><td></td><td>D</td><td>5</td><td>11</td><td>9</td><td>7</td></tr></table> Solve the optimal assignment by Hungarian method.		
8	The profit after assigning the machines to jobs is 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>	Understand	AHS012.05
9	Explain the algorithm for solving transportation problem by Vogel's approximation rule with an example.	Understand	AHS012.04
10	Solve the following transportation problem. <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>Supply</td></tr><tr><td>I</td><td>9</td><td>16</td><td>15</td><td>6</td><td>15</td></tr><tr><td>II</td><td>2</td><td>1</td><td>3</td><td>5</td><td>25</td></tr><tr><td>III</td><td>6</td><td>4</td><td>7</td><td>3</td><td>20</td></tr><tr><td>Demand</td><td>10</td><td>15</td><td>25</td><td>10</td><td>60</td></tr></table>	Understand	AHS012.04
	UNIT – III		
	Short Answer Questions		
1	What are different types of sequencing problems?	Understand	AHS012.07
2	List optimality criteria considered in sequencing problems.	Remember	AHS012.07
3	What are applications of sequencing problems?	Understand	AHS012.07
4	Write the terminology of sequencing techniques in operations research.	Understand	AHS012.07
5	List assumptions made in solving sequencing problems.	Understand	AHS012.07
6	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?	Remember	AHS012.08
7	Explain about Short Processing Time(SPT) rule used in solving sequence problems.	Remember	AHS012.08
8	List conditions assumed in solving n jobs through two machines.	Remember	AHS012.08
9	Processing of two jobs through m machines will be solved by which method?	Understand	AHS012.09
10	Explain about Weighed Short Processing Time(WSPT) rule used in solving sequence problems.	Remember	AHS012.07
1	Define a mixed strategy?	Understand	AHS012.10
2	Explain about pure strategy.	Understand	AHS012.10
3	Define a two-person zero-sum game?	Understand	AHS012.11
4	Define n-person zero-sum game?	Understand	AHS012.11
5	What is a rectangular game?	Understand	AHS012.11
6	Define a strategy?	Remember	AHS012.10
7	What are the characteristics of a two-person zero-sum game?	Understand	AHS012.11
8	State the rules for a game theory?	Understand	AHS012.10
9	What is symmetric games?	Understand	AHS012.11
10	Explain about Dominated Moves in game theory.	Understand	AHS012.10
	Long Answer Questions		

<table>
<tr><td>1.</td><td>Calculate the following sequencing problem to minimize the time elapsed with sequence
<table>
<tr><td colspan="6">M & M2</td></tr>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Machine M1</td><td>7</td><td>10</td><td>8</td><td>9</td><td>7</td></tr>
<tr><td>Machine M2</td><td>2</td><td>1</td><td>4</td><td>0</td><td>5</td></tr>
</table>
Also find the total elapsed time and idle times of each machine.</td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>2.</td><td>Determine the best sequence for ‘5’ jobs that will minimize the elapsed time T, if each of the ‘5’ jobs must go through machines A, B and C in the order ABC, The processing times are.
<table>
<tr><td>Job</td><td colspan="3">Processing time</td></tr>
<tr><td></td><td>A</td><td>B</td><td>C</td></tr>
<tr><td>1</td><td>8</td><td>5</td><td>4</td></tr>
<tr><td>2</td><td>10</td><td>6</td><td>9</td></tr>
<tr><td>3</td><td>6</td><td>2</td><td>8</td></tr>
<tr><td>4</td><td>7</td><td>3</td><td>6</td></tr>
<tr><td>5</td><td>11</td><td>4</td><td>5</td></tr>
</table></td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>3.</td><td>A book binder has one printing press, one binding machine and manuscripts of 5 different jobss. The time required for performing printing and binding operations for different books are shown below.
<table>
<tr><td>Job</td><td colspan="3">Processing time</td></tr>
<tr><td></td><td>A</td><td>B</td><td>C</td></tr>
<tr><td>1</td><td>8</td><td>5</td><td>4</td></tr>
<tr><td>2</td><td>10</td><td>6</td><td>9</td></tr>
<tr><td>3</td><td>6</td><td>2</td><td>8</td></tr>
<tr><td>4</td><td>7</td><td>3</td><td>6</td></tr>
<tr><td>5</td><td>11</td><td>4</td><td>5</td></tr>
</table>
Decide the optimum sequence of processing of jobs in order to minimize the total time required to bring out all the books.</td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>4.</td><td>The following table gives machine time for the six jobs and the three machines. Find the sequence of jobs that minimizes elapsed time to complete the jobs.
<table>
<tr><td rowspan="2">Jobs</td><td colspan="3">Processing Time</td></tr>
<tr><td>Machine A</td><td>Machine B</td><td>Machine C</td></tr>
<tr><td>1</td><td>8</td><td>3</td><td>8</td></tr>
<tr><td>2</td><td>3</td><td>4</td><td>7</td></tr>
<tr><td>3</td><td>7</td><td>5</td><td>6</td></tr>
<tr><td>4</td><td>2</td><td>2</td><td>9</td></tr>
<tr><td>5</td><td>5</td><td>1</td><td>10</td></tr>
<tr><td>6</td><td>1</td><td>6</td><td>9</td></tr>
</table></td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>5.</td><td>Suppose we have five jobs, each of which has to be processed on two machines A & B in the order AB. Processing times are given in the following table:
<table>
<tr><td>Job</td><td>Machine A</td><td>Machine B</td></tr>
<tr><td>1</td><td>6</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>7</td></tr>
<tr><td>3</td><td>10</td><td>8</td></tr>
<tr><td>4</td><td>4</td><td>9</td></tr>
<tr><td>5</td><td>11</td><td>5</td></tr>
</table></td><td>Understand</td><td>AHS012.08</td></tr>
</table>

