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Note : Remove "Table of Content" before including in CP Book Each Course Plan shall be printed and made into a book with cover page Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

# 17CS653 : Operations Research

## A. COURSE INFORMATION

## 1. Course Overview

| Degree:              | B.E                 | Program:       | CS       |
|----------------------|---------------------|----------------|----------|
| Semester :           | VI                  | Academic Year: | 2019-20  |
| Course Title:        | OPERATIONS RESEARCH | Course Code:   | 17CS653  |
| Credit / L-T-P:      | 3/3-0-0             | SEE Duration:  | 3 Hours  |
| Total Contact Hours: | 40                  | SEE Marks:     | 60 Marks |
| CIA Marks:           | 40                  | Assignment     | 5        |
| Course Plan Author:  | Dr.Hemalatha K.L.   | Sign:          | Dt:      |
| Checked By:          |                     | Sign:          | Dt:      |

## 2. Course Content

| Mod | Module Content  | Teaching | Module  | Blooms |
|-----|---|----------|---|--------|
| ule |   | Hours    | Concepts  | Level  |
| 1   | Introduction, Linear Programming: Introduction: The origin,<br>nature and impact of OR; Defining the problem and gathering<br>data; Formulating a mathematical model; Deriving solutions<br>from the model; Testing the model; Preparing to apply the<br>model; Implementation . Introduction to Linear Programming<br>Problem (LPP):Prototype example, Assumptions of LPP,<br>Formulation of LPP and Graphical method various examples.  | 8        | Formulate<br>LPP.   | L4     |
| 2   | Simplex Method –1:The essence of the simplex method; Setting<br>up the simplex method; Types of variables, Algebra of the<br>simplex method; the simplex method in tabular form; Tie<br>breaking in the simplex method, Big M method, Two phase<br>method.  | 8        | Solution of<br>Linear Model<br>(simplex<br>method &<br>graphical<br>method) | L4     |
| 3   | Simplex Method –2: Duality Theory -The essence of duality theory, Primal dual relationship, conversion of primal to dual problem and vice versa. The dual simplex method.   | 8        | optimization<br>techniques  | L3     |
| 4   | Transportation and Assignment Problems: The transportation<br>problem, Initial Basic Feasible Solution (IBFS) by North West<br>CornerRule method, MatrixMinima Method, Vogel's<br>Approximation Method. Optimal solution by Modified<br>Distribution Method (MODI). The Assignment problem; A<br>Hungarian algorithm for the assignment problem. Minimization<br>and Maximization varieties in transportation and assignment<br>problems. | 8        | Transportation<br>, Assignment<br>problems                                  | L4     |
| 5   | Game Theory: Game Theory: The formulation of two persons,<br>zero sum games;saddle point, maximin and minimax principle,<br>Solving simple games- a prototype example; Games with<br>mixed strategies; Graphical solution procedure. Metaheuristics:<br>The nature of Metaheuristics, Tabu Search, Simulated<br>Annealing, Genetic Algorithms.  | 8        | Game<br>Theory,Decisio<br>n analysis.                                       | L4     |

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#### 3. Course Material

| Module | Details   | Available     |
|--------|---|---------------|
| 1      | D.S. Hira and P.K. Gupta, Operations Research, (Revised Edition), Published<br>by S. Chand & Company Ltd, 2014  | In Lib        |
| 2      | Reference books   |               |
|        | 1. S Kalavathy, Operation Research, Vikas Publishing H<br>ouse Pvt Limited, 01-Aug-2002   | In Lib        |
|        | 2. S D Sharma, Operation Research,<br>Kedar Nath Ram Nath Publishers.   | In Lib        |
| 3      | Others (Web, Video, Simulation, Notes etc.)   |               |
|        | 1.http://vtuplanet.com/m/download.php?type=papers&dir=B.E+<br>%28Engineering%29%2FInformation+Science+%28ISE<br>%29%2FSem+6%2FOperations+Research%28Elective<br>%29&file=Operations+Research+NOTES+by+Divya+-+RNSIT+<br>%28www.vtuplanet.com%29.pdf | Not Available |
|        | 2. <u>tu.allsyllabus.com/cse/sem_5/index.phpv</u>   |               |

## 4. Course Prerequisites

| SNo | Course<br>Code | Course Name   | Module / Topic / Description  | Sem | Remarks | Blooms<br>Level |
|-----|----------------|---------------|---|-----|---------|-----------------|
| 1   | 15MAT11<br>,21 | Mathematics-I | Students should have knowledge<br>of equation solving, matrices,<br>algorithms and geometry | 1   |         | L3              |
|     | -              |               |   |     |         |                 |
|     |                |               |   |     |         |                 |

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

## **B. OBE PARAMETERS**

### 1. Course Outcomes

| #         | Cos                                  | Teach. | Concept      | Instr     | Assessmen  | Blooms' |
|-----------|--------------------------------------|--------|--------------|-----------|------------|---------|
|           | ł                                    |        |              | Method    | t Method   | Level   |
| 15CS653.1 | Formulate the LPP for the given data | 8      | Formulate    | Discussio | Assignment | L4      |
|           |                                      |        | LPP.         | n         |            | Analyze |
| 15CS653.2 | Apply the Graphical and Simplex      | 8      | Solution for | Problem   | Slip test  | L4      |
|           | method to solve the LPP, game.       |        | Linear       | solving   |            | Analyze |
|           |                                      |        | Model        |           |            |         |
|           |                                      |        | (simplex     |           |            |         |
|           |                                      |        | method &     |           |            |         |
|           |                                      |        | graphical    |           |            |         |
|           |                                      |        | method)      |           |            |         |
| 15CS653.3 | Select and apply optimization        | 8      | optimization | Lecture   | Seminar    | L4      |
|           | techniques for various problems.     |        | techniques   |           |            | Analyze |
| 15CS653.4 | Demonstrate skills in forming and    | 8      | Transportati | Problem   | Assignment | L4      |
|           | solving assignment problems,T        |        | on ,         | solving   |            | Analyze |
|           | ransportation problems               |        | Assignment   |           |            |         |

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| C.  | Title:                   | Course Plan P  |                |   |             |         |      |      | 4 / 24  |  |
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|   |                          |                |                |   | problems    |         |      |      |         |  |
| 15CS653.5Apply game theory, decision analysis<br>for decision support system to |                          |                |                | 8 | Game        | Problem | Slip | test | L4      |  |
|   |                          |                |                |   | Theory,Deci | solving |      |      | Analyze |  |
|   | construct decis          | sion tree      |                |   | sion        |         |      |      |         |  |
|   |                          |                |                |   | analysis.   |         |      |      |         |  |

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Total 40 Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

## 2. Course Applications

-

| SNo | Application Area  | СО  | Level |
|-----|---|-----|-------|
| 1   | Food and Agriculture<br>Farmers apply linear programming techniques to their work. By determining what<br>crops they should grow, the quantity of it and how to use it efficiently, farmers can<br>increase their revenue.                      | CO1 | L4    |
| 2   | Applications in Engineering<br>Engineers also use linear programming to help solve design and manufacturing<br>problems. For example, in airfoil meshes, engineers seek aerodynamic shape<br>optimization.                                      |     |       |
|     | Transportation Optimization<br>Transportation systems rely upon linear programming for cost and time efficiency.<br>Bus and train routes must factor in scheduling, travel time and passengers.   | CO3 | L4    |
| 4   | Efficient Manufacturing<br>Manufacturing requires transforming raw materials into products that maximize<br>company revenue.  | CO4 | L4    |
| 5   | Linear programming is used to obtain <b>optimal</b> solutions for operations research.<br>Using linear programming allows researchers to find the best, most economical<br>solution to a problem within all of its limitations, or constraints. | CO5 | L4    |
| 6   | Widely used in business and economics, and is also utilized for some engineering problems Industries that use linear programming models include transportation, energy, telecommunications, and manufacturing                                   |     | L4    |

Note: Write 1 or 2 applications per CO.

# 3. Articulation Matrix

#### (CO - PO MAPPING)

| -   | Course Outcomes                 |     | Program Outcomes |     |     |     |    |     |    |     |     |     |     |       |
|-----|---------------------------------|-----|------------------|-----|-----|-----|----|-----|----|-----|-----|-----|-----|-------|
| #   | COs                             | PO1 | PO2              | PO3 | PO4 | PO5 | PO | PO7 | PO | PO9 | PO1 | PO1 | PO1 | Level |
|     |                                 |     |                  |     |     |     | 6  |     | 8  |     | 0   | 1   | 2   |       |
| CO1 | Formulate the LPP for the given | 2   | 2                | 3   | 2   | -   | 2  | 2   | -  | 1   |     |     | 2   | L4    |
|     | data                            |     |                  |     |     |     |    |     |    |     |     |     |     |       |
| CO2 | Apply the Graphical and Simplex | 2   | 2                | 3   | 2   |     | 1  | 2   |    | 2   |     |     | 2   | L4    |
|     | method to solve the LPP, game.  |     |                  |     |     |     |    |     |    |     |     |     |     |       |

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| CO3              | Select and<br>techniques for                    | apply optimization<br>various problems.                      | 1    | 2     | 2     | 3    |   | 2 | 2 |                 | 2   |              |  | 3 | L4 |
| CO4              | Demonstrate s<br>solving assig<br>ransportation | skills in forming and<br>Inment problems,T<br>problems       | 2    | 3     | 3     | 1    |   | 1 | 2 |                 | 2   |              |  | 2 | L4 |
| CO5              | Apply game<br>analysis for<br>system to con     | theory, decision<br>decision support<br>struct decision tree | 1    | 2     | 2     | 2    |   | 1 | 2 |                 | 2   |              |  | 2 | L4 |
| CSPC.            | Average   |  |      |       |       |      |   |   |   |                 |     |              |  |   |    |
| Note: Men        | tion the mapp                                   | ing strength as 1, 2,  | or 3 |       |       |      |   |   |   |                 |     |              |  |   |    |

4. Mapping Justification

| Map | ping | Justification  |    |  |  |  |
|-----|------|--|----|--|--|--|
| со  | PO   | -  | -  |  |  |  |
| CO1 | PO1  | The knowledge of mathematical principles will help the students to apply the same to formulate solutions for engineering problems.     | L4 |  |  |  |
| CO1 | PO2  | Fundamental knowledge in complex analysis will help to analyze the engineering problems easily.  | L4 |  |  |  |
| CO1 | PO3  |  | L4 |  |  |  |
| CO1 | PO4  |  | L4 |  |  |  |
| CO1 | PO5  | No content tool, no mapping  |    |  |  |  |
| CO1 | PO6  |  | L4 |  |  |  |
| CO1 | PO7  |  | L4 |  |  |  |
| CO1 | PO8  | No matching for ethical principles   |    |  |  |  |
| CO1 | PO9  | Student will develop individual knowledge to work in a team or individually .  |    |  |  |  |
| CO1 | PO10 | No mapping.  |    |  |  |  |
| CO1 | PO11 | No mapping.  |    |  |  |  |
| CO1 | PO12 |  | L4 |  |  |  |
| CO2 | PO1  | The knowledge of simplex and graphical method is required to find<br>the solution of complex engineering problems                      | L4 |  |  |  |
| CO2 | PO2  |  | L4 |  |  |  |
| CO2 | PO3  |  | L4 |  |  |  |
| CO2 | PO4  |  | L4 |  |  |  |
| CO2 | PO5  | No content tool, no mapping  |    |  |  |  |
| CO2 | PO6  | Complex analysis may address various society related problems.   | L4 |  |  |  |
| CO2 | PO7  |  | L3 |  |  |  |
| CO2 | PO8  | No matching for ethical principles   |    |  |  |  |
| CO2 | PO9  |  |    |  |  |  |
| CO2 | PO10 | No mapping.  |    |  |  |  |
| CO2 | PO11 | No mapping.  |    |  |  |  |
| CO2 | PO12 | Study of graphical & simplex method is required if students want to start-up their companies.  | L4 |  |  |  |
| CO3 | PO1  |  | L4 |  |  |  |
| CO3 | PO2  | Students can formulate the complex problem as linear programming model and obtain solution to optimize the result.                     | L4 |  |  |  |
| CO3 | PO3  | Design solutions for complex engineering problems like transportation & assignment   | L3 |  |  |  |
| CO3 | PO4  | Students can formulate the complex problem as linear programming model ,can apply all methods obtain solution to give some conclusion. | L4 |  |  |  |
| CO3 | PO4  | No content tool, no mapping  |    |  |  |  |
| CO3 | PO6  | By understanding mathematical principles and LPP students can apply contextual knowledge to assess solution to complex                 | L4 |  |  |  |

