



# GUJARAT TECHNOLOGICAL UNIVERSITY

Syllabus for Master of Computer Applications, 3<sup>rd</sup> Semester

Subject Name: Operations Research

Subject Code: 639406

With effective  
from academic  
year 2020-21

## 1. Teaching and Examination Scheme:

| Teaching Scheme |   |   | Credits | Examination Marks |         |                 |    | Total Marks |
|-----------------|---|---|---------|-------------------|---------|-----------------|----|-------------|
| L               | T | P |         | Theory Marks      |         | Practical Marks |    |             |
|                 |   |   | ESE (E) | PA (M)            | ESE (V) | PA (I)          |    |             |
| 3               | - | 2 | 4       | 70                | 30      | 30              | 20 | 150         |

## 2. Course Outcomes:

| Course Outcome Component | Course Outcome (Learner will be able to)  |
|--------------------------|---|
| CO1                      | <ul style="list-style-type: none"> <li>Understand the various optimization models and their areas of application.</li> </ul>                                      |
| CO2                      | <ul style="list-style-type: none"> <li>Explain the process of formulating and solving real world problems using optimization methods.</li> </ul>                  |
| CO3                      | <ul style="list-style-type: none"> <li>Describe different decision-making environments and apply decision making process in the real-world situations.</li> </ul> |

3. **Course Duration:** The course duration is of 45 sessions of 60 minutes each.

## 4. Course Contents:

| Unit No: | Contents  | No. of Sessions | 70 Marks (External Evaluation) |
|----------|---|-----------------|--------------------------------|
| I        | <ul style="list-style-type: none"> <li><b>Basics of Operations Research and Linear Programming</b></li> <li>(i) Basics of Operation Research<br/>Operation Research introduction, definitions, features, advantages and applications</li> <li>(ii) Linear Programming Problem (L.P.P.)<br/>Linear Programming Problem (L.P.P.), Mathematical definition of a L.P.P. with its components: objective function and constraints, optimal solution, slack, surplus and artificial variables, Graphic method, Simplex method, Big – M method, Primal &amp; Dual problem definition</li> </ul> | 12              | 18                             |
| II       | <ul style="list-style-type: none"> <li><b>Special Cases of L.P.P.</b></li> <li>(i) <b>Transportation problem (T.P.)</b><br/>Mathematical definition of a T.P., Method to find initial basic feasible solution, NorthWest corner rule, Least cost cell entry method, Vogel's approximation method, Test of optimality for finding an optimum solution – MODI method.</li> <li>(ii) <b>Assignment problem (A.P.)</b><br/>Mathematical definition of an Assignment Problem, Method to find an optimum solution - Hungarian Method, Variations of assignment problem</li> </ul>             | 10              | 14                             |
| III      | <ul style="list-style-type: none"> <li><b>Management of Inventory and Replacement</b></li> <li>(a) <b>Management of Inventory</b></li> </ul>  | 08              | 14                             |



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|           |   |    |    |
|-----------|---|----|----|
|           | Introduction and terminology of the inventory management problem including Objective(s) and Constraints; Single Item Inventory Control without Shortages Model –I: EOQ model with constant rate of demand Model – II: EOQ model with different rates of demand<br><b>(b) Management of Replacement</b><br>Definition, replacement of items that deteriorates, replacement of item that fails completely   |    |    |
| <b>IV</b> | <ul style="list-style-type: none"> <li><b>Project Management and Scheduling</b></li> <li><b>(i) Project Management (CPM &amp; PERT)</b><br/>Network concepts, components, rules for network construction, critical path method (CPM) and Project evaluation and Review Techniques (PERT)</li> <li><b>(ii) Production scheduling (job sequencing)</b><br/>Introduction, Johnson’s algorithm for n jobs 2 machines, Johnson’s algorithm for N jobs m machines, 2 jobs m machines using graphical method.</li> </ul> | 10 | 14 |
| <b>V</b>  | <ul style="list-style-type: none"> <li><b>Queuing Theory</b><br/>Introduction, Queuing system and problem, transient and steady states, traffic intensity, probability distributions in queuing systems, single service queuing model(s).</li> </ul>  | 05 | 10 |