<table>
<tr><td>6</td><td>A book binder has one printing press, one binding machine and manuscripts of 7 different book the times required for performing printing and binding operations for different books are shown below.
<table>
<tr><td>Book</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Printing time (hours)</td><td>20</td><td>90</td><td>80</td><td>20</td><td>120</td><td>15</td><td>65</td></tr>
<tr><td>Binding time (hours)</td><td>25</td><td>60</td><td>75</td><td>30</td><td>90</td><td>35</td><td>50</td></tr>
</table></td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>7</td><td>A manufacturing company processes 6 different jobs on two machines A and B. Number of units of each job and its processing times on A and B are given below. Find the optimal sequence, the total minimum elapsed time and idle time for either machine
<table>
<tr><td>Job</td><td>Number of Units of each job</td><td>Processing time Machine A</td><td>Processing time Machine B</td></tr>
<tr><td>1</td><td>3</td><td>5</td><td>8</td></tr>
<tr><td>2</td><td>4</td><td>16</td><td>7</td></tr>
<tr><td>3</td><td>2</td><td>6</td><td>11</td></tr>
<tr><td>4</td><td>5</td><td>3</td><td>5</td></tr>
<tr><td>5</td><td>2</td><td>9</td><td>7.5</td></tr>
<tr><td>6</td><td>3</td><td>6</td><td>14</td></tr>
</table></td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>8</td><td>There are seven jobs, each of which has to go through the machines A and B in the order AB. Processing times in hours are as follows.
<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Machine A</td><td>3</td><td>12</td><td>15</td><td>6</td><td>10</td><td>11</td><td>9</td></tr>
<tr><td>Machine B</td><td>8</td><td>10</td><td>10</td><td>6</td><td>12</td><td>1</td><td>3</td></tr>
</table>
Decide a sequence of these jobs that will minimize the total elapsed time T. Also find T and idle time for machines A and B.</td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>9</td><td>Find the sequence that minimizes the total time required in performing the following job on three machines in the order ABC. Processing times (in hours) are given in the following table.
<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Machine A</td><td>8</td><td>10</td><td>6</td><td>7</td><td>11</td></tr>
<tr><td>Machine B</td><td>5</td><td>6</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>Machine C</td><td>4</td><td>9</td><td>8</td><td>6</td><td>5</td></tr>
</table></td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>10</td><td>There are seven jobs, each of which has to go through the machines A and B in the order AB. Processing times in hours are as follows.
<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Machine A</td><td>6</td><td>24</td><td>30</td><td>12</td><td>20</td><td>22</td><td>18</td></tr>
<tr><td>Machine B</td><td>16</td><td>20</td><td>20</td><td>12</td><td>24</td><td>2</td><td>6</td></tr>
</table>
Decide a sequence of these jobs that will minimize the total elapsed time T. Also find T and idle time for machines A and B.</td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>1.</td><td>Solve the given matrix
B
A $\begin{bmatrix} 2 & -1 \\ -1 & 0 \end{bmatrix}$</td><td>Understand</td><td>AHS012.10</td></tr>
</table>

2.	Solve by graphical method $\begin{array}{c} \\ A1 \\ A2 \\ A3 \\ A4 \end{array}\begin{array}{c} B1 \quad B2 \\ \begin{bmatrix} -2 & 0 \\ 3 & -1 \\ -3 & 2 \\ 5 & -4 \end{bmatrix} \end{array}$	Understand	AHS012.12
3.	Player B I II III IV I 3 5 4 2 Player A II 5 6 2 4 III 2 1 4 0 IV 3 3 5 2 Use the principle of dominance to solve this problem.	Understand	AHS012.12
4.	Consider the following pay-off matrix Player B B_1 B_2 Player A A_1 -2 4 A_1 8 3 A_1 9 0	Understand	AHS012.11
5.	Obtain the optimal strategies for both pensions and the value of the game for two persons zero sum game whose payoff matrix is as follows Player- B B1 B2 Player -A A1 1 -3 A2 3 5 A3 -1 6 A4 4 1 A5 2 2 A6 -5 0	Understand	AHS012.11
6.	Solve by graphical method $\begin{array}{c} \\ A1 \\ A2 \end{array}\begin{array}{c} B1 \quad B2 \quad B3 \\ \begin{bmatrix} 4 & -1 & 0 \\ -1 & 4 & 2 \end{bmatrix} \end{array}$	Understand	AHS012.12
7	Consider the modified pred/prey game with a mixed strategy: Pred/Prey | Active | Passive Active | 2,-10 | 9,-12 Passive | 3,-5 | -1,0 Let p=probab. prey is active q=probab. Predator is active Find all the mixed strategy equilibrium	Understand	AHS012.11
8	Consider the matching game 1/2 | L | R L | 1,-1 | -1,1 R | -1,1 | 1,-1 What is the maxmin strategy for row player?	Understand	AHS012.11