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|                     | <b>DO</b> -             | engineering problems  |   |        |  |  |
| CO3                 | PO7                     | I horough understanding optimizing techniques they can k        | now the   | L3     |  |  |
|                     |                         | environmental contexts.   |   |        |  |  |
| <u> </u>            | P08                     | vo matching.  |   |        |  |  |
| CO3                 | P09                     | Student will develop individual knowledge to work in a tear     | tudent witt develop individual knowledge to work in a team or |        |  |  |
|                     |                         | Individually as a decision analyst.                             |   |        |  |  |
| <u> </u>            | P010                    | No mapping.   |   |        |  |  |
| <u> </u>            | PO11                    | ino mapping.  |   |        |  |  |
| CO3                 | P012                    | Study of optimizing techniques is required.                     |   | L3     |  |  |
| C04                 | PO1                     | Fundamental knowledge in complex analysis will help to ar       | ialyze  | L4     |  |  |
|                     | - DOa                   | the engineering problems very easily.                           |   | 1.4    |  |  |
| C04                 | PO2                     | Students can formulate the complex problem as mathemat          | ICal  | L4     |  |  |
|                     |                         | model and analyze the problem .                                 |   |        |  |  |
|                     | DOa                     | Design colutions for complex angine arise print and large using |   | 1.4    |  |  |
| 04                  | P03                     | transportation & assignment                                     |   | L4     |  |  |
|                     |                         | Indispondition & dssignment.                                    | had thay  | 1.4    |  |  |
| 04                  | P04                     | inforough understanding transportation & assignment met         | nou they  | L4     |  |  |
| CO4                 | DO 4                    | Can conduct investigation of complex problems can be sold       | eu on .   |        |  |  |
| CO4                 | P04                     | Complex analysis may address various society related prob       | lome  | 1.4    |  |  |
| <u> </u>            | P00                     | Complex analysis may address various society related prob       |   | L4     |  |  |
| 04                  | P07                     | Inorough understanding transportation & assignment the          | y Carr  |        |  |  |
|                     |                         | arise in a range of fields                                      | Jinnent   |        |  |  |
| CO4                 | DO8                     | No matching for othical principlos                              |   |        |  |  |
| CO4                 | PO0                     | Student will develop individual knowledge to work in a team or  |   |        |  |  |
| 004                 | FOg                     | individually  |   |        |  |  |
| <u> </u>            | PO10                    | No mapping  |   |        |  |  |
| CO4                 | PO10                    | No mapping.   |   |        |  |  |
| CO4                 | PO12                    | Study of transportation & assignment is required if students    | want to   | 10     |  |  |
| 004                 | FOIZ                    | work in manufacturing business based companies                  | want to   | ∟3     |  |  |
| COF                 | PO1                     | The knowledge of game theory and decision analysis is reg       | uired to  | LA     |  |  |
| 665                 | 101                     | find the solution of complex engineering problems.              |   | 64     |  |  |
| C.O.5               | PO2                     | Students can formulate the complex problem as game the          | )rv   | LΛ     |  |  |
|                     | 1.02                    | model and obtain solution.                                      | ,, y  |        |  |  |
| CO5                 | PO3                     | Design solutions for complex engineering problems using c       | ame   | 4      |  |  |
|                     | . 05                    | theory solution often used in political, economic, and militar  | v   |        |  |  |
|                     |                         | planning.   | ,   |        |  |  |
| CO5                 | PO4                     | Thorough understanding game theory method they can co           | nduct   | L4     |  |  |
|                     |                         | investigation of complex problems can be solved for exam        | ple   |        |  |  |
|                     |                         | much progress has been made in applying game theoretic          | models  |        |  |  |
|                     |                         | to a wide range of economic problems.                           |   |        |  |  |
| CO5                 | PO5                     | No content tool, no mapping                                     |   |        |  |  |
| CO5                 | PO6                     | It has hardly been used to tackle safety management in mu       | lti-plant   | L3     |  |  |
|                     |                         | chemical industrial settings.                                   |   |        |  |  |
| CO5                 | PO7                     | Thorough understanding game theory they can know the            |   | L4     |  |  |
|                     |                         | environmental contexts. Problems related to game theory a       | rise in a   |        |  |  |
|                     |                         | range of fields,  |   |        |  |  |
| CO5                 | PO8                     | No matching for ethical principles                              |   |        |  |  |
| CO5                 | PO9                     | Student will develop individual knowledge to work in a tear     | n or  |        |  |  |
|                     |                         | individually .  |   |        |  |  |
| CO5                 | PO10                    | No mapping.   |   |        |  |  |
| CO5                 | PO11                    | No mapping.   |   |        |  |  |
| CO5                 | PO12                    | Study of game theory is required if students want to progre     | ss in   | L3     |  |  |
|                     |                         | analytics field.  |   |        |  |  |

Note: Write justification for each CO-PO mapping.

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## 5. Curricular Gap and Content

| SNo | Gap Topic | Actions Planned | Schedule Planned | Resources Person | PO Mapping |
|-----|-----------|-----------------|------------------|------------------|------------|
| 1   |           |                 |                  |                  |            |
| 2   |           |                 |                  |                  |            |
| 3   |           |                 |                  |                  |            |
| 4   |           |                 |                  |                  |            |
| 5   |           |                 |                  |                  |            |
|     |           |                 |                  |                  |            |
|     |           |                 |                  |                  |            |

Note: Write Gap topics from A.4 and add others also.

#### 6. Content Beyond Syllabus

| SNo | Gap Topic | Actions Planned | Schedule Planned | Resources Person | PO Mapping |
|-----|-----------|-----------------|------------------|------------------|------------|
| 1   |           |                 |                  |                  |            |
| 2   |           |                 |                  |                  |            |
| 3   |           |                 |                  |                  |            |
| 4   |           |                 |                  |                  |            |
| 5   |           |                 |                  |                  |            |
| 6   |           |                 |                  |                  |            |
| 7   |           |                 |                  |                  |            |
| 8   |           |                 |                  |                  |            |
| 9   |           |                 |                  |                  |            |
| 10  |           |                 |                  |                  |            |
|     |           |                 |                  |                  |            |
|     |           |                 |                  |                  |            |
|     |           |                 |                  |                  |            |

Note: Anything not covered above is included here.

## C. COURSE ASSESSMENT

## 1. Course Coverage

| Mod | Title  | Title Teaching No. of question in Exam |       |       |       |     |       |     | CO          | Levels |
|-----|--|--|-------|-------|-------|-----|-------|-----|-------------|--------|
| ule |  | Hours                                  | CIA-1 | CIA-2 | CIA-3 | Asg | Extra | SEE |             |        |
| #   |  |  |       |       |       |     | Asg   |     |             |        |
| 1   | Introduction, Linear Programming:<br>Introduction: The origin, nature and<br>impact of OR; Defining the problem<br>and gathering data; Formulating a<br>mathematical model; Deriving<br>solutions from the model; Testing<br>the model; Preparing to apply the<br>model; Implementation .<br>Introduction to Linear Programming<br>Problem (LPP):Prototype example,<br>Assumptions of LPP, Formulation of<br>LPP and Graphical method various<br>examples. | 8                                      | 2     |       |       | 1   | 1     | 2   | CO1,<br>CO2 | L2,L4  |
| 2   | Simplex Method -1:The essence of   | 8                                      | -     | 2     | -     | 1   | 1     | 2   | C02         | L4     |
|     | the simplex method; Setting up the   |  |       |       |       |     |       |     |             |        |
|     | simplex method; Types of   |  |       |       |       |     |       |     |             |        |
|     | variables, Algebra of the simplex  |  |       |       |       |     |       |     |             |        |

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|----|--|--|--|----|---|---|---|---|---|-----|------------|------|
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|    |  | Title:   | Course Plan  |    |   |   |   |   |   | Pag | ge: 8 / 2  | 4    |
|    | method;  | the simp   | lex method in  |    |   |   |   |   |   |     |            |      |
|    | tabular  | breaking in the  |  |    |   |   |   |   |   |     |            |      |
|    | simplex  | method, I  | Big M method,  |    |   |   |   |   |   |     |            |      |
|    | Two pha  | se method.   |  |    |   |   |   |   |   |     |            |      |
| 3  | Simplex<br>-The es<br>Primal d<br>of prima<br>versa. Th  | Method –2<br>ssence of<br>ual relation<br>I to dual pr<br>ne dual simp   | : Duality Theory<br>duality theory,<br>ship, conversion<br>oblem and vice<br>olex method.  | 8  | - | - | 2 | 1 | 1 | 2   | CO3        | L4   |
| 4  | Transpor<br>Problem<br>problem<br>Solution<br>CornerRi<br>Method,<br>Method,<br>Modified<br>(MODI). T<br>Hungaria<br>assignm<br>and M<br>transpor<br>problem | rtation an<br>Is: The<br>(IBFS) b<br>Ule method<br>Vogel's<br>Optimal<br>Distribu<br>The Assignr<br>an algorit<br>ent proble<br>laximization<br>tation an<br>Is. | d Assignment<br>transportation<br>Basic Feasible<br>y North West<br>d, MatrixMinima<br>Approximation<br>solution by<br>ution Method<br>nent problem; A<br>thm for the<br>m. Minimization<br>varieties in<br>d assignment | 8  | 2 | - | - | 1 | 1 | 2   | CO4        | L4   |
| 5  | Game T<br>formulat<br>sum gar<br>and mi<br>simple<br>example<br>strategie<br>procedu<br>nature<br>Search,<br>Genetic   | heory: Gar<br>ion of two<br>mes;saddle<br>inimax pri<br>games-<br>e; Games<br>es; Graph<br>re. Metah<br>of Metah<br>Simulate<br>Algorithms.                      | ne Theory: The<br>persons, zero<br>point, maximin<br>nciple, Solving<br>a prototype<br>with mixed<br>nical solution<br>neuristics: The<br>euristics, Tabu<br>ed Annealing,   | 8  | - | 2 | 2 | 1 | 1 | 2   | CO5        | L4   |
| -  |  | Tota   | .l   | 40 | 4 | 4 | 4 | 5 | 5 | 10  | -          | -    |

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

## 2. Continuous Internal Assessment (CIA)

| E velve tieve               | W/ - i Marylan     | 00         | L av sala   |
|-----------------------------|--------------------|------------|-------------|
| Evaluation                  | Weightage in Marks | 00         | Levels      |
| CIA Exam – 1                | 15                 | CO1,CO4    | L2,L4,L3,L4 |
| CIA Exam – 2                | 15                 | CO2, CO5   | L4,L4,L3,L4 |
| CIA Exam – 3                | 15                 | CO3, CO5   | L3,L2,L3    |
|                             |                    |            |             |
| Assignment - 1              | 05                 | CO1,CO4    | L2,L4,L3,L4 |
| Assignment - 2              | 05                 | CO2, CO5   | L4,L4,L3,L4 |
| Assignment - 3              | 05                 | CO3, CO5   | L3,L2,L3    |
|                             |                    |            |             |
| Seminar - 1                 |                    |            |             |
| Seminar - 2                 |                    |            |             |
| Seminar - 3                 |                    |            |             |
|                             |                    |            |             |
| Other Activities – define – |                    | CO1 to Co5 | L2, L3, L4  |

| (And the second | SKIT                     | Teach          | ning Process | Rev No.: 1.0    |
|---|--------------------------|----------------|--------------|-----------------|
|   | Doc Code:                | INST.Ph5b1.F02 |              | Date: 23-3-2020 |
|   | Title:                   | Course Plan    |              | Page: 9 / 24    |
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|   |                          |                | 1            | 1               |

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Slip test

Final CIA Marks

Note : Blooms Level in last column shall match with A.2 above.

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## D1. TEACHING PLAN - 1

Module - 1

| Title: | ntroduction to the concept of automata theory Finite state machine.        | Appr       | 16 Hrs |
|--------|--|------------|--------|
|        |  | Time:      |        |
|        |  |            |        |
|        | Course Outcomes  |            | Pleams |
| d      | The student should be able to:   | -          | Lovel  |
| -      | Formulate the LDD for the given date                                       | -          | Level  |
| 1      | Formulate the LPP for the given data                                       | <u>CO1</u> | L4     |
| h      | Courses Cohodula   |            |        |
|        | Course Scriedule   | -          | -      |
|        | Module Content Covered   |            | Level  |
| 1      | Introduction, Linear Programming: Introduction: The origin, nature and     | C01        | L2     |
|        | impact of OR, Defining the problem and gathering data, Formulating a       |            |        |
|        | mathematical model, Deriving solutions from the model, resting the         |            |        |
| 2      | Introduction to Linear Drogramming Droblem (LDD): Drototy no overmole      | CO1        |        |
| 2      | Introduction to Linear Programming Problem (LPP). Prototype example        |            | L3     |
| 3      | Introduction to Linear Programming Problem (LPP). Prototype example        |            | L3     |
| 4      | Assumptions of LPP, Formulation of LPP.                                    |            | L4     |
| 5      | Assumptions of LPP, Formulation of LPP.                                    |            | L4     |
| 6      | Formulation of LPP.  | CO1        | L4     |
| 7      | Formulation of LPP.  | CO1        | L4     |
| 8      | Graphical method various examples.   | CO1        | L4     |
| 9      | Graphical method various examples.   | ļ          |        |
| 10     | Graphical method various examples.   | ļ          |        |
|        |  |            |        |
| C      | Application Areas  | CO         | Level  |
| 1      | Food and Agriculture   | CO1        | L2     |
|        | Farmers apply linear programming techniques to their work. By              |            |        |
|        | determining what crops they should grow, the quantity of it and how to     |            |        |
|        | use it efficiently, farmers can increase their revenue.                    |            |        |
|        |  |            |        |
| 2      | Among all the mathematical optimization techniques, linear programming     | CO1        | L4     |
|        | is perhaps the most used and best understood by the business and           |            |        |
|        | industrial community, healthcare,Entertainment,finance etc.                |            |        |
|        |  |            |        |
| d      | Review Questions   | _          | -      |
| 1      | Discuss the scope of Operations Research.                                  | CO1        | L2     |
| 2      | What is operation research? Explain origin and the six phases of operation | CO1        | L2     |
|        | research.  |            |        |
| 3      | A retail store stocks two types of shirts A and B. These are packed in     | CO1        | L2     |
|        | attractive cardboard boxes. During a week the store can sell a maximum     |            |        |
|        | of 400 shirts of type A and a maximum of 300 shirts of type B. The storage |            |        |
|        | capacity, however, is limited to a maximum of 600 of both types            |            |        |
|        | combined. Type A shirt fetches a profit of Rs. 2/- per unit and type B a   |            |        |
|        | profit of Rs. 5/- per unit. How many of each type the store should stock   |            |        |
|        | per week to maximize the total profit? Formulate a mathematical model      |            |        |
|        | of the problem.  |            |        |
| 4      | Old hens can be bought at Rs. 50/- each but young ones cost Rs. 100/-      | CO1        | L2     |
|        | each. The old hens lay 3 eggs/week and young hens 5 eggs/week. Each        |            |        |
|        | egg costs Rs. 2/ A hen costs Rs. 5/- per week to fee. If a person has only |            |        |
| 1      | IRS. 2000/- to spend for hens, formulate the problem to decide how many    | í I        |        |

