Department of Mechanical Engineering

Course File

OPERATIONS RESEARCH

(Course Code: A92004)

III ME II Semester

2023-24

S JEEVAN REDDY
Asst.Professor

Ananthagiri, Kodad, Telangana 508 206, India.

Department of Mechanical Engineering

QUANTITATIVE ANALYSIS FOR BUSINESS DECISIONS

Check List

Department of Mechanical Engineering

Int. Marks:30 Ext. Marks:70 Total Marks

ANURAG ENGINEERING COLLEGE

(An Autonomous Institution)

B.Tech ME III Year II-Semester	L	T	P	C
	3	0	0	3

(ME604PC) OPERATIONS RESEARCH

Course Objectives:

1. Analyze any real life system with limited constraints and convert the problem into a mathematical model.
2. Minimize Transportation cost to transport from source to destination and minimize the Assignment cost to assign the jobs to person.
3. Minimize the Total elapsed time i.e minimize time to complete starting of the first job to the ending of last job.
   Replacement gives best profits when we replace the machine if it is not working or damaged or maintains cost is too high.
4. Using game theory we can find which player wins or loss the game.
   Inventory: To maintain sufficient stock without damage and to decrease the rent for Godowns.
5. We can find waiting time and number of customers in the system, number of customer in the line or que and capacity of the customer to serve.

UNIT-I

Development-definition- characteristics and phases- types of models-operation research models-applications.

Allocation: linear programming problem formulation-graphical solutions-simplex method-artificial variables techniques, two- phase method big M method.

UNIT-II

Transportation Problem- formulation-optimal solution, unbalanced transportation problem-degeneracy.

Assignment Problem-formulation- optimal solution-variants of assignment problem-travelling sales man problem

UNIT-III

Sequencing: Introduction – flow- shop sequencing –n jobs through two machines –n job through n machines-job shop sequencing-two job through m machines

Replacement: Introduction- replacement of items that deteriorate with time -when money value is not counted and counted- replacement of items that fail completely- group replacement

UNIT-IV

Theory of games: Introduction-terminology-solution of games with saddle points-and without saddle point's 2 by 2 games- dominance principle- m by 2 and 2 by N games- graphical method

Inventory Models: Definition- Functions-Inventory associated costs- Statement of inventory problem-Classification of inventory problems/Models: Deterministic inventory models- Constant price models-without shortage, with shortage, infinite production rate, finite production rate, and with shortage and finite production rate. Price break models: Single price break & Multi price break model. Stochastic Inventory models: Single period models-Discrete and Continuous models.

UNIT-V:

Waiting lines: Introduction-terminology single channel-poission arrivals and exponential service times -with infinite population and finite populations' models- and exponential service times with infinite populations

Dynamic programming: Introduction -terminology - bell mans principle of optimality applications of dynamic programming -shortest path problem- linear programming problem

Advantages and disadvantages applications of simulation to queuing and inventory.

Text books:

1. Operation Research-J K Sharma 4e -Macmillan.
2. Introduction to OR-Hiller & Liberman-TMH

Reference books:

1. Introduction to OR-Taha-PHI
2. Operation Research-NVS Raju-SMS education-3rd revised edition
3. Operation Research-AM Natarajan,P Balasubrmanian,A Tamilarasi-person education
4. Operation Research-Wagner-PHI Publications
5. Operation Research-MV Durga prasadh, vijaykumar Reddy, J Suresh kumar-Cengage learning.

Course Outcomes:

CO1: Identify and develop O.R models from the verbal description of the real system.
CO2: Understand the mathematical tools to solve assignment, transportations and travelling Salesman problem.
CO3: Able to calculate the Total Elapsed Time and idle time for different machines and minimize The cost.
CO4: Able to calculate saddle point of games and Able to solve Inventory models.
CO5: Calculate service time for different models and able to apply dynamic programming and Able to know the advantages and disadvantages of simulation.