<table>
<tr><td>9</td><td>Consider the following Game:<table><tr><td>1\2</td><td>Stay</td><td>Leave</td></tr><tr><td>Stay</td><td>-Z, -2</td><td>1,0</td></tr><tr><td>Leave</td><td>0,1</td><td>0,0</td></tr></table>In the resulting mixed strategy equilibrium, how does the probability of staying change for row and column player as Z is increased?</td><td>Understand</td><td>AHS012.11</td></tr>
<tr><td>10</td><td>Explain difference between pure strategy and mixed strategy used in game theory. Explain with an example.</td><td>Remember</td><td>AHS012.11</td></tr>
<tr><td colspan="4">Analytical Questions</td></tr>
<tr><td>1</td><td>Strong Book Binder has one printing machine, one binding machine, and the manuscripts of a number of different books. Processing times are given in the following table:<table><tr><th>Book</th><th>Time In Hours</th><th></th></tr><tr><th></th><th>Printing</th><th>Binding</th></tr><tr><td>A</td><td>5</td><td>2</td></tr><tr><td>B</td><td>1</td><td>6</td></tr><tr><td>C</td><td>9</td><td>7</td></tr><tr><td>D</td><td>3</td><td>8</td></tr><tr><td>E</td><td>10</td><td>4</td></tr></table></td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>2</td><td>There are 5 jobs, each of which has to go through the machines A and B in the order AB. The processing times (in hours) are given as<table><tr><td>Job</td><td>:</td><td>J_1</td><td>J_2</td><td>J_3</td><td>J_4</td><td>J_5</td></tr><tr><td>Machine A</td><td>:</td><td>2</td><td>4</td><td>5</td><td>7</td><td>1</td></tr><tr><td>Machine B</td><td>:</td><td>3</td><td>6</td><td>1</td><td>4</td><td>8</td></tr></table>Determine a sequence of these jobs that will minimize the total elapsed time T. Also obtain:
i) the minimum elapsed time
ii) ii) the idle time for each of the machines</td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>3</td><td>A ready-made garments manufacturer has to process five items through 2 stages of production, viz. cutting and sewing. The time taken for each of these items at the different stages is given below (in hours):<table><tr><td rowspan="3">Processing time (hours) {</td><td>Item :</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Cutting:</td><td>5</td><td>7</td><td>3</td><td>4</td><td>6</td></tr><tr><td>Sewing :</td><td>2</td><td>6</td><td>7</td><td>5</td><td>9</td></tr></table>Find an order in which these items should be processed so as to minimize the total processing time. Also calculate the various idle times.</td><td>Understand</td><td>AHS012.08</td></tr>
<tr><td>4</td><td>There are 7 jobs, each of which has to go through the machines A and B in the order AB. Processing times (in hours) are given as follows:<table><tr><td>Job :</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>Machine A :</td><td>3</td><td>12</td><td>15</td><td>6</td><td>10</td><td>11</td><td>9</td></tr><tr><td>Machine B :</td><td>8</td><td>10</td><td>10</td><td>6</td><td>12</td><td>1</td><td>3</td></tr></table>Determine a sequence of these jobs that will minimize the total elapsed time. Also calculate the various idle times.</td><td>Understand</td><td>AHS012.08</td></tr>
</table>

<table>
<tr><td>5</td><td>A machine shop has five machines A, B, C, D and E. Two jobs must be processed through each of these machines. The time (in hours) taken on each of these machines and the necessary sequence of jobs through the shops are given below:

Job 1 Sequence : A B C D E
Time : 2 4 3 6 6
Job 2 Sequence : C A D E B
Time : 4 6 3 3 6

Use the graphical method to obtain the total minimum elapsed time.</td><td>Understand</td><td>AHS012.09</td></tr>
<tr><td>6</td><td>Using the graphical method, calculate the minimum time needed to process job 1 and job 2 on five machines A, B, C, D and E, that is, for each machine find the job which should be done first. Also calculate the total time needed to complete both jobs.

Job 1 Sequence : A B C D E
Time (in hrs) : 1 2 3 5 1
Job 2 Sequence : C A D E B
Time (in hrs) : 3 4 2 1 5</td><td>Understand</td><td>AHS012.09</td></tr>
<tr><td>7</td><td>Use the graphical method to minimize the time required to process the following jobs on the machines, that is, for each machine specify the job that should be done first. Also calculate the total elapsed time for completing both jobs.

Job 1 Sequence : A B C D E
Time (in hrs) : 6 8 4 12 3
Job 2 Sequence : B C A D E
Time (in hrs) : 10 8 6 4 12</td><td>Understand</td><td>AHS012.09</td></tr>
<tr><td>8</td><td>A book binder has one printing press, one binding machine and manuscripts of 7 different books. The times required for performing printing and binding operations for different books are shown below.

<table>
<tr><td>Book</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Printing time (hours)</td><td>40</td><td>180</td><td>160</td><td>40</td><td>240</td><td>30</td><td>130</td></tr>
<tr><td>Binding time (hours)</td><td>50</td><td>120</td><td>150</td><td>60</td><td>180</td><td>70</td><td>100</td></tr>
</table>
Decide the optimum sequence of processing of books in order to minimize the total time required to bring out all the books.</td><td>Understand</td><td>AHS012.09</td></tr>
<tr><td>9</td><td>There are seven jobs, each of which has to go through the machines A and B in the order AB. Processing times in hours are as follows.

<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Machine A</td><td>9</td><td>36</td><td>45</td><td>18</td><td>30</td><td>33</td><td>27</td></tr>
<tr><td>Machine B</td><td>24</td><td>30</td><td>30</td><td>18</td><td>36</td><td>3</td><td>9</td></tr>
</table>
Decide a sequence of these jobs that will minimize the total elapsed time T. Also find T and idle time for machines A and B.</td><td>Understand</td><td>AHS012.09</td></tr>
<tr><td>10</td><td>Find the sequence that minimizes the total time required in performing the following job on three machines in the order ABC. Processing times (in hours) are given in the following table.

<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Machine A</td><td>24</td><td>30</td><td>18</td><td>21</td><td>33</td></tr>
<tr><td>Machine B</td><td>15</td><td>18</td><td>6</td><td>9</td><td>12</td></tr>
<tr><td>Machine C</td><td>12</td><td>27</td><td>24</td><td>18</td><td>15</td></tr>
</table></td><td>Understand</td><td>AHS012.09</td></tr>
</table>