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| 6 Section Con      | SKIT  | Teaching Process  | Rev No.: 1.0 |          |  |  |  |  |  |
|--------------------|---|---|--------------|----------|--|--|--|--|--|
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| Certa and a second | Title:  | Course Plan   | Page: 1      | .0 / 24  |  |  |  |  |  |
| Сорупупт ©201      | of each kind of   | hen should he buy? Assume that he cannot house more           |              |          |  |  |  |  |  |
|                    | than 40 hens.   | nen should ne buy . Assume that he cannot house more          |              |          |  |  |  |  |  |
| 5                  | A computer cor  | npany manufactures laptops & desktops that fetches profit     | CO1          | L4       |  |  |  |  |  |
|                    | of Rs. 700/- & 500/- unit respectively. Each unit of laptop takes 4 hours of assembly time & 2 hours of testing time while each unit of desktop |   |              |          |  |  |  |  |  |
|                    | requires 3 hours  | s of assembly time & 1 hour for testing. In a given month the |              |          |  |  |  |  |  |
|                    | total number of   | hours available for assembly is 210 hours & for inspection    |              |          |  |  |  |  |  |
|                    | is 90 hours. Formulate the problem as LPP in such a way that the total  |   |              |          |  |  |  |  |  |
| 6                  | A toy company   | manufactures two types of dolls, a basic version-doll A and   | CO1          | L4       |  |  |  |  |  |
|                    | a deluxe version  | n- doll B. Each doll of type B takes twice as long to         |              |          |  |  |  |  |  |
|                    | produce as one  | of type A and the company would have time to make             |              |          |  |  |  |  |  |
|                    | maximum of 20   | 00 dolls per day. The supply of plastic is sufficient to      |              |          |  |  |  |  |  |
|                    | produce 1500 d  | oils per dayl Both A & B combined). The deluxe version        |              |          |  |  |  |  |  |
|                    | company make  | s a profit of Rs. 10/- & Rs. 18/- per doll on doll A & B      |              |          |  |  |  |  |  |
|                    | respectively, the   | en how many of each doll should be produced per day in        |              |          |  |  |  |  |  |
|                    | order to maximi   | ize the total profit. Formulate the problem as LPP.           |              |          |  |  |  |  |  |
| 7                  | The standard w  | eight of a special purpose brick is 5Kg and it contains two   | CO1          | L4       |  |  |  |  |  |
|                    | Ingredients B1 &  | & B2. B1 cost Rs. 5/- per kg & B2 costs Rs. 8/- per kg.       |              |          |  |  |  |  |  |
|                    | of B1 & a minim   | um of 2 kg of B2, since the demand for the product is likely. |              |          |  |  |  |  |  |
|                    | to be related to  | the price of the brick. Formulate the above problem as LP     |              |          |  |  |  |  |  |
|                    | model.  |   |              |          |  |  |  |  |  |
| 8                  | A marketing ma  | anager wishes to allocate his annual advertising budget of    | CO1          | L2       |  |  |  |  |  |
|                    | Rs. 20,000 in tw  | ro media group M & N. The unit cost of the message in the     |              |          |  |  |  |  |  |
|                    | media 'M' is Rs.  | 200 & 'N' is Rs. 300. The media M is monthly magazine &       |              |          |  |  |  |  |  |
|                    | mot more than t<br>messages shou  | ild appear in the media N. The expected effective audience    |              |          |  |  |  |  |  |
|                    | per unit messad   | the for media M is 4.000 & for N is 5.000. Formulate the      |              |          |  |  |  |  |  |
|                    | problem as Line   | ear Programming problem.                                      |              |          |  |  |  |  |  |
|                    | <u> </u>  |   |              |          |  |  |  |  |  |
| e                  | Experiences   |   | -            | -        |  |  |  |  |  |
| 2                  |   |   | COI          | L2       |  |  |  |  |  |
| 3                  |   |   |              |          |  |  |  |  |  |
| 4                  |   |   | CO1          | L3       |  |  |  |  |  |
| 5                  |   |   |              |          |  |  |  |  |  |

# Module – 4

| Title:   | Transportation and Assignment Problems                                  | Appr  | 10 Hrs |
|----------|---|-------|--------|
|          |   | Time: |        |
|          |   |       |        |
| a        | Course Outcomes   | -     | Blooms |
| -        |   | -     | Level  |
| 1        | Demonstrate skills in forming and solving assignment problems,T         | CO4   | L4     |
|          | ransportation problems  |       |        |
|          |   |       |        |
| b        | Course Schedule   | -     | -      |
| Class No | Module Content Covered  | CO    | Level  |
| 11       | The transportation problem  | CO4   | L2     |
| 12       | Initial Basic Feasible Solution (IBFS) by North West CornerRule method, | CO4   | L2     |
|          | MatrixMinima Method, Vogel's Approximation Method.                      |       |        |
| 13       | Initial Basic Feasible Solution (IBFS) by North West CornerRule method, | CO4   | L3     |
|          | MatrixMinima Method, Vogel's Approximation Method.                      |       |        |

| Comun o |  | SK             | IT            |                    |               |          | Teac     | hing F             | Proc       | ess          | 5         |           |      | Rev No.: | 1.0    |
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| ( s     | ))) [  | )oc C          | Code: II      | le: INST.Ph5b1.Fo2 |               |          |          |                    | Date: 23-  | 3-2020       |           |           |      |          |        |
|         |  | Titl           | le: C         | Course Plan        |               |          |          |                    |            |              | Page: 11  | / 24      |      |          |        |
|         | Initia   | al Ra          | sic Feas      | sible S            | olution       | (IBES    | ) by N   | Jorth              | W/e        | st (         | CornerR   | ile meth  | bod  | COA      | 13     |
|         | Matr   | ixMir          | nima Me       | thod, \            | /ogel's       | Appro    | oximat   | tion N             | 1eth       | od.          |           |           |      | 004      | -5     |
| 15      | Optii  | mal s          | olution       | by Moo             | dified D      | istribu  | ution N  | Netho              | d (N       | 40[          | ))        |           |      | CO4      | L4     |
| 16      | The Assignment problem; A Hungarian algorithm for the assign |                |               |                    |               |          |          |                    |            |              |           | assignm   | ent  | CO4      | L2     |
|         | prob   | lem            |               |                    |               |          |          |                    |            |              | <u> </u>  |           |      |          | 1      |
| 17      | Ine  | ASSI           | gnment        | probl              | em; A         | Hung     | garian   | algo               | rith       | m            | for the   | assignm   | ient | CO4      | L4     |
| 18      | Minir  | nizat          | ion and       | Maxin              | nizatior      | ı varie  | eties ir | n tran             | spo        | rtat         | ion and   | assignm   | ent  | CO4      | L3     |
| 19      | prob<br>Minir  | lems<br>nizat  | s.<br>ion and | Maxin              | nizatior      | ı varie  | ties ir  | n tran             | spo        | rtat         | ion and   | assignm   | ent  | CO4      | L4     |
|         | prob   | lems           | <u>.</u>      |                    |               | <u> </u> |          |                    |            |              |           |           |      |          |        |
| 20      | Minii<br>prob  | nizat<br>lems  | ion and<br>5. | Maxin              | nization      | i varie  | eties ir | n tran             | spo        | rtat         | ion and   | assignm   | ient | CO4      | L4     |
|         | Ann  | icati          | on Area       | c                  |               |          |          |                    |            |              |           |           |      | 00       | l evel |
| 1       | Dem  | onst           | rate skil     | ls in foi          | rmina a       | ind so   | lvina    | assia              | nme        | ent          | problem   | IS.       |      | CO4      | L3     |
|         | Tran   | sport          | tation pr     | oblem              | S.            |          |          |                    |            |              |           |           |      |          | _0     |
|         |  |                |               |                    |               |          |          |                    |            |              |           |           |      |          |        |
| d       | Revi   | ew G           | uestion       | IS                 |               |          |          |                    |            |              |           |           |      | -        | -      |
| 1       | Find   | initia         | l Basic F     | easibl             | e solut       | ion fo   | r the f  | ollow              | ring       | T.P          | . Using a | Ill metho | ds . | CO4      | L3     |
|         |  |                |               | 1                  | 2             |          | 3        | Sup                | pl         | 1            |           |           |      |          |        |
|         |  |                |               | _                  |               |          |          | У                  |            |              |           |           |      |          |        |
|         |  |                | 1             | 5                  | 1             |          | 7        | 10                 |            | -            |           |           |      |          |        |
|         |  |                | 2             | 6                  | 4             |          | о<br>-   | 80                 |            | -            |           |           |      |          |        |
|         |  |                | <u> </u>      | <u> </u>           | 2             |          | 5<br>50  | 15                 |            | -            |           |           |      |          |        |
|         |  |                | d             | ' /5               | 20            | ;        | 50       |                    |            |              |           |           |      |          |        |
| 2       | Defir  | ne de          | egenera       | cv in <sup>-</sup> | T.P .Fin      | d opt    | imal s   | soluti             | on f       | or           | the follo | wing T.   | Ρ&   | CO4      | L4     |
|         | form   | ulate          | e as a ma     | athema             | atical m      | nethoo   | d.       |                    |            |              |           | 0         |      |          |        |
|         |  |                |               |                    | 1             |          |          |                    | -          |              |           | <u> </u>  | ,    |          |        |
|         |  |                |               | 1                  | 2             | 3        | 4        |                    | 5          |              | 6         | Suppl     |      |          |        |
|         |  | 1              |               | 0                  | 12            |          | 6        |                    | 0          |              | 10        | <u>y</u>  |      |          |        |
|         |  | 2              |               | 7                  | 3             | 7        | 7        | ,                  | 5          |              | 5         | <u> </u>  |      |          |        |
|         |  | 3              |               | 6                  | 5             | 9        | 1        | 1                  | 3          |              | 11        | 2         |      |          |        |
|         |  | 4              |               | 6                  | 8             | 11       | 2        |                    | 2          |              | 10        | 9         |      |          |        |
|         |  | D              | emand         | 4                  | 4             | 6        | 2        |                    | 4          |              | 2         |           |      |          |        |
| 3       | The  | proc           | luction       | capaci             | ties of       | the      | factor   | ies a              | re 1       | 000          | 0,700,90  | o units   | per  | CO4      | L4     |
|         | mon  | th .th         | ne requ       | iremer             | nts fror      | n the    | deal     | ers a              | re (       | 900<br>trar  | ,800,50   | 0 & 400   | 250  |          |        |
|         | Rs 8   | niils p<br>7 & | o at          | throo              | facto         | ris the  | foll     | owing              | ing<br>n t | urar<br>abli | sportati  | unit      | are  |          |        |
|         | 1.3.0,   | trans          | portatio      | n cost             | s from        | the fa   | actorie  | es to              | the        | de           | alers.de  | termine   | the  |          |        |
|         | optir  | num            | solutior      | n to ma            | iximize       | the to   | oatl re  | turns.             |            |              |           |           |      |          |        |
|         |  |                |               |                    |               |          |          |                    |            |              |           |           |      |          |        |
|         |  |                | _             | 1                  | 2             | 3        | 4        |                    |            |              |           |           |      |          |        |
|         |  |                |               | 2                  | 2             | 2        | 4        |                    |            |              |           |           |      |          |        |
|         |  |                | C.            | 3                  | <u>5</u><br>२ | 2        | 1        |                    |            |              |           |           |      |          |        |
| 4       | A pro  | oduc           | t is prod     | luced b            | by 4 fac      | tories   | f1f,2,f  | <sup>:</sup> 3 &f∠ | 1.Th       | neir         | unit pro  | duction   |      | CO4      | L4     |
|         | cost   | s are          | Rs. 2,3,1     | .,&5.uni           | t costs       | of tra   | nspor    | tation             | , ,p       | rod          | luction c | apacity 8 | S.   |          |        |
|         | requ   | irem           | ents are      | given              | below         | find o   | ptimu    | m sol              | lutic      | on fo        | or the gi | ven T.P t | 0    |          |        |
|         | mon  | nimiz          | e the cc      | ost.               | 6             | <u> </u> | C        |                    |            |              |           |           |      |          |        |
|         |  |                |               | <b>E</b> 1         | 51            | 52       | 6        | 54                 |            |              |           |           |      |          |        |
|         |  |                |               | F2                 | 10            | 8        | 7        | 5                  | -+         |              |           |           |      |          |        |
| L       |  |                |               |                    |               |          | 1 1      |                    |            |              |           |           |      |          |        |

| Some Con        | SKIT                         |           |         |       | Teach  | ning Pro | cess                    | Rev No.:  | 1.0     |
|-----------------|------------------------------|-----------|---------|-------|--------|----------|-------------------------|-----------|---------|
| 200             | Doc Code:                    | INST.Ph   | 5b1.F0  | 2     |        |          |                         | Date: 23- | -3-2020 |
| C C             | Title:                       | Course    | Plan    |       |        |          |                         | Page: 12  | / 24    |
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|                 |                              | F3        | 13      | 3     | 9      | 12       |                         |           |         |
|                 |                              | F4        | 4       | 6     | 8      | 3        |                         |           |         |
| 5               | Explain va                   | arious st | eps inv | olved | in Hur | ngarian  | algorithm with example. | CO4       | L4      |
|                 |                              |           |         |       |        |          |                         |           |         |
| е               | Experiences                  |           |         |       |        |          |                         | -         | -       |
| 1               |                              |           |         |       |        |          |                         | CO1       | L2      |
| 2               |                              |           |         |       |        |          |                         |           |         |
| 3               |                              |           |         |       |        |          |                         |           |         |
| 4               |                              |           |         |       |        |          |                         | CO        | L3      |
| 5               |                              |           |         |       |        |          |                         |           |         |