Co-Po Mapping:

PO'S / CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	√				√						√
CO 2	√	√	√		√			√			
CO 3	√	√	√								√
CO 4	√										
CO 5	√	√	√		√			√			√

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Timetable

II ME, II Semester –OPERATIONS RESEARCH

Day/Hour	9.30-10.20	10.20-11.10	11.20-12.10	12.10-1.00	1.00-1.40	1.40-2.25	2.25-3.10	3.15-4.00
Monday			O.R		LUNCH BREAK			
Tuesday								O.R
Wednesday				O.R				
Thursday								
Friday				O.R				
Saturday				O.R				

Department of Mechanical Engineering

Vision of the Institute

To be a premier Institute in the country and region for the study of Engineering, Technology and Management by maintaining high academic standards which promotes the analytical thinking and independent judgment among the prime stakeholders, enabling them to function responsibly in the globalized society.

Mission of the Institute

To be a world-class Institute, achieving excellence in teaching, research and consultancy in cutting-edge Technologies and be in the service of society in promoting continued education in Engineering, Technology and Management.

Quality Policy

To ensure high standards in imparting professional education by providing world-class infrastructure, top-quality-faculty and decent work culture to sculpt the students into Socially Responsible Professionals through creative team-work, innovation and research

Vision of the Department

To impart technical knowledge and skills required to succeed in life, career and help society to achieve self sufficiency.

Mission of the Department

- To become an internationally leading department for higher learning.
- To build upon the culture and values of universal science and contemporary education.
- To be a center of research and education generating knowledge and technologies which lay groundwork in shaping the future in the fields of electrical and electronics engineering.
- To develop partnership with industrial, R&D and government agencies and actively participate in conferences, technical and community activities.

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Program Educational Objectives (ME)
Graduates will be able
PEO1: To transcend in a professional career by acquiring knowledge in basic sciences, mathematics and mechanical engineering.
PEO2: To exhibit problem solving skills on par with global requirements in industry and R&D.
PEO3: To adopt the latest technologies, evolve as entrepreneurs, solving mechanical engineering problems, dealing with environmental society and ethical issues.
PEO4: Ability to involve actively in multidisciplinary teams and lifelong

PSO'S
PSO1: Problem Solving Skills: Ability identifies, analyze and solve engineering problems relating to mechanical engineering system together with allied engineering streams.
PSO2: Professional Skills: Ability to use the software effectively in the design, analysis and manufacturing of mechanical components and systems.
PSO3: Successful Career and Entrepreneurship Skills: An ability of collaborative learning to find out cost-effective, optimal solution, sustainable growth.

Program Outcomes (ME)
Engineering Graduates will be able to:
PO 1:An ability to apply the knowledge of mathematics, science and engineering fundamentals.
PO 2: An ability to conduct Investigations using design of experiments, analysis and interpretation of data to arrive at valid conclusions.
PO 3: An ability to design mechanical engineering components and processes within economic, environmental, ethical and manufacturing constraints.
PO 4: An ability to function effectively in multidisciplinary teams.
PO 5: An ability to identify, formulates, analyze and solve Mechanical Engineering problems.
PO 6: An ability to understand professional, ethical and social responsibility.
PO 7: An ability to communicate effectively through written reports or oral presentations.
PO 8: The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
PO 9: An ability to recognize the need and to engage in independent and life-long learning.
PO 10: A knowledge of contemporary issues.
PO 11: An ability to use the appropriate techniques and modern engineering tools necessary for engineering practice.

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COURSE OBJECTIVES

On completion of this Subject/Course the student shall be able to:

S.No	Objectives
1	Analyze any real life system with limited constraints and convert the problem into a mathematical model.
2	Minimize Transportation cost to transport from source to destination and minimize the Assignment cost to assign the jobs to person.
3	Minimize the Total elapsed time i.e minimize time to complete starting of the first job to the ending of last job. Replacement gives best profits when we replace the machine if it is not working or damaged or maintains cost is too high.
4	Using game theory we can find which player wins or loss the game. Inventory: To maintain sufficient stock without damage and to decrease the rent for Godowns.
5	We can find waiting time and number of customers in the system, number of customer in the line or que and capacity of the customer to serve.