<table>
<tr><td>1</td><td>Consider a two-person zero-sum game matrix which represents payoff to the player A, see .Find the optimal strategy.
<table><tr><td></td><td></td><td>Player B</td><td></td><td></td><td></td></tr><tr><td></td><td>I</td><td>II</td><td>III</td><td>IV</td><td>V</td></tr><tr><td>Player A I</td><td>-2</td><td>0</td><td>0</td><td>5</td><td>3</td></tr><tr><td>II</td><td>4</td><td>2</td><td>1</td><td>3</td><td>2</td></tr><tr><td>III</td><td>-4</td><td>-3</td><td>0</td><td>-2</td><td>6</td></tr><tr><td>IV</td><td>5</td><td>3</td><td>-4</td><td>2</td><td>-6</td></tr></table></td><td>Understand</td><td>AHS012.11</td></tr>
<tr><td>2</td><td>Solve the game whose payoff matrix is given below:
<table><tr><td></td><td></td><td>Player B</td><td></td></tr><tr><td></td><td>I</td><td>II</td><td>III</td></tr><tr><td>I</td><td>-2</td><td>15</td><td>-2</td></tr><tr><td>Player A II</td><td>-5</td><td>-6</td><td>-4</td></tr><tr><td>III</td><td>-5</td><td>20</td><td>-8</td></tr></table></td><td>Understand</td><td>AHS012.11</td></tr>
<tr><td>3</td><td>Solve the game whose payoff matrix is given below:
B
A [5 1
3 4]</td><td>Understand</td><td>AHS012.11</td></tr>
<tr><td>4</td><td>Solve by graphical method
<table><tr><td></td><td>B1</td><td>B2</td><td>B3</td></tr><tr><td>A1</td><td>1</td><td>3</td><td>12</td></tr><tr><td>A2</td><td>8</td><td>6</td><td>2</td></tr></table></td><td>Understand</td><td>AHS012.12</td></tr>
<tr><td>5</td><td>Consider the following version of the prisoners dilemma game (Player one’s payoffs are in bold):
<table><tr><td colspan="2"></td><td>Player Two</td><td></td></tr><tr><td colspan="2"></td><td>Cooperate</td><td>Cheat</td></tr><tr><td rowspan="2">Player One</td><td>Cooperate</td><td>$10 $10</td><td>$0 $12</td></tr><tr><td>Cheat</td><td>$12 $0</td><td>$5 $5</td></tr></table>What is each player’s dominant strategy?</td><td>Understand</td><td>AHS012.12</td></tr>
<tr><td>6</td><td>Consider the following game. Two criminals are thinking about pulling off a bank robbery. The take from the bank would be $20,000 each , but the job requires two people (one to rob the bank and one to drive the getaway car. Each criminal could instead rob a liquor store. The take from robing a liquor store is only $1000 but can be done with one person acting alone.
Write down the payoff matrix for this game.
<table><tr><td colspan="2"></td><td>Player Two</td><td></td></tr><tr><td colspan="2"></td><td>Bank Job</td><td>Liquor Store</td></tr><tr><td rowspan="2">Player One</td><td>Bank Job</td><td>20,000 20,000</td><td>0 1,000</td></tr><tr><td>Liquor Store</td><td>1,000 0</td><td>1,000 1,000</td></tr></table></td><td>Understand</td><td>AHS012.12</td></tr>
<tr><td>7</td><td>Consider the following game. Two criminals are thinking about pulling off a bank robbery. The take from the bank would be $20,000 each , but the job requires two people (one to rob the bank and one to drive the getaway car. Each criminal could instead rob a liquor store. The take from robing a liquor store is only $1000 but can be done with one person acting alone.
What are the strategies and equilibrium of this game.
<table><tr><td colspan="2"></td><td>Player Two</td><td></td></tr><tr><td colspan="2"></td><td>Bank Job</td><td>Liquor Store</td></tr><tr><td rowspan="2">Player One</td><td>Bank Job</td><td>20,000 20,000</td><td>0 1,000</td></tr><tr><td>Liquor Store</td><td>1,000 0</td><td>1,000 1,000</td></tr></table></td><td>Understand</td><td>AHS012.12</td></tr>
</table>