# E1. CIA EXAM – 1

# a. Model Question Paper - 1

| Crs ( | Code: | ode: 15CS653 Sem: VI Marks: 30 Time:   |   |  |             |          | 75 minu                           | tes    |            |   |      |       |
|-------|-------|--|---|--|-------------|----------|-----------------------------------|--------|------------|---|------|-------|
|       |       |  |   |  |             |          |                                   |        |            |   |      |       |
| Cour  | rse:  | Operations   | Researc   | h  |             | 1        | I                                 |        |            | 1   |      |       |
| -     | -     | Note: Answ   | ver any 3   | quest                                      | ions, ead   | ch carry | equal m                           | arks.  |            | Mark  | s CO | Level |
| 1     | а     | What is operation research? Explain origin and the six phases c operation research.  |   |  |             |          |                                   |        |            |   | CO1  | L1,L4 |
|       | b     | A farmer<br>sq.m.area.E<br>40 sq.m of<br>Q tree is 15<br>is also estir<br>P trees sh<br>17/8.The re<br>much as fro<br>Use mathe  | 000 5<br>ast<br>l of<br>e.e.it<br>r of<br>han<br>as | CO1  | L4          |          |                                   |        |            |   |      |       |
|       | С     | Use graphi   | cal meth  | od to s                                    | olve the    | the abo  | ve LPP p                          | roblem | ۱.         | 5   | CO1  | L4    |
|       |       |  |   |  |             |          |                                   |        |            |   |      |       |
| 2     | а     | Use graph<br>x1+x2>=6 ;x1  | ical met<br>+4x2>=12 ;                              | hod to<br>x <sub>1</sub> ,x <sub>2</sub> > | solve<br>=0 | Min z    | =3X <sub>1</sub> +2X <sub>2</sub> | ;      | 5X1+X2>=10 | ; 5   | CO1  | L4    |
|       | b     | A firm manufactures two types of products A & B and sells them at a profit of Rs.2 on type A and Rs.3 on type B. Each product is processed or two machines G and H.Type A requires one minute of processing time or 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 than6hours 40 minutes while H is available for 10 hours during any working day.How many types of type A and type B should be produced so that the tota profit is maximized. |   |  |             |          |                                   |        |            | it a 5<br>on<br>on<br>200<br>40<br>ow<br>otal | CO1  |       |
|       | С     | Use graphi   | cal meth  | od to s                                    | olve the    | the abo  | ve LPP p                          | roblem | ۱.         | 5   | CO1  | L4    |
|       |       | • ·  |   |  |             |          |                                   |        |            |   |      |       |
| 3     | a     | Find initial Basic Feasible solution for the following T.P. Using all methods  |   |  |             |          |                                   |        |            | ods 5   | CO4  | L4    |
|       |       |  |   | 1  | 2           | 3        | Suppl<br>y                        |        |            |   |      |       |
|       |       |  | 1   | 5  | 1           | 7        | 10                                | ]      |            |   |      |       |
|       |       |  | 2   | 6  | 4           | 6        | 80                                | ]      |            |   |      |       |
|       |       |  | 3   | 3  | 2           | 5        | 15                                |        |            |   |      |       |
|       |       |  | Deman   | 75   | 20          | 50       |                                   |        |            |   |      |       |

| 6        | STREET, CON |                           | SKIT                   |                          |   |                |                | Teach              | ing Pr           | oces             | S                  |                        |           | Rev I | NO.: 1.0 |    |
|----------|-------------|---------------------------|------------------------|--------------------------|---|----------------|----------------|--------------------|------------------|------------------|--------------------|------------------------|-----------|-------|----------|----|
| 12       | Deal        | Doc Code: INST.Ph5b1.Fo2  |                        |                          |   |                |                |                    |                  |                  |                    | Date                   | 23-3-2    | 020   |          |    |
| C        | 2           | 1                         | Title:                 | Cou                      | rse Pla   | an             |                |                    |                  |                  |                    |                        |           | Page  | : 13 / 2 | 4  |
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|          |             |                           | d                      |                          |   |                |                |                    |                  |                  |                    |                        | _         |       |          |    |
|          | b           | Define                    | e degenei              | racy                     | y in T.P .Find optimal solution for the following T.P & |                |                |                    |                  |                  |                    | 10                     | CO4       | L4    |          |    |
|          |             | formu                     | late as a r            | nath                     | emati   | cal m          | ethoc          | 1.                 |                  | _                |                    |                        |           |       |          |    |
|          |             |                           |                        | 1                        |   | 2              | 3              | 4                  |                  | 5                | 6                  | Suppl                  |           |       |          |    |
|          |             |                           | 4                      |                          |   | 10             |                | 6                  |                  | ~                | 10                 | У                      |           |       |          |    |
|          |             |                           | 2                      | $\frac{9}{7}$            | ,   | 2              | 9              | - 0                |                  | 9<br>r           | 10                 | 5                      |           |       |          |    |
|          |             |                           | 2                      | /                        |   | <u>3</u><br>r  |                | /                  |                  | 5<br>2           | 5                  | 0                      |           |       |          |    |
|          |             |                           | 3                      | 6                        |   | 5<br>0         | 9              | - 11               |                  | <u>3</u>         | 10                 | 2                      |           |       |          |    |
|          |             |                           | 4<br>Domano            |                          |   | 0              | 6              | 2                  |                  | <u>ک</u>         | 2                  | 9                      |           |       |          |    |
| <u> </u> |             |                           | Deman                  | 4                        | -   | 4              | 0              | 2                  |                  | 4                | 2                  |                        |           |       |          |    |
|          |             | Tho n                     | raduction              |                          | apoitio   | c of           | tha f          | actoric            | c are            | 1000             | 700.00             | o unito n              |           |       | <u> </u> | 14 |
|          |             | month<br>per m<br>o at th | n .the req<br>omth.the | uiren<br>per u<br>ris th | nents<br>unit re  | from<br>turn ( | the c<br>exclu | dealers<br>ding tr | s are s<br>anspo | 900,8<br>ortatio | 00,500<br>on cost) | & 400 un<br>are Rs.8,7 | its<br>′& |       |          |    |
|          |             | the factor                | ctories to             | the i                    | deale   | rs det         | ermin          | e the              | optim            | um s             | olution            | to maximi              | ze        |       |          |    |
|          |             | the to                    | atl returns            | 5.                       | acato   | 0.000          | errini         |                    | openn            |                  | otation            |                        |           |       |          |    |
|          |             |                           | Γ                      | -                        | 1   | 2              | 3              | 4                  |                  |                  |                    |                        |           |       |          |    |
|          |             |                           |                        | A                        | 2   | 2              | 2              | 4                  |                  |                  |                    |                        |           |       |          |    |
|          |             |                           |                        | В                        | 3   | 5              | 3              | 2                  |                  |                  |                    |                        |           |       |          |    |
|          |             |                           |                        | С                        | 4   | 3              | 2              | 1                  |                  |                  |                    |                        |           |       |          |    |
|          |             |                           | _                      |                          |   |                |                |                    |                  |                  |                    |                        |           |       |          |    |
|          |             |                           |                        |                          |   |                |                |                    |                  |                  |                    |                        |           |       |          |    |
|          |             |                           |                        |                          |   |                |                |                    |                  |                  |                    |                        |           |       |          |    |
|          | b           | A pro                     | duct is pr             | oduc                     | ced b   | y 4 fa         | actorie        | es f1f,2           | 2,f 3 &          | f4 .Tł           | neir unit          | producti               | on        | 10    | CO4      | L4 |
|          |             | costs                     | are Rs. 2              | 2,3,1,8                  | \$5.uni   | cost           | s of ti        | ranspo             | rtatior          | n ,pro           | oduction           | n capacity             | <u> </u>  |       |          |    |
|          |             | requir                    | ements a               | re gr                    | ven b   | elow           | nna c          | ptimu              | m soll           | ltion            | for the            | given T.P              | to        |       |          |    |
|          |             | rnornii                   | mize the c             | JOSL.                    |   | 1              | 50             | 50                 | C 4              |                  |                    |                        |           |       |          |    |
|          |             |                           |                        |                          | 1 7   | 21             | 32             | 6                  | 11               | -                |                    |                        |           |       |          |    |
|          |             |                           |                        |                          | $\frac{1}{2}$   |                | 4<br>8         | 7                  |                  | -                |                    |                        |           |       |          |    |
|          |             |                           |                        |                          | 2 1   | .0<br>2        | 2              | /                  | 12               | -                |                    |                        |           |       |          |    |
|          |             |                           |                        |                          |   | -3<br>1        | <u> </u>       | 8                  | 3                | _                |                    |                        |           |       |          |    |
|          |             |                           |                        | <u> </u>                 | <u>-   ^</u>  | T              | <u> </u>       | <u> </u>           | 5                |                  |                    |                        |           |       |          |    |
|          |             |                           |                        |                          |   |                |                |                    |                  |                  |                    |                        |           |       |          |    |
|          |             |                           |                        |                          |   |                |                |                    |                  |                  |                    |                        |           |       |          |    |

## b. Assignment -1

Note: A distinct assignment to be assigned to each student.