COURSE OUTCOMES

The expected outcomes of the Course/Subject are:

S.No	Outcomes
1.	Identify and develop O.R models from the verbal description of the real system.
2.	Understand the mathematical tools to solve assignment, transportations and travelling Salesman problem.
3.	Able to calculate the Total Elapsed Time and idle time for different machines and minimize The cost.
4.	Able to calculate saddle point of games and Able to solve Inventory models.
5.	Calculate service time for different models and able to apply dynamic programming and Able to know the advantages and disadvantages of simulation.

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Note: Please refer to Bloom's Taxonomy, to know the illustrative verbs that can be used to state the outcomes.

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GUIDELINES TO STUDY THE COURSE / SUBJECT

Course Design and Delivery System (CDD):

- The Course syllabus is written into number of learning objectives and outcomes.
- Every student will be given an assessment plan, criteria for assessment, scheme of evaluation and grading method.
- The Learning Process will be carried out through assessments of Knowledge, Skills and Attitude by various methods and the students will be given guidance to refer to the text books, reference books, journals, etc.

The faculty be able to –

- Understand the principles of Learning
- Understand the psychology of students
- Develop instructional objectives for a given topic
- Prepare course, unit and lesson plans
- Understand different methods of teaching and learning
- Use appropriate teaching and learning aids
- Plan and deliver lectures effectively
- Provide feedback to students using various methods of Assessments and tools of Evaluation
- Act as a guide, advisor, counselor, facilitator, motivator and not just as a teacher alone

Signature of HOD

Date:

Signature of faculty

Date:

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COURSE SCHEDULE

The Schedule for the whole Course / Subject is:

S. No.	Description	Duration (Date)		Total No. of Periods
		From	To	
1.	**Unit – I:** Introduction to Operations Research: Nature and Scope of Operations Research: Origins of OR, Applications of OR in different Managerial Areas, Problem Solving and Decision-making, Quantitative and Qualitative Analysis. Defining a Model, Types of Models and Process for Developing an Operations Research Model, Practices, Opportunities and Shortcomings of using an OR Model.	16.06.2023	30.06.2023	9
2.	**Unit – II:** Linear Programming Method: Structure of LPP, Assumptions of LPP, Application Areas of LPP, Guidelines for Formulation of LPP, Formulation of LPP for Different Areas, Solving of LPP by Graphical Method: Extreme Point Method, Simplex Method, Converting Primal LPP to Dual LPP, Limitations of LPP.	04.07.20223	19.07.2023	21
3.	**Unit – III: Assignment Model:** Algorithm for Solving Assignment Model, Hungarians Method for Solving Assignment Problem, Variations of Assignment Problem: Multiple Optimal Solutions, Maximization Casein Assignment Problem, Unbalanced Assignment Problem, Travelling Salesman Problem, Simplex Method for Solving Assignment Problem. **Transportation Problem:** Mathematical Model of Transportation Problem, Methods for Finding Initial Feasible Solution: Northwest Corner Method, Least Cost Method, Vogel's Approximation Method, Test of Optimality by Modi Method, Unbalanced Supply and Demand, Degeneracy and its resolution.	24.07.2023	14.08.2023	12
4.	Unit – IV: Decision Theory: Introduction, Ingredients of Decision Problems. Decision-making under Uncertainty Cost of Uncertainty Under Risk, Under Perfect Information, Decision Tree, Construction of Decision Tree. Network Analysis: Network Diagram, PERT, CPM, Critical Path Determination, Project Completion Time, Project Crashing.	16.08.2023	06.09.2023	14
5.	Unit – V: Queuing Theory: Queuing Structure and Basic Component of a Queuing Model, Distributions in	08.09.2023	06.10.2023	18

	Queuing Model, Different Queuing Models with FCFS, Queue Discipline, Single and Multiple Service Station with Finite and Infinite Population. Game Theory, Saddle Point, Value of the Game incidence at a plane dielectric boundary			