## 5. Pedagogy:

- ICT enabled Classroom teaching
- Case study
- Practical / live assignment: Practical to be implemented using Python Based google or tools library or ‘R’ (Sample practical list is attached in Appendix-A)
- Interactive class room discussions

## 6. Evaluation:

Students shall be evaluated on the following components:

|          |  |                            |
|----------|--|----------------------------|
| <b>A</b> | <b>Internal Evaluation</b>   | <b>( Total - 20 Marks)</b> |
|          | <ul style="list-style-type: none"> <li>• Continuous Evaluation Component</li> </ul>    | 10 marks                   |
|          | <ul style="list-style-type: none"> <li>• Class Presence &amp; Participation</li> </ul> | 10 marks                   |
| <b>B</b> | <b>Mid-Semester examination</b>  | <b>(30 Marks)</b>          |
| <b>C</b> | <b>End –Semester Examination(Theory)</b>   | <b>(70 Marks)</b>          |
| <b>D</b> | <b>End –Semester Examination(Practical/Viva)</b>                                       | <b>(30 Marks)</b>          |

## 7. Reference Books:

| No. | Author       | Name of the Book                              | Publisher                  |
|-----|--------------|---|----------------------------|
| 1.  | J. K. Sharma | Operations Research – Theory and Application* | Macmillan Publishers India |



|    |                                      |  | Ltd.                           |
|----|--------------------------------------|--|--------------------------------|
| 2. | Kanti Swarup, Gupta P.K. , Man Mohan | Operations Research                        | Sultan Chand & Sons, New Delhi |
| 3. | V. K. Kapoor                         | Operations Research – Problems & Solutions | Sultan Chand & Sons, New Delhi |
| 4. | Shah, Gor, Soni                      | Operations Research                        | PHI                            |

\* Book mentioned at Sr no. 1 is considered as textbook to cover the topics.

Chapter wise coverage from Book 1.

| Unit No | Topics                            | Chapter                                 |
|---------|-----------------------------------|---|
| 1       | Basics of Operation Research      | Ch – 1 (1.1 to 1.5, 1.10, 1.13)         |
|         | Linear Programming Problem        | Ch – 2 (2.1, 2.2,2.3,2.4, 2.6,2.7, 2.8) |
|         | Simplex and Big-M Methods of LPP  | Ch. 4 (4.1 to 4.6)                      |
|         | Duality in LPP                    | Ch.5 (5.1, 5.2)                         |
| 2       | Transportation Problem            | Ch – 9 (9.1 to 9.5)                     |
|         | Assignment Problem                | Ch – 10 (10.1 to 10.4)                  |
| 3       | Inventory Management              | Ch – 14 (14.1 to 14.7)                  |
|         | Replacement                       | Ch – 17 (17.1 to 17.4)                  |
| 4       | Project Management (CPM and PERT) | Ch – 13 (13.1 to 13.6)                  |
|         | Job Sequencing                    | Ch – 20 (20.1 to 20.3, 20.5, 20.6)      |
| 5       | Theory of Queues                  | Ch – 16 (16.1 to 16.6)                  |

### Appendix-A

#### Sample Practical List

1. A toy manufacture produces two types of dolls; a basic version doll A and a deluxe version doll B. Each doll of type B takes twice as long to produces as one doll of type A. The company has time to make a maximum of 2,000 dolls of each type per day, and the supply of plastic is sufficient to produce 1,500 dolls per day and each type requires equal amount of it. The deluxe version, i.e. type B requires a fancy dress of which there are only 600 per day available. If the company makes a profit of Rs. 30 and Rs. 50 per doll, respectively, on doll A and B; how many of each should be produced per day in order to maximize profit? Formulate the problem as LPP and solve it by graphic method.
2. Solve using the Simplex method the following problem:  

$$\text{Maximize } Z = f(x,y) = 3x + 2y$$

$$\text{Subject to: } 2x + y \leq 18$$

$$2x + 3y \leq 42$$

$$3x + y \leq 24$$

$$x \geq 0, y \geq 0$$
3. Solve using the Simplex method the following problem:  