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|   |      |          |             | М           | odel As     | ssignme   | nt Ques          | stions                |              |         |          |       |
|---|------|----------|-------------|-------------|-------------|-----------|------------------|-----------------------|--------------|---------|----------|-------|
| Crs C   | ode: | 15CS65   | 3 Sem:      | VI          | M           | 1arks:    | 5                | Tir                   | ne: 9        | 0 - 120 | minute   | S     |
| Cours   | se:  | Operatio | ons Resear  | rch         |             |           |                  |                       |              |         |          |       |
| Note: Each student to answer 2-3 assignments. Each assignment carries equal m |      |          |             |             |             |           |                  |                       |              | rk.     |          |       |
| SNo USN Assignment Description  |      |          |             |             |             |           |                  |                       |              | Marks   | СО       | Level |
| 1   |      |          | A paper n   | nill produc | es two      | grades    | of pape          | er namely 2           | X and Y.     | 5       | CO1      | L4    |
|   |      |          | Because     | of raw ma   | terial re   | strictior | ıs, it car       | nnot produ            | ice more     |         |          |       |
|   |      |          | than 400    | tons of gra | ade X a     | nd 300 l  | ons of g         | grade Y in            | a week.      |         |          |       |
|   |      |          | There are   | 160 produ   | uction h    | nours in  | a week.          | . It require          | s 0.2 and    |         |          |       |
|   |      |          | 0.4 hours   | to produc   | e a ton     | of prod   | ucts X a         | and Y resp            | ectively     |         |          |       |
|   |      |          | with corre  | esponding   | profits     | of Rs. 20 | 00/-an           | d Rs. 500,            | /- per ton.  |         |          |       |
|   |      |          | Formulate   | e the abov  | 'e as a l   | _PP to n  | naximize         | e profit an           | d find the   |         |          |       |
|   |      |          | optimum     | product n   | <u>1IX.</u> |           |                  |                       |              |         | 001      |       |
| 2   |      |          | Use grap    | nical metr  | IOCI TO S   | OLVE Ma   | 3X Z=3X1         | .+4X2 ; 5X            | 1+4X2<=200   | 5       | CO1      | L4    |
|   |      |          | ,           | 3X1+5X2<=1  | .50 ,5x1    | L+4XZ>=1  | 00 , 0XI<br>22-0 | +4x2>=00              |              |         |          |       |
| 2   |      |          | The prod    | luction ca  | nacitios    | $x_{1,x}$ | factori          | oc aro 10             |              |         | CO1      |       |
| 3   |      |          | units nor   | r month     | the re      | auirome   | nts fro          | es ale 100<br>m the d | loalors are  | 5       | COI      | L4    |
|   |      |          |             | 500 & 4C    | one re      | s ner i   | nomth            | the ner i             | unit return  |         |          |       |
|   |      |          | (excludin   | a transpo   | ortation    | cost)     | are Rs           | 5.8.7 & C             | at three     | 2       |          |       |
|   |      |          | factoris.th | ne followi  | na tab      | le aive   | s unit           | transporta            | ation costs  |         |          |       |
|   |      |          | from the    | factories   | to the      | e deale   | ers.dete         | rmine the             | e optimum    |         |          |       |
|   |      |          | solution t  | o maximiz   | e the to    | oatl retu | rns.             |                       | I            |         |          |       |
|   |      |          |             |             | 1           | 2         | 3 4              | ł                     |              |         |          |       |
|   |      |          |             | A           | 2           | 2         | 2 4              | ł                     |              |         |          |       |
|   |      |          |             | В           | 3           | 5         | 3 2              | 2                     |              |         |          |       |
|   |      |          |             | С           | 4           | 3         | 2 1              |                       |              |         |          |       |
|   |      |          |             |             |             |           |                  |                       |              |         |          |       |
|   |      |          |             |             |             |           |                  |                       |              |         |          |       |
|   |      |          |             |             |             |           |                  |                       |              |         |          |       |
| 4   |      |          | Exp         | plain vario | us step     | os involv | ved in l         | Hungariar             | n algorithm  | n 5     | CO4      | L2    |
|   |      |          | WIt         | h example   | ).<br>      |           | £                | . <b>6</b> . 11       |              |         | <u> </u> |       |
| 5   |      |          | Find initia | al Basic Fe | easible     | solution  | for the          | e iouowing            | J T.P. USING | 5       | CO4      | L4    |
|   |      |          | aumetrio    | us.         |             |           |                  |                       |              |         |          |       |
|   |      |          |             |             | 1           | 2         | 2                | Suppl                 | 1            |         |          |       |
|   |      |          |             |             | +           |           |                  |                       |              |         |          |       |
|   |      |          |             | 1           | 5           | 1         | 7                | 10                    |              |         |          |       |
|   |      |          |             | 2           | 6           | 4         | 6                | 80                    |              |         |          |       |
|   |      |          |             | 3           | 3           | 2         | 5                | 15                    | 1            |         |          |       |
|   |      |          |             | Deman       | 75          | 20        | 50               |                       | 1            |         |          |       |
|   |      |          |             | d           | , 0         |           |                  |                       |              |         |          |       |

# D2. TEACHING PLAN - 2

# Module – 5

| Title:   | Game Theory  | Appr  | 10 Hrs |
|----------|--|-------|--------|
|          |  | Time: |        |
| a        | Course Outcomes  | -     | Blooms |
| -        | The student should be able to:   | -     | Level  |
| 1        | Apply game theory, decision analysis for decision support system to construct decision tree. | CO5   | L4     |
|          |  |       |        |
| b        | Course Schedule  | -     | -      |
| Class No | Module Content Covered   | CO    | Level  |
| 21       | The formulation of two persons, zero sum games;saddle point                                  | CO5   | L2     |

| Some To        | SKIT                                      | Rev No.: 1.0   |          |            |
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|                |   |  |          |            |
| 22             | Game Theory:                              | Game Theory: The formulation of two persons, zero sum                            | CO5      | L4         |
|                | games;saddle                              | point  |          |            |
| 22             | maximin and                               | minimax principle. Solving simple games, a prototype                             | COF      | 1.4        |
| 23             |   | minimax principle, solving simple games a prototype                              | 005      | 64         |
|                | example,                                  |  |          |            |
| 24             | maximin and                               | minimax principle, Solving simple games- a prototype                             | CO5      | L4         |
|                | example;                                  |  |          |            |
| 25             | Games with mi                             | red strategies: Graphical solution procedure                                     | COF      | 14         |
| 25             |   | ted strategies, draphical solution procedure.                                    | 005      | ∟4         |
| 26             | Games with mi                             | ked strategies; Graphical solution procedure.                                    | CO5      | L4         |
| 27             | Graphical solut                           | ion procedure.   | CO5      | L2         |
| 28             | Graphical solut                           | ion procedure.   | CO5      | L4         |
| 20             | Metaheuristics                            | The nature of Metabeuristics Tabu Search Simulated                               | COF      | Ι <i>Λ</i> |
| -9             | Annealing Con                             | etic Algorithms  | 005      | <u>-4</u>  |
|                | Anneating, der                            |  |          |            |
| 30             | Metaheuristics:                           | The nature of Metaheuristics, Tabu Search, Simulated                             | CO5      | L4         |
|                | Annealing, Gen                            | etic Algorithms.   |          |            |
|                |   |  |          |            |
| с              | Application Ar                            | eas  | со       | Level      |
| 1              | Problems relate                           | ed to game theory arise in a range of fields, for example,                       | CO5      | L4         |
|                | healthcare, trar                          | nsportation and military planning.   |          |            |
|                |   |  |          |            |
| d              | Review Questi                             | ons  | -        | -          |
|                | Define the follo                          | f matrix   | 005      | L2         |
|                | e)two perso                               | n zero, sum game, f)strategy, g)minimax & maximin                                |          |            |
|                | principles h)a                            | Iominance principle  |          |            |
| 2              | Solve the follo                           | wing game by applying a) graphical method b)dominance                            | CO5      | L4         |
|                | rule                                      |  |          |            |
|                | a)  | b)   |          |            |
|                | <u> </u>                                  |  |          |            |
|                | A1  | 3 -3 4 2 2 6   |          |            |
|                | A2  | -1 1 -3  |          |            |
| 3              | Two player A 8                            | B are playing a game of tossing a coin simultaneously                            | CO5      | L3         |
|                | player A wins 1                           | unit of value when there are two heads , wins nothing                            |          |            |
|                | when there are                            | two tails and looses $\frac{1}{2}$ unit of value when there is one               |          |            |
|                | nead and one t                            | all. Determine the pay-off matrix , the best strategies for<br>value of the game |          |            |
|                |   |  | CO5      | 4          |
|                | In A Game Of N                            | latching coins with two players, suppose A wins one unit of                      |          | -7         |
|                | wins nothing                              | hen there are two tails & losses <sup>1</sup> /2 unit of value when there        |          |            |
|                | are one head &                            | one tail.  |          |            |
|                | Determine the                             | payoff matrix, the best strategies for each player and the                       |          |            |
|                | value of the ga                           | me   |          |            |
| 5              | Explain briefly                           | he following a) tabu search b)genetic algorithm                                  | CO5      | L4         |
|                | c)simulated an                            | nealing technique.   |          |            |
| <b>e</b>       | ⊨xperiences                               |  | -        | -          |
| <u> </u>       |   |  | $CO_1$   | 10         |
| 2              |   |  | CO1      | L2         |

| ( Comments      | SKIT                       | Teaching Process | Rev No.:  | 1.0     |
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| 4               |                            |                  | CO3       | L3      |
| 5               |                            |                  |           |         |

## Module – 2

| Title:   | Simplex Method  | Appr<br>Time: | 10 Hrs |
|----------|---|---------------|--------|
| a        | Course Outcomes   | -             | Blooms |
| -        | The student should be able to:  | -             | Level  |
| 1        | Apply the Graphical and Simplex method to solve the LPP, game.  | CO2           | L3     |
|          |   |               |        |
| b        | Course Schedule   | -             | -      |
| Class No | Module Content Covered  | CO            | Level  |
| 31       | The essence of the simplex method the simplex method in tabular form;   | CO2           | L2     |
| 32       | The essence of the simplex method the simplex method in tabular form;   | CO2           | L3     |
| 33       | Setting up the simplex method.  | CO2           | L3     |
| 34       | Setting up the simplex method.  | CO2           | L4     |
| 35       | Types of variables, Algebra of the simplex method;  | CO2           | L2     |
| 36       | Types of variables, Algebra of the simplex method;  | CO2           | L2     |
| 37       | Tie breaking in the simplex method.   | CO2           | L4     |
| 38       | Tie breaking in the simplex method.   | CO2           | L4     |
| 39       | Big M method,   | CO2           | L4     |
| 40       | Two phase method.   | CO2           | L4     |
|          |   |               |        |
| С        | Application Areas   | СО            | Level  |
| 1        | For example Although many problems in architecture, engineering, construction and urban and regional development can be modelled with linear programming. | CO2           | L3     |
|          |   |               |        |
| d        | Review Questions  | -             | -      |
|          | Explain the steps involved in simplex method? Explain about special case in simplex method with example.  | 02            | L3     |
| 2        | Solve the following using simplex method.   | CO2           | L3     |
|          | Max p= 2x + y , x + 4y < = 24 , x - y <= - 3 , x + 2y <= 14 , 2x - y <= 8   |               |        |
| 3        | solve the following using Two Phase method  | CO2           | L2     |
|          | MAX Z = 5X1- 4X2 + 3X3 , 2X1 + X2 - 6X3 = 20 , 6X1 + 5X2 + 10X3 <= 76 , 8X1-<br>3X2+6X3<=50   |               |        |
| 4        | Write the procedure to solve LPP of Two Phase method.   | CO2           | L4     |
| 5        | Solve the following using simplex method  | CO2           | L4     |
|          | Max z = 5X+8Y , 4X+6Y < = 24 , 2X+Y< =18 , 3X+9Y < = 36   |               |        |
| е        | Experiences   | -             | -      |
| 1        |   | CO1           | L2     |
| 2        |   |               |        |
| 3        |   | • •           |        |
| 4        |   | CO3           | L3     |
|          |   |               |        |

|   | ( Second | SKIT      | Teaching Process | Rev No.: 1.0    |
|---|----------|-----------|------------------|-----------------|
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## E2. CIA EXAM – 2

# a. Model Question Paper - 2

| Crs ( | Code | 15CS653                | Sem:          | VI       | ١                           | Marks:    | 30         |           | Time: 75          | minute | S   |       |
|-------|------|------------------------|---------------|----------|-----------------------------|-----------|------------|-----------|-------------------|--------|-----|-------|
| Cou   | rse: | Operations             | Research      |          | ·                           |           |            |           |                   |        |     |       |
| -     | -    | Note: Ansv             | ver any 2 qu  | uestion  | s, each                     | n carry   | equal r    | narks.    |                   | Marks  | СО  | Level |
| 1     | а    | Explain var            | ious steps ir | nvolvec  | l in Hur                    | ngarian   | algorit    | hm with   | example.          | 5      | CO2 | L4    |
|       | b    | Find the as<br>profit. | signment o    | f jobs t | o macl                      | hines tł  | nat will   | result ir | n the maximum     | 10     | CO2 | L4    |
|       |      |                        |               | M1       | M2                          | M3        | M4         | M5        | ]                 |        |     |       |
|       |      |                        | J1            | 6.2      | 7.8                         | *         | 10.1       | 8.2       |                   |        |     |       |
|       |      |                        | J2            | 7.0      | 8.4                         | 6.5       | 7.5        | 6.0       |                   |        |     |       |
|       |      |                        | _J3           | 8.7      | 9.2                         | 11.1      | 7.0        | 8.2       |                   |        |     |       |
|       |      |                        | J4            | *        | 6.4                         | 8.7       | 7.7        | 8.0       |                   |        |     |       |
|       |      |                        |               |          |                             |           |            |           |                   |        |     |       |
| 2     | а    | Define the             | following     | a)pure   | strate                      | gy        | b)mixe     | d strate  | gy c)saddle       | 5      | CO2 | L4    |
|       |      | point d)pa             | iy-off matrix |          |                             | <b>.</b>  |            | 、         | o · ·             |        |     |       |
|       |      | e)two pers             | on zero su    | ım gam   | ne 1<br>Nainta              | r)strateq | ЭУ         | g)minii   | max & maximin     | ו      |     |       |
|       |      | principles             | n)qominar     | ice prin | icipie                      |           |            |           |                   |        |     |       |
|       | b    | Solve the f            | ollowing ga   | me by    | applyir                     | ng a) gr  | aphical    | metho     | d b)dominance     | \$ 5   | CO5 | L4    |
|       |      | rule                   | 00            | ,        | ,                           | 0 0       |            |           |                   |        |     |       |
|       |      | a)                     |               |          | b)                          |           |            |           |                   |        |     |       |
|       |      | B1                     | B2 B'         | 3        |                             |           |            |           |                   |        |     |       |
|       |      |                        |               |          |                             |           |            |           |                   |        |     |       |
|       |      | AI 3                   | -3 4          |          |                             |           |            |           |                   |        |     |       |
|       |      | A2 -1                  | 1 -3          |          |                             |           |            |           |                   |        |     |       |
|       |      |                        |               |          |                             |           |            |           |                   |        |     |       |
|       |      |                        |               |          |                             |           |            |           |                   |        |     |       |
| 3     | а    | Find the a             | ssignment     | of mer   | n to jo                     | bs that   | will m     | ninimize  | the total time    | e 5    | CO5 | L3    |
|       |      | taken.                 |               |          | 1                           |           |            |           |                   |        |     |       |
|       |      |                        |               | J1       | J2 J3                       | 3 J4      | J <u>5</u> |           |                   |        |     |       |
|       |      |                        | A             | 2        | $\frac{9}{2}$               | 7         | 1          |           |                   |        |     |       |
|       |      |                        | В             | 0        | 8 /<br>6 /                  | 0         | 1          |           |                   |        |     |       |
|       |      |                        |               | 4        | $\frac{0}{2}$ $\frac{5}{7}$ | 3         | 1          |           |                   |        |     |       |
|       |      |                        | F             | 5        | 2 /                         | 5         | 1          |           |                   |        |     |       |
|       | b    | Explain bri            | efly the fo   | llowing  | <u>ງ ອ</u><br>ເ ລ)          | tabu s    | earch      | b)aei     | netic algorithm   | 5      | COS | 12    |
|       |      | c)simulated            | d annealing   | technic  | jue.                        |           |            | 2,90      | istic algorithm   |        | 200 |       |
|       |      |                        |               |          | ,                           |           |            |           |                   |        |     |       |
| 4     | а    | Two playe              | r A & B are   | playing  | g a ga                      | me of     | tossing    | a coin    | simultaneously    | ′ 5    | CO5 | L3    |
|       |      | player A w             | ins 1 unit c  | of value | e wher                      | n there   | are tw     | o head    | s ,wins nothing   | I      |     |       |
|       |      | when there             | e are two ta  | ails and | lloose                      | s ½ un    | it of va   | lue whe   | en there is one   | ,<br>, |     |       |
|       |      | head and c             | one tail. Det | ermine   | the pa                      | ay-off n  | natrix ,   | the bes   | st strategies for |        |     |       |
|       |      | eacn playe             | r & value of  | the gar  | ne.                         |           |            |           |                   |        |     |       |
|       | b    | Solve the f            | ollowing ga   | me ala   | nolv si                     | uitable   | methor     | d b)do    | minance rule c    | 5      | COS |       |
|       |      | apply grap             | hical metho   | d.       |                             |           |            |           |                   |        | 200 |       |