Total No. of Instructional periods available for the course: 73 Hours

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SCHEDULE OF INSTRUCTIONS - COURSE PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
1.	1	16.06.2023	1	Introduction to Operations Research: Nature and Scope of Operations Research	1 2	J.K. Sharma, Operations Research
	2	17.06.2023	1	Origins of OR, Applications of OR in different Managerial Areas,	1 2	J.K. Sharma, Operations Research
	3	19.06.2023	1	Problem Solving and Decision-making,	1 1	J.K. Sharma, Operations Research
	4	20.06.2022	1	Quantitative Analysis	1 1	J.K. Sharma, Operations Research
	5	21.06.2023	1	Qualitative Analysis	1 1	J.K. Sharma, Operations Research
	6	23.06.2023	1	Defining a Model, Types of Models	1 2	J.K. Sharma, Operations Research
	7	24.06.2023	1	Process for Developing an Operations Research Model	1 1	J.K. Sharma, Operations Research
	8	27.06.2023	1	Practices, Opportunities and Shortcomings of using an OR Model.	1 2	J.K. Sharma, Operations Research
2.	1	28.06.2023	1	Linear Programming Method: Structure of LPP, Assumptions of LPP	1 2	J.K. Sharma, Operations Research
	2	30.06.2023	1	Application Areas of LPP	1 2	J.K. Sharma, Operations Research
	3	04.07.2023	1	Guidelines for Formulation of LPP	1 2	
	4	05.07.2023	1	Formulation of LPP for Different Areas,	1 2	J.K. Sharma, Operations Research
	5	07.07.2023	1	Solving of LPP by Graphical Method: Extreme Point Method	1 2	J.K. Sharma, Operations Research

	6	10.07.2023	1	Simplex Method	1 2	J.K. Sharma, Operations Research
	7	12.07.2023	1	Artificial variable techniques: Big m method	1 2	J.K. Sharma, Operations Research
	8	14.07.2023	1	Two-phase simplex method	1 2	J.K. Sharma, Operations Research
	9	18.07.2023	2	Converting Primal LPP to Dual LPP	1 2	J.K. Sharma, Operations Research
	10	19.07.2023	1	Limitations of LPP	1 2	J.K. Sharma, Operations Research
3.	1	24.07.2023	1	Assignment Model: Introduction	1 2	J.K. Sharma, Operations Research
	2	25.07.2023	1	Algorithm for Solving Assignment Model: Hungarians Method for Solving Assignment Problem,	1 2	J.K. Sharma, Operations Research
	3	27.07.2023	1	Travelling Salesman Problem,	1 2	J.K. Sharma, Operations Research
	4	31.07.2023	1	Simplex Method for Solving Assignment Problem.	1 2	J.K. Sharma, Operations Research
	5	01.08.2023	1	Transportation Problem: Mathematical Model of Transportation Problem	1 2	J.K. Sharma, Operations Research
	6	04.08.2023	1	Methods for Finding Initial Feasible Solution: Northwest Corner Method	1 2	J.K. Sharma, Operations Research
	7	05.08.2023	1	Least Cost Method	1 2	J.K. Sharma, Operations Research
	8	07.08.2023	1	Vogel's Approximation Method	1 2	J.K. Sharma, Operations Research
	9	08.08.2023	1	Test of Optimality by Modi Method,	1 2	J.K. Sharma, Operations Research
	10	14.08.2023	1	Unbalanced Supply and Demand	1 2	J.K. Sharma, Operations Research
	11	16.08.2023	1	Degeneracy and its resolution.	1 2	J.K. Sharma, Operations