<table>
<tr><td>8</td><td>Consider the following bargaining problem: $20 dollars needs to be split between Jack and Jill. Jill gets to make an initial offer. Jack then gets to respond by either accepting Jill's initial offer or offering a counter offer. Finally, Jill can respond by either accepting Jakes offer or making a final offer. If Jake does not accept Jill's final offer both Jack and Jill get nothing. Jack discounts the future at 10% (i.e. future earnings are with 10% less than current earnings while Jill discounts the future at 20%. Calculate the equilibrium of this bargaining problem.</td><td>Understand</td><td>AHS012.12</td></tr>
<tr><td>9</td><td>Consider the game of chicken. Two players drive their cars down the center of the road directly at each other. Each player chooses SWERVE or STAY. Staying wins you the admiration of your peers (a big payoff) only if the other player swerves. Swerving loses face if the other player stays. However, clearly, the worst output is for both players to stay! Specifically, consider the following payouts.
(Player one's payoffs are in bold):
<table>
<tr><td colspan="2"></td><td>Player Two</td><td></td></tr>
<tr><td colspan="2"></td><td>Stay</td><td>Swerve</td></tr>
<tr><td rowspan="2">Player One</td><td>Stay</td><td>-6 -6</td><td>2 -2</td></tr>
<tr><td>Swerve</td><td>-2 2</td><td>1 1</td></tr>
</table>
Does either player have a dominant strategy? Explain.</td><td>Understand</td><td>AHS012.12</td></tr>
<tr><td>10</td><td>Consider the game of chicken. Two players drive their cars down the center of the road directly at each other. Each player chooses SWERVE or STAY. Staying wins you the admiration of your peers (a big payoff) only if the other player swerves. Swerving loses face if the other player stays. However, clearly, the worst output is for both players to stay! Specifically, consider the following payouts.
(Player one's payoffs are in bold):
<table>
<tr><td colspan="2"></td><td>Player Two</td><td></td></tr>
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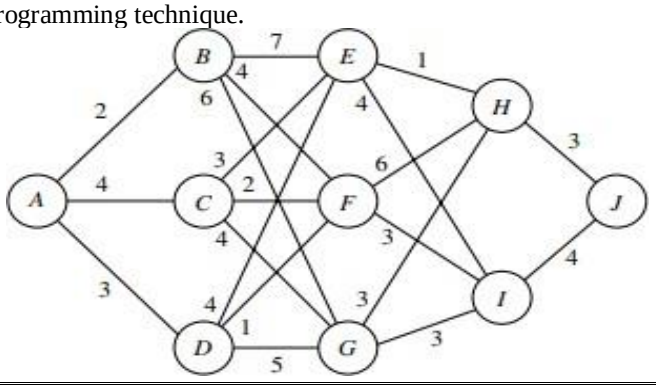
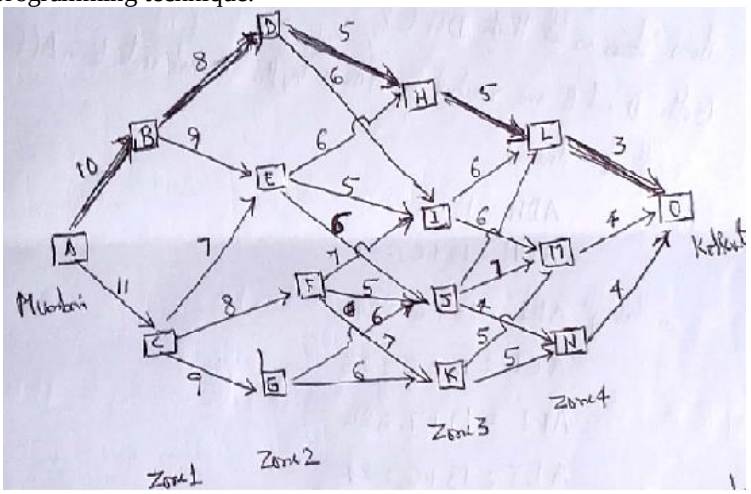
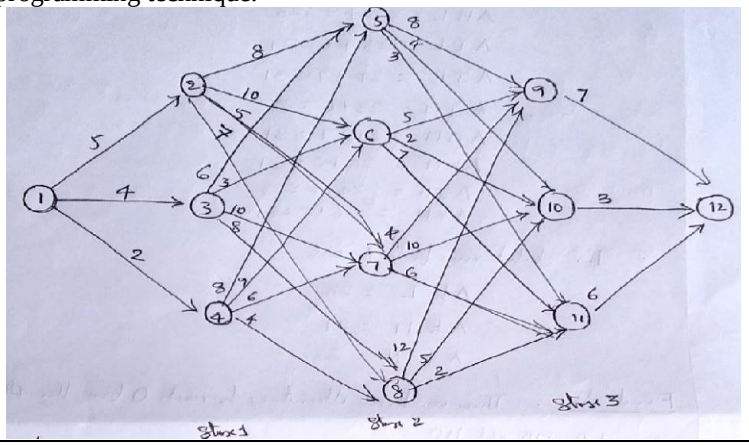
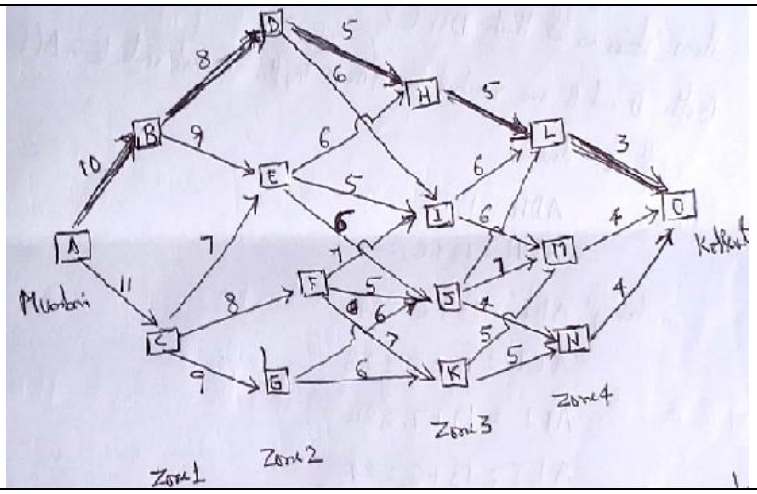
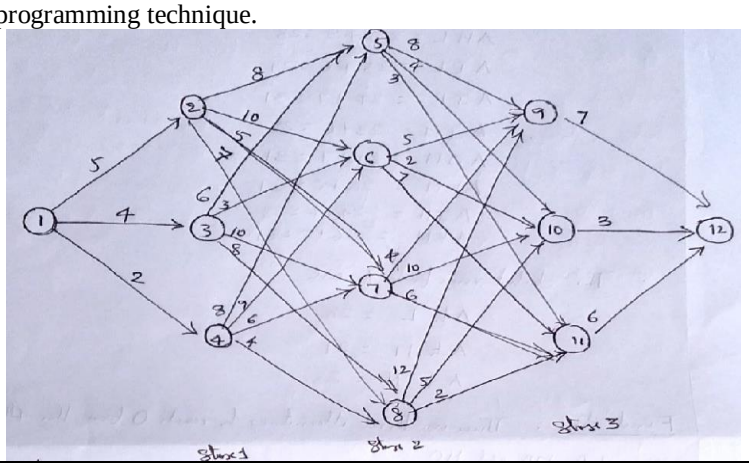
<tr><td rowspan="2">Player One</td><td>Stay</td><td>-6 -6</td><td>2 -2</td></tr>
<tr><td>Swerve</td><td>-2 2</td><td>1 1</td></tr>
</table>
Does either player have a dominant strategy? Explain. If both player A and Player B use this probability mix, what is the chance that they crash?</td><td>Understand</td><td>AHS012.12</td></tr>
</table>

UNIT – IV
Short Answer Questions

S. No.	Question	Blooms Taxonomy Level	Course Learning Outcomes
1	Define dynamic programming.	Remember	AHS012.14
2	Define stage decision.	Remember	AHS012.15
3	Define state and stage.	Remember	AHS012.15
4	Define state variable and decision variable.	Remember	AHS012.15
5	What is immediate and optimal return.	Remember	AHS012.16
6	State Bellman's principle of optimality.	Remember	AHS012.13
7	What are the applications of dynamic programming?	Understand	AHS012.15
8	State the examples of dynamic programming?	Understand	AHS012.16
9	Write recursive equation used in dynamic programming.	Understand	AHS012.16
10	What are the requirements of dynamic programming techniques?	Remember	AHS012.14
11	What are characteristics of dynamic programming?	Remember	AHS012.14
12	What are fundamental concepts of Dynamic Programming?	Remember	AHS012.15
13	What procedure to be followed to convert given L.P. Problem to Dynamic Programming Problem?	Understand	AHS012.16
14	Write recursive equation of dynamic programming and explain about it	Understand	AHS012.16
15	Write mathematical representation of dynamic programming	Remember	AHS012.14
16	How dynamic programming will be useful in selection of advertisement media?	Remember	AHS012.15
17	How dynamic programming will be useful in selection of advertisement media?	Remember	AHS012.15
18	How dynamic programming will be useful in spare part level determination?	Remember	AHS012.15