## b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

|           | Model Assignment Questions |            |    |        |   |       |            |  |  |  |
|-----------|----------------------------|------------|----|--------|---|-------|------------|--|--|--|
| Crs Code: | 15CS653                    | Sem:       | VI | Marks: | 5 | Time: | 75 minutes |  |  |  |
| Course:   | Operation                  | s Research | 1  |        |   |       |            |  |  |  |

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| Note: | Each student | to answer 2-;   | 3 assignmer  | nts. Eac  | h assig | gnment ca  | arries equal mar | ſk.   |     |       |
|-------|--------------|---|--------------|-----------|---------|------------|------------------|-------|-----|-------|
| SNo   | USN          |   | Assig        | nment     | Desci   | ription    |                  | Marks | СО  | Level |
| 1     |              | Solve the fol   | lowing using | g BIG-N   | ∕l metł | nod        |                  | 5     | CO5 | L4    |
|       |              | Min z=2x1+9x  | 2+x3 ,x1+4x2 | 2+2X3>=   | 5,3x1   | +x2+2x3>=  | 4.               |       |     |       |
| 2     |              | Solve the fol   | lowing using | g Two I   | Phase   | method     |                  | 5     | CO5 | L4    |
|       |              | Max z=5x1+8   | x2 ,3x1+2x2> | -=3 , ×1· | +4x2>=  | 4 X1+X2<=  | 5.               |       |     |       |
| 3     |              | Solve the fol   | lowing using | g Two I   | Phase   | method     |                  |       | CO5 | L4    |
|       |              | Max z=2x1+x2+x3 ,4x1+6x2+3x3<=8 , 3x1-6x2-4x3<=1 , 2x1+3x |              |           |         |            |                  |       |     |       |
|       |              | 5×3>=4.   |              |           |         |            |                  |       |     |       |
| 4     |              | Solve the fol   | lowing gam   | e by ap   | oplying | g graphica | al rule          | 5     | CO6 | L4    |
|       |              | 2   | 2            |           | 3       |            | -1               |       |     |       |
|       |              | 4   | 3            |           | 2       |            | 6                |       |     |       |
| 5     |              | Solve the fol   | lowing gam   | e by ap   | oplying | g graphica | al rule          | 5     | CO7 | L3    |
|       |              | 2   | -1           | 5         |         | -2         | 6                |       |     |       |
|       |              | -2  | 4            | -3        |         | 1          | 0                |       |     |       |

# D3. TEACHING PLAN - 3

# Module – 3

| Title:   | Simplex Method –2   | Appr  | 10 Hrs |
|----------|---|-------|--------|
|          | Courses Outcomes  | Time: | Disama |
| a        | Course Outcomes   | -     | Blooms |
| -        | The student should be able to:  | -     | Level  |
| 1        | Select and apply optimization techniques for various problems.  | CO3   | L2     |
|          |   |       |        |
|          | Course Schedule   | -     | -      |
| Class No | Module Content Covered  | 00    | Level  |
| 41       | Duality Theory - The essence of duality theory,   | 003   | L3     |
| 42       | Duality Theory - The essence of duality theory,   | CO3   | L2     |
| 43       | Primal dual relationship  | CO3   | L2     |
| 44       | Primal dual relationship  | CO3   | L2     |
| 45       | conversion of primal to dual problem and vice versa   | CO3   | L3     |
| 46       | conversion of primal to dual problem and vice versa   | CO3   | L2     |
| 47       | The dual simplex method.  | CO3   | L3     |
| 48       | The dual simplex method with examples.  | CO3   | L4     |
| 49       | The dual simplex method with examples.  | CO3   | L4     |
| 50       | The dual simplex method with examples.  | CO3   | L4     |
|          |   |       |        |
| С        | Application Areas   | СО    | Level  |
| 1        | Efficient Manufacturing   | CO3   | L4     |
|          | Manufacturing requires transforming raw materials into products that maximize company revenue.  |       |        |
| 2        | Linear programming is used to obtain <b>optimal</b> solutions for operations research. Using linear programming allows researchers to find the best, most economical solution to a problem within all of its limitations, or constraints. | CO3   | L4     |
|          |   |       |        |
| d        | Review Questions  | -     | -      |
| 1        | Explain the following (i)the essence of duality theory (ii) primal dual   | CO3   | L2     |

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|  | Title:                       | Course Plan                             | Page: 19 / 24 |         |  |  |  |
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|  | rlationship                  |   |               |         |  |  |  |
| 2  | Write the dual o             | CO3                                     | L2            |         |  |  |  |
|  | MAX Z =2X1+3X                | 2+X3 , 4X1+3X2+X3 = 6 , X1+2X2+5X3 = 4. |               |         |  |  |  |
| 3  | Write the dual (             | CO3                                     | L3            |         |  |  |  |
|  | >= 4 , 7X1-2X2-X             | 4,7X1-2X2-X3 <= 10                      |               |         |  |  |  |
|  | X1-2X2+5X3 >= 3              | 3 , 4X1+7X2-2X3 >= 2                    |               |         |  |  |  |
| е  | Experiences                  |   | -             | -       |  |  |  |
| 1  |                              |   | CO1           | L2      |  |  |  |
| 2  |                              |   |               |         |  |  |  |
| 3  |                              |   |               |         |  |  |  |
| 4  |                              |   | CO3           | L3      |  |  |  |
| 5  |                              |   |               |         |  |  |  |

# E3. CIA EXAM – 3

# a. Model Question Paper - 3

| Crs ( | Code: | 15CS653   | Sem:  | VI  | Marks:                               | 30                            | Time: 7                            | 75 minute             | es  |          |
|-------|-------|---|---|---|--------------------------------------|-------------------------------|------------------------------------|-----------------------|-----|----------|
| Coui  | rse:  | Operation   | s Research  |   |                                      |                               |                                    |                       |     |          |
| -     | -     | Note: Ans   | wer any 2 q   | uestions, ea  | ach carry e                          | equal marks.                  |                                    | Marks                 | CO  | Level    |
| 1     | а     | Explain th<br>case in sin                         | e steps inv   | volved in sir<br>od with exan                           | mplex me<br>nple.                    | thod? Explai                  | n about speci                      | al 5                  | Соз | L1       |
|       | b     | Solve the   | following us  | sing simplex  | method                               |                               |                                    | 10                    | Соз | L3       |
|       |       | Max z = 5X  | (+8Y , 4X+6)  | Y < = 24 , 2X+  | Y< =18 , 3×                          | (+9Y < = 36                   |                                    |                       |     |          |
| 2     | a     | Define the<br>basic fea<br>(v)unboun              | e following<br>Isible solut<br>ded solutior               | (i)feasible sc<br>.ion (iv)non:<br>1.                   | olution (ii)<br>-degenera            | basic solutio<br>Ite basic fe | n (iii)degenera<br>easible solutio | te <sup>5</sup><br>on | Соз | L1       |
|       | b     | Find all k<br>variables &<br>Max Z=3X1            | basic solutio<br>& feasible so<br>1+4X2 , X1+>            | ons to the<br>olutions at e<br><2 < = 450 , 2           | problem<br>each step<br>2X1+X2 < = ( | & mention k<br>600            | basic, non-bas                     | ic <sup>10</sup>      | Co3 | L3       |
|       |       |   |   |   |                                      |                               |                                    |                       |     | <u> </u> |
| 3     | а     | solve the f                                       | following us  | ing Big-M n   | nethod                               |                               |                                    | 6                     | Co3 | L3       |
|       | b     | solve the f                                       | following us<br>X1-4X2+3X3                                | ing 2-phase<br>, 2X1+X2                                 | method<br>2-6X3 = 20                 | , 6X1+5X2                     | +10X3 <= 76                        | , 9                   | C03 | L3       |
|       |       | 8X1-3X2+6   | 6X3 <= 50   |   |                                      |                               |                                    |                       |     |          |
| 4     | а     | Explain th<br>rlationship                         | e following   | (i)the esser  | nce of dua                           | ality theory                  | (ii) primal du                     | al 6                  | Co3 | L1       |
|       | b     | Write the<br>6X1+X2+3X<br>X1-2X2+5X<br>(ii) MAX Z | dual of<br>(3 >= 4 , 7X1-<br>(3 >= 3 , 4X1<br>=2X1+3X2+X3 | (i)MIN Z<br>2X2-X3 <= 10<br>+7X2-2X3 >=<br>} , 4X1+3X2+ | = 3X1-2X2<br>2<br>X3 = 6 , X         | +4X3 , 3X1<br>1+2X2+5X3 = 2   | +5X2+4X3 >= 7<br>1.                | . 9                   | Co3 | L3       |

## b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

| Model Assignment Questions |         |      |    |        |   |       |            |
|----------------------------|---------|------|----|--------|---|-------|------------|
| Crs Code:                  | 15cs653 | Sem: | VI | Marks: | 5 | Time: | 75 minutes |

|                    | SKIT                     | Teaching Process | 5 | Rev No.: 1.0    |
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| Courso             | Operations De            | search           |   |                 |

| Course: | Operations Research |
|---------|---------------------|
|         |                     |

| oours |              |   |       |      |       |
|-------|--------------|---|-------|------|-------|
| Note: | Each student | to answer 2-3 assignments. Each assignment carries equal ma   | rk.   |      |       |
| SNo   | USN          | Assignment Description  | Marks | со   | Level |
| 1     |              | solve the following using Big-M_method<br>MAX 7= 2X + Y , 3X+Y=3 , X+2Y<=3, 4X+3Y>=6  | 5     | CO9  | L2    |
| 2     |              | solve the following using 2-phase method<br>MAX Z = 5X1-4X2+3X3 , 2X1+X2-6X3 = 20 , 6X1+5X2+10X3<br><= 76 , 8X1-3X2+6X3 <= 50   | 5     | CO9  | L2    |
| 3     |              |   | 5     | CO9  | L2    |
| 4     |              | Explain the following (i)the essence of duality theory (ii primal dual rlationship  | ) 5   | CO10 | L4    |
| 5     |              | Write the dual of (i)MIN Z = 3X1-2X2+4X3, 3X1+5X2+4X3 >= 7<br>6X1+X2+3X3 >= 4, 7X1-2X2-X3 <= 10<br>X1-2X2+5X3 >= 3, 4X1+7X2-2X3 >= 2<br>(ii) MAX Z =2X1+3X2+X3, 4X1+3X2+X3 = 6, X1+2X2+5X3 = 4. | . 5   | CO10 | L4    |