						Research
4	1	17.08.2023	1	Decision Theory: Introduction, Ingredients of Decision Problems	1 2	J.K. Sharma, Operations Research
	2	18.08.2023	1	Decision-making under Uncertainty	1 2	J.K. Sharma, Operations Research
	3	21.08.2023	1	Decision-making under risk	1 2	J.K. Sharma, Operations Research
	4	25.08.2023	1	Decision-making under certainty	1 1	J.K. Sharma, Operations Research
	4	28.08.2023	1	Decision Tree, Construction of Decision Tree.	1 2	J.K. Sharma, Operations Research
	5	30.08.2023	1	Network Analysis: Network Diagram	1 2	J.K. Sharma, Operations Research
	6	02.09.2023	1	PERT,CPM	1 2	J.K. Sharma, Operations Research
	7	05.09.2023	1	Critical Path Determination	1 2	J.K. Sharma, Operations Research
	8	06.09.2023	1	Project Completion Time	1 2	J.K. Sharma, Operations Research
	9	08.09.2023	1	Project crashing	1 2	
5	1	11.09.2023	1	Queuing Theory: Queuing Structure	1 2	J.K. Sharma, Operations Research
	2	12.09.2023	1	Basic Component of a Queuing Model	1 2	J.K. Sharma, Operations Research
	3	19.09.2023	1	Distributions in Queuing Mode	1 2	J.K. Sharma, Operations Research
	4	21.09.2023	1	Different Queuing Models with FCFS,	1 2	J.K. Sharma, Operations Research
	5	22.09.2023	1	Queue Discipline, Single Service Station with Finite Population	1 2	J.K. Sharma, Operations Research
	6	23.09.2023	1	Queue Discipline, Single Service Station with Infinite Population	1 2	J.K. Sharma, Operations Research
	7	24.09.2023	1	Queue Discipline,	1	J.K. Sharma,

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				Multiple Service Station with Finite Population	2	Operations Research
	8	25.09.2023		Queue Discipline, Multiple Service Station with Infinite Population	1 2	J.K. Sharma, Operations Research
	9	26.09.2023	1	Introduction of Game Theory	1 2	J.K. Sharma, Operations Research
	10	29.09.2023	1	Basic definitions of game Theory	1 2	J.K. Sharma, Operations Research
	11	30.09.2023	1	Calculation of saddle point and Value of the Game	1 2	J.K. Sharma, Operations Research
	8	06.10.2023	1	Revision of Unit III	1 2	J.K. Sharma, Operations Research

Signature of HOD

Date:

Signature of faculty

Date:

Note:

1. Ensure that all topics specified in the course are mentioned.
2. Additional topics covered, if any, may also be specified in bold.
3. Mention the corresponding course objective and outcome numbers against each topic.

LESSON PLAN (U-I)

Department of Mechanical Engineering

Lesson No: 01 Duration of Lesson: 2hr30 min

Lesson Title: Introduction to Operations Research

Instructional / Lesson Objectives:

- To make students identify a problem or question is to analyze
- The students can create a mathematical model of the problem or question
- Employ the model to create possible solutions
- Analyze and compare possible solutions to find the best fit.

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Teaching AIDS : PPTs, Digital Board

Time Management of Class :

5 mins for taking attendance 130 min for the lecture delivery 15 min for doubts session

Assignment / Questions:

(Note: Mention for each question the relevant Objectives and Outcomes Nos.1,2,3,4 & 1,3..)

Refer assignment – I & tutorial-I sheets

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LESSON PLAN (U-II)

Lesson No:2 Duration of Lesson: 1hr30 MIN

Lesson Title: Linear Programming problem

Instructional / Lesson Objectives:

- To make students identify a problem or question is to analyze
- The students can create a mathematical model of the problem or question
- Employ the model to create possible solutions
- Analyze and compare possible solutions to find the best fit.

Teaching AIDS : PPTs, Digital Board

Time Management of Class :

5 mins for taking attendance 15 for revision of previous class 55 min for lecture delivery 15 min for doubts session

Assignment / Questions:

(Note: Mention for each question the relevant Objectives and Outcomes Nos.1,2,3,4 & 1,3..)

Refer assignment – I & tutorial-I sheets

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LESSON PLAN (U-III)

Lesson No: 4,5 Duration of Lesson: 1hr30 MIN

Lesson Title: Assignment and Transportation problem

Instructional / Lesson Objectives:

- To make students identify a problem or question is to analyze
- The students can create a mathematical model of the problem or question
- Employ the model to create possible solutions
- Analyze and compare possible solutions to find the best fit.

