GUJARAT TECHNOLOGICAL UNIVERSITY

Syllabus for Master of Computer Applications, 5th Semester
Subject Name: Operations Research (OR)
Subject Code: 4659310

With effective from academic year 2018-19

1. **Learning Objectives:**

- To get a basic understanding of Operation Research Techniques for optimum utilization of constrained resources in wide range of areas including industry, business, commerce, administration, management, service supply, maintenance, agriculture, medicines and healthcare, defense etc.
- For a given problem statement, students will be able to develop ability to
  - Classify the class of problem (LPP or Transportation or Assignment ... etc),
  - Formulate the appropriate OR model,
  - Find the solution, and
  - Interpret the results

NOTE: Mathematical derivations are not included for any topic identified.

2. **Prerequisites:** Basic knowledge of Mathematics and Probability Distributions

3. **Contents:**

Unit	Chapter Details	Weightage Percentage
Unit I	**Basics of Operations Research, Transportation Problem & Assignment Problem** **(a) Basics of Operation Research** Introduction, definitions, features, advantages and applications **(b) Transportation problem (T.P.)** Formulation of a T.P., Methods 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. Variations of Transportation Problems **(c) Assignment problem (A.P.)** Formulation of an Assignment Problem, Method to find an optimum solution - Hungarian Assignment Method, Variations of assignment problem	**20%**
Unit II	**Management of Inventory and Replacement** **(a) Management of Inventory** 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. **(b) Management of Replacement** Definition, replacement of items that deteriorates, replacement of item that fails completely	**15%**
Unit III	**(a) Theory of Games** Introduction, Two-Person Zero Sum game, Pure strategies (Minimax & Maximin principles) Games with Saddle Point, Rules to determine Saddle Point, Mixed Strategies, Rules of Dominance, Solution methods games without Saddle Point	**25%**

	(b) Queuing Theory Introduction, Queuing system and problem, transient and steady states, traffic intensity, probability distributions in queuing systems, single service queuing model(s). **(c) Simulation** Introduction, applications, Monte-Carlo Method, Simulation using Computers, Simulation of Inventory Problems, Queuing Problems, Investment problems	
Unit IV	**Project Management and Scheduling** **(a) Project Management (CPM & PERT)** Network concepts, components, rules for network construction, critical path method (CPM) and Project evaluation and Review Techniques (PERT) **(b) Production Scheduling (Job Sequencing)** Introduction, Johnson's algorithm for N jobs on 2 machines, Johnson's algorithm for N jobs on M machines	**20%**
Unit V	**Linear Programming Problem (L.P.P.)** Linear Programming Problem (L.P.P.), Formulation of a L.P.P. with its components: objective function and constraints, optimal solution, slack, surplus and artificial variables, Graphical method, Simplex method, Big-M method, Primal & Dual problem definition	**20%**

Desirable Topic: Decision Thoery (EMV criteria, EVPI, EPPI), Max-min principle, Minmax principle, Hurwitz's principle, Laplace principle (Chapter 11 from Main Text Book)

4. Text Book:

1. J. K. Sharma, "Operations Research – Theory and Application", 4th Edition, Macmillan Publishers India Ltd.

5. Reference Books:

1. Kanti Swarup, Gupta P.K. , Man Mohan, "Operations Research", Sultan Chand & Sons, New Delhi
2. Shah, Gor, Soni, "Operations Research", PHI
3. V. K. Kapur, "Operations Research – Problems & Solutions", Sultan Chand & Sons, New Delhi

6. Chapter wise Coverage from Main Reference Book(s):

Unit No.	Text Books	Topics/Subtopics
1	Basics of Operation Research	Ch – 1 (1.1 to 1.5, 1.10, 1.13)
	Transportation Problem	Ch – 9 (9.1 to 9.5)
	Assignment Problem	Ch – 10 (10.1 to 10.4)

2	Inventory Management	Ch – 14 (14.1 to 14.7)
	Replacement	Ch – 17 (17.1 to 17.4)
3	Game theory	Ch. 12 (12.1 to 12.6)
	Queuing theory	Ch. 16 (16.1 to 16.6)
	Simulation	Ch – 19 (19.1 to 19.12)
4	Project Management (CPM and PERT)	Ch – 13 (13.1 to 13.6)
	Job Sequencing	Ch – 20 (20.1 to 20.3, 20.5)
5	Basics of Linear Programming	Ch – 2 (2.1, 2.2,2.3,2.4, 2.6,2.7, 2.8)
	Graphical Method of LPP	Ch – 3 (3.1, 3.2, 3.3.1 to 3.3.3, 3.4)
	Simplex Method of LPP	Ch. 4 (4.1 to 4.6)
	Duality in LPP	Ch. 5 (5.1 and 5.2)

7. Accomplishments of the student after completing the course:

- Ability to classify and formulate Operation Research problems.
- Ability to design and construct suitable optimization models and to find solution of real life problems from diverse fields.
- Ability to interpret results.

8. Practical List

Tools: R /R Studio

1. A company is involved in the production of two items (X and Y). The resources need to produce X and Y are twofold, namely machine time for automatic processing and craftsman time for hand finishing. The table below gives the number of minutes required for each item:
   Machine time Craftsman time

   Item X 13 20
   Y 19 29

   The company has 40 hours of machine time available in the next working week but only 35 hours of craftsman time. Machine time is costed at £10 per hour worked and craftsman time is costed at £2 per hour worked. Both machine and craftsman idle times incur no costs. The revenue received for each item produced (all production is sold) is £20 for X and £30 for Y.
   The company has a specific contract to produce 10 items of X per week for a particular customer.
    - Formulate the problem of deciding how much to produce per week as a linear program.
    - Solve this linear program graphically

2. Solve using the Simplex method the following problem:
   Maximize $Z = f(x,y) = 3x + 2y$
   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:
   Maximize $p = 2x - 3y + z$ Objective function
   subject to $x + y + z \leq 10$
   $4x - 3y + z \leq 3$
   $2x + y - z \leq 10$
   $x \geq 0, y \geq 0, z \geq 0$

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 tonne. The requirement is 8,000 tonnes 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