## F. EXAM PREPARATION

# 1. University Model Question Paper

| Cour  | rse:  | Operations Research Month /   | Year  | May / | 2019   |
|-------|-------|---|-------|-------|--------|
| Crs ( | Code: | 15CS653 Sem: VI Marks: 80 Time:   |       | 180 m | inutes |
| -     | Note  | Answer all FIVE full questions. All questions carry equal marks.  | Marks | CO    | Level  |
| 1     | а     | What is operation research? Explain origin and the six phases of operation research.  | 2     | CO1   | L2     |
|       | b     | A farmer has to plant two kinds of tree P and Q in a land 4000<br>sq.m.area.Each P terr requires at least 25 sq.m and Q tree requires at least<br>40 sq.m of land.the annual water requirement of P tree is 30 units nad of<br>Q tree is 15 units per tree,while at most 3000 units of water is available.it<br>is also estimated that the ratio of the number of Q trees to the number of<br>P trees should not be less than 6/19 and should not be more than<br>17/8.The return per tree from P is expected to be one and half times as<br>much as from Q tree.<br>Use mathematical formulation to the LPP. | 6     | CO1   | L4     |
|       | с     | Use graphical method to solve the the above LPP problem.  | 8     | CO1   | L4     |
| -     | a     | A person requires 10,12 and 12 units chemicals A,B,C respectively for his garden. One unit of liquid product contains 5,2 and 1 units of A,B and C respectively. One unit of dry product contains 1,2 and 4 units of A,B,C. If the liquid product sells for Rs. 3/- and the dry product sells for Rs. 2/-, how many of each should be purchased, in order to minimize the cost and meet the requirements.   | 2     | CO1   | L4     |
|       | b     | A paper mill produces two grades of paper namely X and Y. Because of<br>raw material restrictions, it cannot produce more than 400 tons of grade X<br>and 300 tons of grade Y in a week. There are 160 production hours in a<br>week. It requires 0.2 and 0.4 hours to produce a ton of products X and Y<br>respectively with corresponding profits of Rs. 200/- and Rs. 500/- per ton.<br>Formulate the above as a LPP to maximize profit and find the optimum<br>product mix.   | 6     | CO1   | L4     |
|       | С     | Use graphical method to solve Min z=20x1+10x2 ; x1+2x2<=40;<br>3x1+x2>=30 ;4x1+3x2>=60 ; x1,x2>=0   | 8     | CO1   | L4     |
| 2     | а     | Explain the steps involved in simplex method? Explain about special case  | 4     | C02   | L4     |

| 6      | SKIT Teaching Process |   |                 |                             |                     |             | F                         | Rev No.: 1.0            |                |                  |         |         |    |
|--------|-----------------------|---|-----------------|-----------------------------|---------------------|-------------|---------------------------|-------------------------|----------------|------------------|---------|---------|----|
|        |                       | Doc Code:   | INST.Ph         | 15b1.F02                    |                     |             |                           |                         |                | [                | Date: 2 | )20     |    |
| Co.    |                       | Title:  | Course          | Plan                        |                     |             |                           |                         |                | F                | Dage:   | 21 / 24 |    |
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|        |                       | in simp   | olex met        | hod with                    | examp               | le.         |                           |                         |                |                  |         | 00.     |    |
|        | a                     | Solve the following using simplex method. Max p= 2x + y , |                 |                             |                     |             |                           |                         |                |                  |         | CO2     | L4 |
|        |                       | x + 4v < = 24 , x - v <= - 3 , x + 2v <= 14 . 2x - v <= 8 |                 |                             |                     |             |                           |                         |                |                  |         |         |    |
|        | С                     |   |                 |                             |                     |             |                           |                         |                |                  |         |         | L4 |
|        |                       | solve the lollo   | wing usi        | ng iwo i                    | -nase m             | ietnoa      | l                         |                         |                |                  |         |         |    |
|        |                       | MAX Z = 5X1 - 4   | 4X2 + 3X        | 3, 2X1                      | . + X2 - 6          | 6X3 = 2     | 20, 6>                    | <1 + 5X2 +              | 10X3 <= 7      | 6,               |         |         |    |
|        |                       | 8X1-3X2+6X3<=50   |                 |                             |                     |             |                           |                         |                |                  |         |         |    |
| _      | а                     | Define the fo   | llowing         | (i)solutio                  | on (ii)fea          | asible      | solutio                   | n (iii)ha               | asic solut     | ion              | 1       | C:02    | 14 |
|        | ŭ                     | (iv)basic feasik  | ole solu        | tion (v)de                  | egenera             | te bas      | sic feas                  | ible feas               | ible solut     | ion              | 4       | OOL     | -4 |
|        |                       | (vi)optimal ba  | sic feas        | ible solu                   | ution (vi           | i)unbo      | unded                     | solution                | (viii)feasil   | ole              |         |         |    |
|        |                       | region.   |                 |                             |                     |             |                           |                         |                |                  |         |         |    |
|        | b                     | Solve the follo   | wing us         | ing BIG-N                   | A metho             | od<br>P     |                           |                         |                |                  | 8       | CO2     | L4 |
|        | 6                     | Max Z=2x+y ,3<br>Find all basic s                         | x+y=3 , x       | +2y<=3,                     | 4x+3y>=0            | o<br>probl  | ome                       |                         |                |                  | 4       | $CO_2$  | 14 |
|        | C                     | Max z=x1+3x2+   | 3x3 . x1+       | 2X2+3X3=                    | 4 .2x1+′            | 3x2+5x      | 3=7                       |                         |                |                  | 4       | 002     | ∟4 |
|        |                       |   | <u> </u>        |                             |                     | <u> </u>    | <u> </u>                  |                         |                |                  |         |         |    |
| 3      | а                     | Explain the fo  | llowing         | (i)the es                   | sence c             | of dua      | lity the                  | ory (ii)                | primal d       | ual              | 4       | CO3     | L4 |
|        |                       | relationship  | <u> </u>        |                             |                     |             |                           |                         |                |                  |         | 001     |    |
|        | b                     | Write the dual $MAX = 2X_{1+2}$                           | . 0†<br>Va+Va   | 1/1+2/2                     | +¥2 - 6             | V1+2        | ¥2+∈¥2                    | - 1                     |                |                  | 8       | CO3     | L4 |
|        | C                     | Write the dual  | of MIN          | $\frac{4}{1}$ $\frac{3}{2}$ | -2X2+1>             | (3 3)       | <u>~~'5~3</u><br>(1+5X2+, | <u>- 4.</u><br>1X3 >= 7 | 6X1+X2+3       | Xa               | Δ       | CO3     | 11 |
|        | Ŭ                     | >= 4 , 7X1-2X2-   | X3 <= 10        | •                           |                     |             |                           | -//3////                |                |                  | -       | 000     |    |
|        |                       | X1-2X2+5X3 >=   | 3 , 4X1         | +7X2-2X3                    | >= 2                |             |                           |                         |                |                  |         |         |    |
|        |                       |   |                 |                             |                     |             |                           |                         |                |                  | -       |         |    |
| -      | a                     | Briefly discuss   | about s         | ensitivity                  | analysi             | S<br>starts | 4 . 0.0                   | < 20 x4                 | - 21/2 - 4 4 0 |                  | 6       | CO3     | L4 |
|        | U                     | 8 x2 >=0 by so  | lvina its       | ∠= 0∧1 +<br>dual prol       | oxz, sui<br>blem us | ina sin     | nolex m                   | <=20, XI '<br>nethod    | * 2X2 <=10     | , X1             | 10      | 003     | ∟4 |
|        |                       |   | i i i g i i c   |                             |                     |             |                           |                         |                |                  |         |         |    |
| 4      | а                     | Find initia <u>l Bas</u>                                  | ic Feasil       | ole soluti                  | on for th           | ne folla    | owing T                   | .P. Using               | all metho      | ds               | 4       | CO4     | L4 |
|        |                       |   | 1               | 2                           | 3                   | S           | uppl                      |                         |                |                  |         |         |    |
|        |                       | 1   |                 |                             |                     | <u> </u>    |                           |                         |                |                  |         |         |    |
|        |                       | 2   | 6               | 1                           | 6                   | 8           | 0                         |                         |                |                  |         |         |    |
|        |                       | 3   | 3               | 2                           | 5                   | 1           | 5                         |                         |                |                  |         |         |    |
|        |                       | Der   | nan 75          | 5 20                        | 50                  |             |                           |                         |                |                  |         |         |    |
|        |                       | d   |                 |                             |                     |             |                           |                         |                |                  |         |         |    |
|        | b                     | Define degene   | eracy in        | T.P .Find                   | d optima            | al solu     | ition fo                  | r the foll              | owing T.F      | ° &              | 6       | CO4     | L4 |
|        |                       |   |                 |                             |                     | 1           | 5                         | 6                       | Suppl          | 1                |         |         |    |
|        |                       |   | -               |                             |                     |             |                           | Ũ                       | y y            |                  |         |         |    |
|        |                       | 1   | 9               | 12                          | 9                   | 6           | 9                         | 10                      | 5              |                  |         |         |    |
|        |                       | 2   | 7               | 3                           | 7                   | 7           | 5                         | 5                       | 6              |                  |         |         |    |
|        |                       | 3   | 6               | 5                           | 9                   | 11          | 3                         | 11                      | 2              |                  |         |         |    |
|        |                       | 4<br>Demar  |                 | 0                           | 6                   | 2           | 2                         | 2                       | 9              | $\left  \right $ |         |         |    |
|        | С                     | The production  | $\frac{14}{14}$ | 4<br>cities of              | the fac             | tories      | are 10                    | 00,700.9                | 00 units r     | j<br>Der         | 6       | CO4     | 4  |
|        | -                     | month the re  | quireme         | nts from                    | the dea             | alers a     | are 900                   | ,800,500                | & 400 ur       | nits             | -       |         |    |
|        |                       | per momth.the   | e per un        | it return (                 | excludi             | ng trar     | nsporta                   | tion cost               | are Rs.8,      | 7 &              |         |         |    |
|        |                       | 9 at three fact   | oris.the        | tollowing                   | g table g           | lives u     | nit tran                  | sportatio               | n costs fro    | om               |         |         |    |
|        |                       | the factories to  | υ line de<br>ns | ealers.det                  | ermine.             | rue ob      | Jurnum                    | Solution                | io maxim       | ı∠e              |         |         |    |
|        |                       |   |                 |                             |                     |             |                           |                         |                |                  |         |         |    |
|        |                       |   |                 | 1 2                         | 3                   | 4           |                           |                         |                |                  |         |         |    |
|        |                       |   | A               | 2 2                         | 2                   | 4           |                           |                         |                |                  |         |         |    |