$$\text{Maximize } p = 2x - 3y + z$$

$$\text{Objective function subject to } x + y + z \leq 10$$

$$4x - 3y + z \leq 3$$

$$2x + y - z \leq 10$$

$$x \geq 0, y \geq 0, z \geq 0$$



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4. Develop a generalized program to solve optimized **Transportation problem**. First develop the program for a balanced problem, make a copy of that program and then modify to take care of unbalanced problem. Ask number of sources and destinations and the costs of transportation from every source to every destination. Show allocation at every step, final allocation and total transportation cost.
5. Develop a generalized program to solve optimized **Assignment problem**. First develop the program for a balanced problem, make a copy of that program and then modify to take care of unbalanced problem. Ask number of sources and destinations and the costs of transportation from every source to every destination. Show allocation at every step, final allocation and total transportation cost.
6. A certain item costs Rs. 75 per ton. The requirement is 8,000 tons per year and each time the stock is replenished there is a set – up cost of Rs. 600. The cost of carrying inventory has been estimated at 12.8 per cent of the value of the stock per year. Find out the optimal order quantity, number of orders required to be placed in a year, number of days between two successive orders and total variable inventory cost. Assume 360 days in a year.
7. A television repairman finds that the time spent on repairing each TV has an exponential distribution with a mean of 15 minutes. He repairs the sets in the order in which they arrive. The arrival of sets follows a Poisson distribution approximately with an average rate of 16 per 8 hour day. Find out for how many hours would the repairman be busy in a day, what is the average number of TV sets in the system and the average waiting time of a TV set in the system.
8. There are 5 workers and their work time to complete their jobs on different machines are given below. Develop a program to solve **Assignment problem** for minimum solution

|          | Machine 1 | Machine 2 | Machine 3 | Machine 4 | Machine 5 |
|----------|-----------|-----------|-----------|-----------|-----------|
| Worker 1 | 8         | 5         | 7         | 7         | 8         |
| Worker 2 | 9         | 5         | 6         | 7         | 8         |
| Worker 3 | 6         | 8         | 5         | 6         | 9         |
| Worker 4 | 8         | 10        | 7         | 6         | 5         |
| Worker 5 | 4         | 6         | 5         | 6         | 4         |

9. There are 5 salesman and each of them can work on any one of 5 districts. Table below shows average revenue generated by each of them. Develop a program to solve **Assignment problem** for maximization.

|            | District 1 | District 2 | District 3 | District 4 | District 5 |
|------------|------------|------------|------------|------------|------------|
| Salesman 1 | 250        | 198        | 206        | 220        | 210        |
| Salesman 2 | 240        | 220        | 196        | 208        | 212        |
| Salesman 3 | 260        | 240        | 198        | 220        | 220        |
| Salesman 4 | 240        | 250        | 194        | 208        | 200        |
| Salesman 5 | 240        | 220        | 198        | 200        | 204        |



10. A television repairman finds that the time spent on his jobs has an exponential distribution with mean of 30 minutes. If he repairs sets in the order in which they came in, and if the arrival of sets follows a Poisson distribution approximately with an average rate of 10 per 8-hour day, what is the repairman's expected idle time each day? How many jobs are ahead of the average set just brought in?
11. On an average 96 patients per 24-hour day require the service of an emergency clinic. Also on an average, a patient requires 10 minutes of active attention. Assume that the facility can handle only one emergency at a time. Suppose that it costs the clinic Rs 100 per patient treated to obtain an average servicing time of 10 minutes, and that each minutes of decrease in this average time would cost Rs. 10 per patient treated. How much would have to be budgeted by the clinic to decrease the average size of the queue from one and one-third patients to half patient.
12. Students arrive at the head office according to a Poisson input process with a mean rate of 40 per hour. The time required to serve a student has an exponential distribution with a mean of 50 per hour. Assume that the students are served by a single individual, find the average waiting time of a student.
13. Develop a program to Find Critical Path, completion time, float time for following activity table.

| Activity | Duration |
|----------|----------|
| 1-2      | 6        |
| 1-3      | 8        |
| 2-4      | 3        |
| 2-5      | 5        |
| 3-5      | 9        |
| 4-5      | 6        |
| 5-6      | 8        |

**Desirable:**

14. Develop a generalized **sequencing** program for n jobs and m machines. First develop a program for n jobs two machines, make a copy and then make it general for n jobs m machines. Show the sequence after every iteration, final sequence, total elapsed time and idle times for every machine