19	How dynamic programming will be useful in equipment replacement policy?	Remember	AHS012.16
20	How dynamic programming will be useful in inventory control?	Remember	AHS012.13
	Long Answer Questions		
1	Define dynamic programming. What are the characteristics of it?	Remember	AHS012.14
2	Use dynamic programming to solve the following LPP: Maximize Z=3x1+5x2 Subject to x1≤4 x2≤6 3x1+2x2 x1≤18 where $x_1, x_2 \geq 0$	Understand	AHS012.15
3	Maximize $z = 5x_1 + 9x_2$ subject to $-x_1 + 5x_2 \leq 3$ $5x_1 + 3x_2 \leq 27$ $x_1, x_2 \geq 0$ Use dynamic programming to solve the above LPP Problem.	Understand	AHS012.15
4	A vessel is to be loaded with stocks of 3 items. Each item '*i*' has a weight of $w_i$and a value of v_i. The maximum cargo weight the vessel can take is 5 and the details of the three items are as follows: J WJ VJ 1 1 30 2 3 80 3 2 65 Develop the recursive equation for the above case and find the most valuable cargo load without exceeding the maximum cargo weight by using dynamic programming?	Understand	AHS012.16
5	The WORLD HEALTH COUNCIL is devoted to improving health care in the underdeveloped countries of the world. It now has five medical teams available to allocate among three such countries to improve their medical care, health education, and training programs. Therefore, the council needs to determine how many teams (if any) to allocate to each of these countries to maximize the total effectiveness of the five teams. **Thousands of Additional Person-Years of Life** **Country** **Medical Teams** / **1** / **2** / **3** 0 / 0 / 0 / 0 1 / 45 / 20 / 50 2 / 70 / 45 / 70 3 / 90 / 75 / 80 4 / 105 / 110 / 100 5 / 120 / 150 / 130	Understand	AHS012.16
6	Find the shortest path from city A to city J by using dynamic programming technique. 	Understand	AHS012.17

7	Solve the following LPP by using Dynamic Programming technique Maximize z=2x1+5x2 subject to 2x1+x2<=430 2x2<=460 where x1,x2>=0	Understand	AHS012.16
8	Explain fundamental concepts involved in Dynamic Programming Techniques with an example.	Remember	AHS012.14
9	Explain procedure adopted in analysis of dynamic programming with an illustration.	Remember	AHS012.14
10	Explain about formulation of dynamic programming problem with appropriate equations.	Remember	AHS012.14
11	Explain steps involved in finding shortest path by using dynamic programming techniques.	Understand	AHS012.17
12	Find the shortest path from city A to city O by using dynamic programming technique. 	Understand	AHS012.17
13	Find the shortest path from city 1 to city 12 by using dynamic programming technique. 	Understand	AHS012.17
14	Find the longest path from city A to city O by using dynamic programming technique.	Understand	AHS012.17

			
15	Find the longest path from city 1 to city 12 by using dynamic programming technique. 	Understand	AHS012.17
16	Use dynamic programming to solve the above LPP Problem Maximize $z = 8x_1 + 7x_2$ subject to $2x_1 + x_2 \leq 8$, $5x_1 + 2x_2 \leq 15$, where $x_1, x_2 \geq 0$	Understand	AHS012.15
17	Use dynamic programming to solve the above LPP Problem Maximize $z = 4x_1 + 14x_2$ subject to $2x_1 + 7x_2 \leq 21$, $7x_1 + 2x_2 \leq 21$, where $x_1, x_2 \geq 0$	Understand	AHS012.15
18	Use dynamic programming to solve the above LPP Problem Maximize $z = 3x_1 + 4x_2$ subject to $2x_1 + x_2 \leq 40$, $2x_1 + 5x_2 \leq 180$, where $x_1, x_2 \geq 0$	Understand	AHS012.15
19	Use dynamic programming to solve the above LPP Problem Maximize $z = x_1 + 9x_2$ subject to $2x_1 + x_2 \leq 25$, $2x_2 \leq 11$, where $x_1, x_2 \geq 0$	Understand	AHS012.15
20	Use dynamic programming to solve the above LPP Problem Maximize $z = 2x_1 + 4x_2$ subject to $2x_1 + 3x_2 \leq 48$, $x_1 + 3x_2 \leq 42$, $x_1 + x_2 \leq 21$, where $x_1, x_2 \geq 0$	Understand	AHS012.15
Analytical Questions			