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|------|-------------|----------------------|-------------------|----------------|-----------|-------------|----------------------|--------------|---------------|--------------|----------------|--------|-----------------|-----------|---|------------|----|
|      | ~~ ())      | Doc C                | Code:             | INST.Ph5b1.Fo2 |           |             |                      |              |               |              |                |        | Date: 23-3-2020 |           |   |            |    |
|      | -           | Tit                  | le:               | Cours          | ırse Plan |             |                      |              |               |              |                |        | Page: 22 / 24   |           |   |            |    |
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|      |             |                      |                   | В              | 3         | 5           | 3                    |              | 2             |              |                |        |                 |           |   |            |    |
|      |             |                      |                   | С              | 4         | 3           | 2                    |              | 1             |              |                |        |                 |           |   |            |    |
|      |             |                      |                   |                |           |             |                      |              |               |              |                |        |                 |           |   |            |    |
| -    | а           | A produ              | uct is p          | produc         | ed by     | 4 fa        | actori               | es f:        | 1f,2,1        | f 3 &f       | 4 .Th          | neir u | ınit p          | roduction | 4 | CO4        | L4 |
|      |             | costs                | are               | Rs.            | 2,3,1     | &5.u        | init                 | CO           | sts           | of           | tra            | anspo  | ortatio         | on        |   |            |    |
|      |             | proal,               | JCTION            | capac          | ITY &     | requ        | lirem                | ents         | are           | e give       | en be          | elow   | πna             | optimum   |   |            |    |
|      |             | solution             | IOF LITE          | e given        |           | 1           | <u>1111111</u><br>52 | ∠e u<br>∣ so |               | SI.          |                |        |                 |           |   |            |    |
|      |             |                      |                   | F1             | 2         | L           | 1                    | 6            |               | 11           | -              |        |                 |           |   |            |    |
|      |             |                      |                   | F2             | 10        | <u>,</u>    | 8                    | 7            |               | 5            | -              |        |                 |           |   |            |    |
|      |             |                      |                   | F3             | 13        | 3           | 3                    | 9            |               | 12           | -              |        |                 |           |   |            |    |
|      |             |                      |                   | F4             | . 4       |             | 6                    | 8            |               | 3            |                |        |                 |           |   |            |    |
|      | b           |                      | Exp               | lain va        | rious s   | steps       | s invo               | lvec         | l in l        | Hung         | arian          | algo   | rithm           | with      | 4 | CO4        | L4 |
|      |             |                      |                   |                |           |             | e                    | exam         | nple          |              |                |        |                 |           |   |            |    |
|      | С           | Fi                   | nd the            | assigr         | ment      | of jo       | bs to                | ma           | chir          | ies th       | at wi          | ll res | ult in          | the       | 8 | CO4        | L4 |
|      |             | m                    | iaximui           | m prof         | It.       |             | 10                   |              |               | N44          |                |        |                 |           |   |            |    |
|      |             |                      |                   | 11             | 62        |             | 1VI2<br>7 Q          | I^[\]        | 3             | 101          |                | 5      |                 |           |   |            |    |
|      |             |                      |                   | 12             | 7.0       |             | 7.0<br>8.4           | 6            | 5             | 75           | 6              | 0      |                 |           |   |            |    |
|      |             |                      |                   | 13             | 8.7       |             | <u>9.4</u><br>9.2    | 11           | <u>,</u><br>1 | 7.0          | 8.             | 2      |                 |           |   |            |    |
|      |             |                      |                   | J4             | *         |             | <u> </u>             | 8.7          | 7             | 7.7          | 8.             | 0      |                 |           |   |            |    |
|      |             |                      |                   |                |           |             |                      |              |               |              | _              |        |                 |           |   |            |    |
| 5    | а           | Define t             | he foll           | owing          | a)pi      | ure s       | strate               | gy           | k             | o)mixe       | ed st          | rateg  | ĴУ              | c)saddle  | 6 | CO5        | L2 |
|      |             | point d              | l)pay-o           | ff matr        | ix        |             |                      | -            |               |              |                |        |                 |           |   |            |    |
|      |             | e)tw                 | o pers            | on zer         | o sun     | n gai       | me                   | f)st         | rate          | egy          | g)             | minin  | nax 8           | maximin   |   |            |    |
|      | h           | principle            | es n)             | aomin          | ance p    | orinc       | ipie                 | tho          | foll          | ovvinc       |                | mok    |                 |           | 6 | COF        |    |
|      | U D         | Solve                |                   | B1             | B2        | B3          | 3                    | arar         | hic           | al me        | j yai<br>thod  | he r   | omina           | nce rule  | 0 | 005        | ∟4 |
|      |             | b)                   | A1                | 3              | -3        | 1           | _                    | grap         | / 1100        | b)           |                |        |                 |           |   |            |    |
|      |             |                      | A 2               | 1              | 1         | -           |                      |              |               |              | 3              | -2     | 4               |           |   |            |    |
|      |             |                      | A2                | -1             | L L       | -3          |                      |              |               |              | -1             | 4      | 2               |           |   |            |    |
|      |             |                      |                   |                |           |             |                      |              |               |              | 2              | 2      | 0               |           |   |            |    |
|      | C           | Two pla              | ver A 8           | Rare           | nlavir    | nd a        | name                 | ≏ ∩f '       | toss          | ina a        | coin           | simu   | Iltane          |           | 4 | COF        | 14 |
|      |             | plaver A             | wins 1            | L unit o       | fvalue    | e wh        | ien th               | nere         | are           | two          | hea            | ds .w  | ins no          | othing    | 4 | 005        | ∟4 |
|      |             | when th              | ere are           | e two t        | ails an   | d lo        | oses                 | ¹∕₂ ur       | nit o         | f valu       | e wh           | nen tr | nere i          | sone      |   |            |    |
|      |             | head an              | d one             | tail. De       | termir    | ne th       | ie pay               | y-off        | ma            | itrix ,      | the b          | oest s | trate           | gies for  |   |            |    |
|      |             | each pla             | ayer &            | value (        | of the    | gam         | e.                   |              |               |              |                |        |                 |           |   |            |    |
|      |             |                      |                   |                |           |             |                      |              |               |              |                |        |                 |           |   |            |    |
| -    | а           | In A Car             | mo Of             | Match          | ina co    | inc y       | vith t               |              | مام           | iore e       | uppo           |        | ving            | ono unit  | 6 | CO5        | L3 |
|      |             | of value             | when              | there :        | are tw    | n he        | ads                  | wo j         | Jiay          | eis, s       | uppu           | JSE P  | N WILLS         |           |   |            |    |
|      |             | wins no              | thina             | when           | there     | are         | two                  | tails        | 8             | losse        | $5\frac{1}{2}$ | unit ( | of va           | ue when   |   |            |    |
|      |             | there ar             | e one l           | nead &         | one t     | ail .       |                      |              |               |              |                |        |                 |           |   |            |    |
|      |             | Determ               | nine the          | e payo         | ff mat    | rix, tl     | he be                | est s        | trate         | egies        | for e          | each   | playe           | r and the |   |            |    |
|      |             | value of             | the ga            | ame            |           |             |                      |              |               |              |                |        |                 |           |   |            |    |
|      | b           | Explain              | briefly           | the fol        | lowing    | ga)         | tabu                 | l sea        | rch           | b)ge         | enetio         | c algo | orithn          | ו         | 6 | CO5        | L4 |
|      |             | CISIMULA<br>Solvo th | ateu an           | wing           | y lech    | niqu<br>War | ie.<br>Dolvir        |              | h             | nanco        | rulo           |        |                 |           | Δ | $C \cap r$ | 1  |
|      | C           |                      |                   | wing g         |           | ∍y al       | pryn                 | iy u         |               |              | o              |        |                 |           | 4 | 005        | ∟4 |
|      |             | 4                    |                   |                | 5         |             |                      |              |               |              | 0              |        |                 |           |   |            |    |
|      |             | 6                    |                   |                | 4         |             |                      |              |               |              | 6              |        |                 |           |   |            |    |
|      |             | 4 2 4                |                   |                |           |             |                      |              |               |              |                |        |                 |           |   |            |    |

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2. SEE Important Questions

| Course: |       | Operations Research Month /  |                             |                 |                       |                  |        |                     |          | / Year      | May /      | 2018  |        |
|---------|-------|--|-----------------------------|-----------------|-----------------------|------------------|--------|---------------------|----------|-------------|------------|-------|--------|
| Crs C   | Code: | 15CS65S  | iem:                        | 6               |                       | Mark             | S:     | 80                  |          | Time:       |            | 180 m | inutes |
|         | Nete  | 3  |                             |                 |                       |                  |        |                     | -1       |             |            |       | 1      |
| Mo      | Ono   | Answer at  | I FIVE IUII C               | questio         | ons. All              | quesu            | ons c  | arry equ            | at mai   | KS.         | -<br>Marks | -     | Vear   |
| dul     | GHU.  |  |                             |                 |                       |                  |        |                     |          |             |            |       | Tear   |
| 1       | 1     | What are   | the differer                | nt pha          | ses of C              | DR stuc          | dv.Ex  | olain brie          | efl∨.    |             | 6          | CO1   | 2017   |
|         | 2     | Define the following:a)unbounded solution b)slack variable               |                             |                 |                       |                  |        |                     |          |             | 5          | CO1   | 2017   |
|         |       | c)Feasible region  |                             |                 |                       |                  |        |                     |          |             |            |       |        |
|         | 3     | Solve by g<br>3x1 + x2>=   | graphical m<br>30, 4x1 + 3x | ethoc<br>2 >-60 | l Min Z=<br>2,x1,x2>  | 20X1 +<br>=0.    | 10X2   | sub to: x           | 1 + 2X2  | 2 <=40,     | 5          | CO1   | 2016   |
|         | 4     | Explain th   | e 6 basic a                 | ssump           | otions o              | of Simp          | lex m  | ethod               |          |             | 6          | CO1   | 2016   |
|         | 5     | Write a br<br>sir  | ief note on<br>nplex emth   | unbo<br>10d.    | unded                 | solutio          | n anc  | l infeasib          | ole sol  | ution of    | 8          | CO1   | 2007   |
| 2       | 1     | Define sla   | ck variable                 | , surpl         | lus varia             | able             |        |                     |          |             | 4          | CO2   | 2015   |
|         | 2     | Solve by b   | oia M meth                  | od:Ma           | ax 7=2x1              | + 3X2 -          | + 10x3 | 2                   |          |             | 6          | CO2   | 2016   |
|         |       |  |                             |                 | ×1 ×2 ×2              |                  | 10/(2  | )                   |          |             |            |       |        |
|         | 3     | Usina Two  | $2x_3=0, x_2=0$             | thod            | .x1,x2,x;<br>'Min 7 = | 3>=0<br>⊧7 5x1 – | · 3X2  |                     |          |             | 10         | CO2   | 2015   |
|         | 5     | Sub to :3x:  | 1 -X2 - X3>=                | 3, X1 -         | - x2 + x3             | }>=0             | 0,.2   |                     |          |             |            |       |        |
|         | 4     | Solve by S   | Simplex me                  | thod            | Max 7=                | 2x1 + 3          | 2x2 +x | 3<=210              |          |             | 2          | CO2   | 2014   |
|         |       |  |                             |                 |                       |                  |        | $2 \cdot - + \circ$ |          |             |            |       |        |
|         |       | XI + X2 + 3X   | 3<=300,X1                   | + 3x2 1         | •x3<=30               | U,XI,XZ          | ,x3>=( | J                   |          |             |            |       |        |
| 3       | 1     | Give the c   | haracterist                 | ics of          | dual pr               | oblem            |        |                     |          |             | 8          | co3   | 2014   |
|         | 2     | Expalin th   | e primal du                 | ial rela        | ationshi              | ip.              |        |                     |          |             | 6          | CO3   | 2014   |
|         | 3     | Explain th   | e essence                   | of dua          | ality the             | ory              |        |                     |          |             | 10         | CO3   | 2010   |
|         | 4     | Write the  | duals of Ma                 | ax Z =>         | x1 + 2X               |                  |        |                     |          |             | 10         | CO3   | 2009   |
| 4       | 1     | Find the initial basic feasible solution using North-West corner method: |                             |                 |                       |                  |        |                     |          |             | 6          | CO4   | 2011   |
|         |       |  | D1                          | D2              |                       | D3               |        | D4                  | Re<br>en | quirem<br>t |            |       |        |
|         |       | F1   | 3                           | 3               |                       | 4                |        | 1                   | 100      | C           |            |       |        |
|         |       | F2   | 4                           | 2               |                       | 4                |        | 2                   | 125      | 5           | -          |       |        |
|         |       | F3   | 1                           | 5               |                       | 3                |        | 2                   | 75       | -           | -          |       |        |
|         |       | Dem and  | 120                         | 80              |                       | 75               |        | -<br>2E             | /3       |             | -          |       |        |
|         | 2     | Evolain th   |                             | thod            |                       | 75               |        | 20                  |          |             | 4          | CO4   | 2011   |
|         | 3     | Use VAM  | to find the                 | intial k        | oasic fe              | asible           | soluti | ons                 |          |             | 4          | CO4   | 2011   |
|         | 0     | Factories  | W1                          |                 | W2                    |                  | W3     | -                   | Avail    | bale        |            |       | 5      |
|         |       | F1   | 16                          |                 | 20                    |                  | 12     |                     | 200      |             |            |       |        |
|         |       | F2   | 14                          |                 | 8                     |                  | 18     |                     | 160      |             |            |       |        |
|         |       | F3   | 26                          |                 | 24                    |                  | 16     |                     | 90       |             |            |       |        |
|         |       | Required   | 180                         |                 |                       |                  | 170    |                     |          |             |            |       |        |
|         |       |  |                             |                 |                       |                  |        |                     |          |             |            |       |        |
|         |       |  |                             |                 |                       |                  |        |                     |          |             |            |       |        |

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|   | 4 | Ex<br>an                         | plain variou<br>1 example.                                  | s steps inv         | olved ir | n Hung  | arian m | ethod | with  | 8  | CO4 | 2012 |
|---|---|----------------------------------|---|---------------------|----------|---------|---------|-------|-------|----|-----|------|
|   | 5 | Solve the assignment problem:    |   |                     |          |         |         |       |       |    |     | 2011 |
|   |   |                                  |   |                     |          |         |         |       |       |    |     |      |
|   |   |                                  | P1  | P2                  |          | P3      |         | P4    |       |    |     |      |
|   |   | T1                               | 42  | 35                  |          | 28      |         | 21    |       |    |     |      |
|   |   | T2                               | 30  | 25                  |          | 20      |         | 15    |       |    |     |      |
|   |   | Т3                               | 30  | 25                  |          | 20      |         | 15    |       |    |     |      |
|   |   | Т4                               | 24  | 20                  |          | 16      |         | 12    |       |    |     |      |
| 5 | 1 | Explain<br>strategie<br>c)Two pe | :a)Minmax<br>es<br>erson zero si                            | and max<br>um game. | min pri  | nciple  | b)Pure  | and   | mixed | 6  | CO5 | 2013 |
|   | 2 | Solve by c                       | oncept of domin   | ance:               |          |         |         |       |       | 10 | CO5 | 2013 |
|   |   | 6                                | 15  | 30                  | 21       | 21      |         |       |       |    |     |      |
|   |   | 3                                | 3   | 6                   | 6        | 4       |         |       |       |    |     |      |
|   |   | 12                               | 12  | 24                  | 36       | 3       |         |       |       |    |     |      |
|   |   |                                  |   |                     |          |         |         |       |       |    |     |      |
|   | 3 | Solve the g                      | graphical method  | 1:                  |          |         |         |       |       | 10 | CO5 | 2015 |
|   |   |                                  | I   | II                  |          | I       | IV      | V     |       |    |     |      |
|   |   | I                                | 2   | -1                  | 5        | -       | -2      | 6     |       |    |     |      |
|   |   | 11                               | -2  | 4                   | -3       | 1       | 1       | 0     |       |    |     |      |
|   | 4 | Give an o                        | Give an outline of the Basic Simulated Annealing algorithm. |                     |          |         |         |       |       |    |     | 2015 |
|   | 5 | Explain k                        | oriefly 1)Gene  | etic algorit        | hm 2)Tal | ou sear | rch     |       |       | 6  | CO5 | 2005 |

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