<table>
<tr><td>1</td><td>In a cargo-loading problem, there are four items of different weight per unit and value as shown below. The maximum cargo load is restricted to 17 units. How many units of each item is loaded to maximize the value?
<table>
<tr><th>Item (i)</th><th>Weight (w1)</th><th>Value (v1)</th></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
<tr><td>2</td><td>3</td><td>5</td></tr>
<tr><td>3</td><td>4</td><td>7</td></tr>
<tr><td>4</td><td>6</td><td>11</td></tr>
</table></td><td>Understand</td><td>AHS012.17</td></tr>
<tr><td>2</td><td>Solve the given L.P. Model by using dynamic programming technique.
Maximize Z=8x1+7x2
Subject to
2x1+x2≤ 8
5x1+2x2≤ 15
where x1,x2>=0</td><td>Understand</td><td>AHS012.16</td></tr>
<tr><td>3</td><td>Solve the given L.P. Model by using dynamic programming technique.
Maximize Z=3x1+4x2
Subject to
2x1+x2≤ 40
2x1+5x2≤ 180
where x1,x2>=0 and verify solution by using graphical method.</td><td>Understand</td><td>AHS012.16</td></tr>
<tr><td>4</td><td>Solve the following LP problem by dynamic programming:
Maximize Z = 10x1 + 8x2
subject to
2x1 + x2 ≤ 25
3x1 + 2x2 ≤ 45
x2 ≤ 10
x1 ≥ 0, x2 ≥ 0
Verify your solution by solving it graphically.</td><td>Understand</td><td>AHS012.16</td></tr>
<tr><td>5</td><td>Solve the following LP problem by dynamic programming:
Minimize
f (x1, x2) = (50x1 + 0.2x21) + (50x2 + 0.2x22) + 8(x1 − 80)
subject to
x1 ≥ 80
x1 + x2 = 200
x1 ≥ 0, x2 ≥ 0</td><td>Understand</td><td>AHS012.16</td></tr>
<tr><td>6</td><td>Explain procedure to solve given LPP problem by using Dynamic Programming Technique with an illustration.</td><td>Remember</td><td>AHS012.15</td></tr>
<tr><td>7</td><td>Solve the following LPP by using dynamic programming technique:
Maximize Z=3x1+4x2
Subject to
x1+x2≤450
x1+2x2≤600
where x1, x2 ≥ 0</td><td>Understand</td><td>AHS012.16</td></tr>
<tr><td>8</td><td>Solve the following LPP by using dynamic programming technique:
Minimize Z=x1 - 3x2+3x3
Subject to
3x1 - x2+2x3≤7
2x1+4x2 ≥ - 12
- 4x1+3x2+8x3≤10
where x1, x2, x3 ≥ 0</td><td>Understand</td><td>AHS012.16</td></tr>
<tr><td>9</td><td>Solve the following LP Problem by using dynamic programming technique:
Maximize Z=5x1+3x2
Subject to
2x1+x2≤1
x1+4x2≥6
where x1, x2 ≥ 0</td><td>Understand</td><td>AHS012.16</td></tr>
<tr><td>10</td><td>Solve the following LPP by using dynamic programming technique:
Maximize Z=5x1 - 4x2+3x3</td><td>Understand</td><td>AHS012.16</td></tr>
</table>

	Subject to 2x1 +x2 - 6x3=20 6x1+5x2+10x3≤ 76 8x1 - 3x2+6x3≤50 where x1, x2, x3 ≥ 0		
	UNIT – V **Short Answer Questions**		
1	Define quadratic approximation?	Understand	AHS012.18
2	Write short notes on nonlinear programming?	Understand	AHS012.18
3	What are Different types of NLP Problems?	Understand	AHS012.18
4	Write short notes on Lengrangian function?	Understand	AHS012.21
5	What is Gradient ? Give an example.	Remember	AHS012.20
6	Write short note on Hessian matrix?	Remember	AHS012.20
7	Describe constrained and unconstrained problems?	Remember	AHS012.20
8	What is a quadratic objective function?	Remember	AHS012.18
9	Write short notes on Legrangian Multipliers.	Remember	AHS012.21
10	Write short notes on Generalized Reduced Gradient method.	Remember	AHS012.22
11	Define unconstrained optimization with an example.	Understand	AHS012.18
12	Define linear constrained optimization with an example.	Understand	AHS012.18
13	Explain quadratic programming with an illustration.	Understand	AHS012.18
14	Define convex programming.	Understand	AHS012.21
15	Explain separable programming with an example.	Remember	AHS012.20
16	Define non convex programming.	Remember	AHS012.20
17	Which method is used to solve optimization problems having continuous objective function and equality or inequality constrains?	Remember	AHS012.20
18	What are different cases of quadratic approximation methods for constrained problems ?	Remember	AHS012.18
19	Explain different strategies for quadratic approximation.	Remember	AHS012.21
20	What is constrained variable metric method? Explain with an example	Understand	AHS012.18
	Long Answer Questions		
1	Explain Various steps in the Direct Successive Quadratic Programming Solution?	Remember	AHS012.20
2	Compare and contrast features of sub problem generated by Direct quadratic approximation and Quadratic approximation of langrangian function.	Remember	AHS012.21
3	Compare the treatment of inequality constraints in the GRG and CVM algorithms. How do the methods of estimating multiplier values differ?	Remember	AHS012.21
4	Solve the problem Minimize $f(x) = 6x_1 x_2$—1 + $x_2 x_1$—2 Subject to $h(x)$=x1x2—2=0 $g(x) = x1 + x2 — 1 >=0$ From the initial feasible estimate x^0 = (2, 1) using the direct successive quadratic programming (QP) strategy?	Understand	AHS012.20
5	Explain procedure to find quadratic approximation of the Legrangian function? Give one example?	Remember	AHS012.21
6	Explain the Constrained Variable Metric Method in detail with example?	Remember	AHS012.22
7	Explain different strategies of quadratic approximation methods for constrained problems with an example.	Remember	AHS012.22
8	Solve the problem Minimize $f(x) = 6x_1x_2^{-1} + x_2x_1^{-2}$ Subject to $h(x) = x_1x_2 - 2=0$ $g(x) = x_1 + x_2 - 1 >= 0$ From the initial feasible estimate x^0 = (2, 1) using the direct successive quadratic programming (QP) strategy?	Understand	AHS012.20

9	Suppose the CVM algorithm were employed with a problem involving a quadratic objective function and quadratic inequality constraints. How much iteration is likely to be required to solve the problem, assuming exact arithmetic? What assumptions about the problem are likely to be necessary in making this estimate?	Understand	AHS012.22
10	Direct Successive Quadratic Programming Solution in solving non linear programming techniques?	Remember	AHS012.20
11	Differentiate features of sub problem generated by Direct quadratic approximation and Quadratic approximation of langrangian function.	Remember	AHS012.21
12	How equality and inequality constraints in the GRG and CVM algorithms. How do the methods of estimating multiplier values differ?	Remember	AHS012.21
13	Solve the problem Minimize $f(x) = 4x_1 x_2^{-1} + 2 x_2 x_1^{-2}$ Subject to $h(x)=x1x2-2=0$ $g(x) = x_1 + x_2 - 1 >=0$ From the initial feasible estimate $x^0 = (2, 1)$ using the direct successive quadratic programming (QP) strategy?	Understand	AHS012.20
14	What are steps involved to find quadratic approximation of the Legrangian function? Give one example?	Remember	AHS012.21
15	How Constrained Variable Metric Method is used in non linear programming techniques in detail with example?	Remember	AHS012.22
16	What are different strategies of quadratic approximation methods for constrained problems with an example.	Remember	AHS012.22
17	Solve the problem Minimize $f(x) = 4x_1x_2^{-1} + 2x_2x_1^{-2}$ Subject to $h(x) = x_1x_2 - 2=0$ $g(x) = x_1 + x_2 - 1 >= 0$ From the initial feasible estimate $x^0 = (2, 1)$ using the direct successive quadratic programming (QP) strategy?	Understand	AHS012.20
18	If CVM algorithm is employed with a problem involving a quadratic objective function and quadratic inequality constraints. How many iterations are likely to be required to solve the problem, assuming exact arithmetic? What assumptions about the problem are likely to be necessary in making this estimate?	Understand	AHS012.22
19	Solve the problem Minimize $f(x) = 8x_1x_2^{-1} + 6x_2x_1^{-2}$ Subject to $h(x) = x_1x_2 - 2=0$ $g(x) = x_1 + x_2 - 1 >= 0$ From the initial feasible estimate $x^0 = (2, 1)$ using the direct successive quadratic programming (QP) strategy?		
20	Suppose the GRG algorithm were employed with a problem involving a quadratic objective function and quadratic inequality constraints. How many iterations are likely to be required to solve the problem, assuming exact arithmetic? What assumptions about the problem are likely to be necessary in making this estimate?		
Analytical Questions			
1	Given the problem Minimize $f(x) = 3x^2 - 4x$ Subject to $h(x)=2x_1 + x_2 - 4=0$ $g(x) = 37 - x_1^2 - x_2^2 >=0$ the point $x^0=(-1,6)$, and the multiplier values$(v,u)=($ a) Formulate the Legrangian quadratic programming (QP) sub problem. b) Show that $d=0$ is the sub problem solution. c) Show that the point satisfies the second-order conditions for the original problem	Understand	AHS012.21

2	Solve the following LP problem using the branch-and-bound method: Maximize f = 3x1 + 4x2 subject to 7x1 + 11x2 ≤ 88, 3x1 − x2 ≤ 12, x1 ≥ 0, x2 ≥ 0 xi = integer, i = 1, 2	Understand	AHS012.21
3	Solve the problem Minimize $f(x) = 6x_1x_2^{-1} + x_2x_1^{-2}$ Subject to $h(x) = x_1x_2 - 2=0$ $g(x) = x_1 + x_2 - 1 >= 0$ From the initial feasible estimate $x^0 = (2, 1)$ u=0 and v=0 by using the Lagrangian quadratic programming (QP) strategy?	Understand	AHS012.21
4	Solve the problem Minimize $f(x) = 6x_1x_2^{-1} + x_2x_1^{-2}$ Subject to $h(x)=x1x2-2=0$ $g(x) = x1 + x2 - 1 >=0$ From the initial feasible estimate $x^0 = (2, 1)$ using the direct successive quadratic programming (QP) strategy and compare with Lagrangian quadratic programming results.	Understand	AHS012.21
5	Maximize f = 4x1 + 2x2 + 3x3 + c4x4 subject to x1 + x3 + x4 ≤ 24 3x1 + x2 + 2x3 + 4x4 ≤ 48 2x1 + 2x2 + 3x3 + 2x4 ≤ 36i ≥ 0, i = 1 to 4 Where c4 is a discrete random variable that can take values of 4, 5, 6, or 7 with probabilities of 0.1, 0.2, 0.3, and 0.4, respectively. Using Legrangian quadratic programming (QP method, find the solution that maximizes the expected value off)	Understand	CAHS012.21
6	Given the problem Minimize $f(x) = 5x^2 - 6x$ Subject to $h(x)=4x_1+x_2-6=0$ $g(x) = 37 - x_1^2-x_2^2 >=0$ the point $x^0=(-1,6)$, and the multiplier values$(v,u)=($ d) Formulate the Legrangian quadratic programming (QP) sub problem. e) Show that $d=0$ is the sub problem solution. f) Show that the point satisfies the second-order conditions for the original problem	Understand	AHS012.21
7	Solve the following LP problem using the branch-and-bound method: Maximize f = 3x1 + 4x2 subject to 7x1 + 11x2 ≤ 88, 3x1 − x2 ≤ 12, x1 ≥ 0, x2 ≥ 0 xi = integer, i = 1, 2	Understand	AHS012.21
8	Solve the problem Minimize $f(x) = 6x_1x_2^{-1} + x_2x_1^{-2}$ Subject to $h(x) = x_1x_2 - 2=0$ $g(x) = x_1 + x_2 - 1 >= 0$ From the initial feasible estimate $x^0 = (2, 1)$ u=0 and v=0 by using the Lagrangian quadratic programming (QP) strategy?	Understand	AHS012.21
9	Solve the problem Minimize $f(x) = 4x_1x_2^{-1} + 2x_2x_1^{-2}$ Subject to $h(x)=x1x2-2=0$ $g(x) = x1 + x2 - 1 >=0$ From the initial feasible estimate $x^0 = (2, 1)$ using the direct successive quadratic programming (QP) strategy and compare with Lagrangian quadratic programming results.	Understand	AHS012.21

10	Maximize f = 8x1 + 4x2 + 6x3 + 2c4x4 subject to x1 + x3 + x4 ≤ 24 3x1 + x2 + 2x3 + 4x4 ≤ 48 2x1 + 2x2 + 3x3 + 2x4 ≤ 36i ≥ 0, i = 1 to 4 Where c4 is a discrete random variable that can take values of 4, 5, 6, or 7 with probabilities of 0.1, 0.2, 0.3, and 0.4, respectively. Using Legrangian quadratic programming (QP method, find the solution that maximizes the expected value off)	Understand	CAHS012.21

Prepared by:

Mr. R M Noorullah, Associate Professor, Department of CSE HOD, CSE