.

Teaching AIDS : PPTs, Digital Board
Time Management of Class :

5 mins for taking attendance 15 for revision of previous class 55 min for lecture delivery 15 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1,2,3,4 & 1,3..)

Refer assignment-II & tutorial-II sheets.

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LESSON PLAN (U-IV)

Lesson No:6,7 Duration of Lesson: 1hr30 MIN

Lesson Title: Decision theory

Instructional / Lesson Objectives:

- To make students identify a problem or question is to analyze
- The students can create a mathematical model of the problem or question
- Employ the model to create possible solutions
- Analyze and compare possible solutions to find the best fit.

Teaching AIDS : PPTs, Digital Board

Time Management of Class :

5 mins for taking attendance 15 for revision of previous class 55 min for lecture delivery 15 min for doubts session

Assignment / Questions:

(Note: Mention for each question the relevant Objectives and Outcomes Nos.1,2,3,4 & 1,3..)

Refer assignment – I & tutorial-I sheets

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LESSON PLAN (U-V)

Lesson No:8,9 Duration of Lesson: 1hr30 MIN

Lesson Title: Queuing theory

Instructional / Lesson Objectives:

- To make students identify a problem or question is to analyze
- The students can create a mathematical model of the problem or question
- Employ the model to create possible solutions
- Analyze and compare possible solutions to find the best fit.

Teaching AIDS : PPTs, Digital Board
Time Management of Class :

5 mins for taking attendance 15 for revision of previous class 55 min for lecture delivery 15 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1,2,3,4 & 1,3..)

Refer assignment – I & tutorial-I sheets

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Department of Mechanical Engineering
ASSIGNMENT – 1

This Assignment corresponds to Unit No. 1

Question No.	Question	Objective No.	Outcome No.
1	Explain applications of O.R in different managerial areas.	1	1
2	Explain advantages and disadvantages of O.R	1	1
3	Explain modeling of O.R and explain about any two models in O.R	1	1

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ASSIGNMENT – 2

This Assignment corresponds to Unit No. 2

Question No.	Question	Objective No.	Outcome No.
1	A firm manufactures two products A and b on which the profits earned per unit are Rs 3 and Rs 4 respectively. Each product is processed on two machines M1 and M2. Product A requires one minute of processing time on M1 and two minutes on M2 while B requires one minute on M1 and one minute on M2. Machine M1 is available for not more than 7 hours, while machine M2 is available for 10 hours during any working day. Formulate the number of units of products A and B to be manufactured to get maximum profit.	2	2
2	Write an algorithm for graphical method of solving LPP	2	2
3	Solve the following LPP by using simplex method Subject to $3X_1+X_2+ 3X_3\leq 7$ $X_1-2X_2\leq 6$ $4X_1+ 3X_2 +5X_3\leq 10$ and $X_1, X_2, X_3 \geq 0$	2	2

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Date:

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ASSIGNMENT – 3

This Assignment corresponds to Unit No. 3

<table>
<tr><th>Question No.</th><th>Question</th><th>Objective No.</th><th>Outcome No.</th></tr>
<tr><td>1</td><td>Solve the following T.P by using North-west corner rule
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>SUPPLY</th></tr>
<tr><td>I</td><td>10</td><td>15</td><td>13</td><td>14</td><td>150</td></tr>
<tr><td>II</td><td>11</td><td>9</td><td>8</td><td>16</td><td>100</td></tr>
<tr><td>III</td><td>7</td><td>12</td><td>18</td><td>19</td><td>50</td></tr>
<tr><td>Demand</td><td>50</td><td>100</td><td></td><td>80</td><td>70</td></tr>
</table></td><td>3</td><td>3</td></tr>
<tr><td>2</td><td>Explain Vogel's approximation method of finding an IBFS of T.P</td><td>3</td><td>3</td></tr>
</table>

Signature of HOD

Signature of faculty

Date:

Date:

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ASSIGNMENT – 4

This Assignment corresponds to Unit No. 4

Question No.	Question	Objective No.	Outcome No.
1	What are the steps involved in decision making?	4	4
2	Explain the utility as a decision Criterion.	4	4
3	What is decision making?. Explain and differentiate this under the conditions of certainty and uncertainty	4	4

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Date:

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ASSIGNMENT – 5

This Assignment corresponds to Unit No. 5

Question No.	Question	Objective No.	Outcome No.
1	A self service store employee's one cashier at its counter. Nine customers arrive on an average every 5 minutes while the cashier can serve 10 customers in 5 minutes. Assuming Poisson distribution for arrival rate and exponent distribution for service time, find the following (i) Average number of customers in the system (ii) Average number of customers in the queue or average queue length (iii)Average time a customer spends in the system (iv) Average time a customer waits before being served.	4	4
2	(b) Find the ranges of values of p and q which will render the entry (2,2) a saddle point for the game B_1 B_2 B_3 A_1 2 4 5 A_2 10 7 q A_3 4 P 6	4	4
3	List out characteristics of games	4	4

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TUTORIAL – 1

This tutorial corresponds to Unit No. 1 (Objective Nos.: 1, Outcome Nos.: 1)

Q1. Who defined Operations Research as scientific approach to problem solving for executive management?
a) E.L. Arnoff b) P.M.S. Blackett c) H.M. Wagner d) None of the above

Q2. Operations Research attempts to find the best and ---------- solution to a problem
a) Optimum b) Perfect c) Degenerate d) None of the above

Q3. ---------- are called mathematical models
a) Iconic Models b) Analogue Models c) Symbolic Models d) None of the above

Q4. Write any two definitions of O.R

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TUTORIAL – 2

This tutorial corresponds to Unit No. 2 (Objective Nos.: 2, Outcome Nos.: 2)

Q1. In simplex algorithm, which method is used to deal with the situation where an infeasible starting basic solution is given?
a) Slack variable b) Simplex method c) M- method d) None of the above

Q2. LP model is based on the assumptions of ----------
a) Proportionality b) Additivity c) Certainty d) All of the above

Q3. Any solution to a LPP which satisfies the non- negativity restrictions of the LPP is called its --------
a) Unbounded solution b) Optimal solution c) Feasible solution d) Both A and B

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TUTORIAL SHEET – 3

This tutorial corresponds to Unit No. 3 (Objective Nos.: 3, Outcome Nos.: 3)

Q1. A feasible solution is called a basic feasible solution if the number of non-negative allocations is equal to ----------

a) m-n+1 b) m-n-1 c) m+n-1 d) None of the above

Q2. MODI method is used to obtain ----------

a) Optimal solutions b) Optimality test c) Both A and B d) Optimization

Q3. The assignment matrix is always a

a) Rectangular matrix b) Square matrix c) Identity matrix d) None of the above

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TUTORIAL – 4

This tutorial corresponds to Unit No. 4 (Objective Nos.: 3, Outcome Nos.: 3)

Q1. A type of decision making environment is

a)certainty b) uncertainty c) risk d) all of these

Q2. Which of the following criterion is not used for decision making under uncertainty?

a) Maximin b) maximax c) minimax d) minimize expected loss

Q3. Essential characteristics of a decision model are

a)states of nature b) decision alternatives c) payoff d) all of these

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Date:

Department of Mechanical Engineering

TUTORIAL SHEET – 5

This tutorial corresponds to Unit No. 5 (Objective Nos.: 5, Outcome Nos.: 5)

Q1. Customer behavior in which the customer moves from one the queue to another in a multiple channel situation is

a)balking b) reneging c) jockeying d) alternating

Q2. The system of loading and unloading of goods usually follows:

a)LIFO b)FIFO c)SIRO d)SBP

Q3. What happens when maximin and minimax values of the game are same?

a) no solution exists b) solution is mixed c) saddle point exists d) none of these

Signature of HOD

Date:

Signature of faculty

Date:

Department of Mechanical Engineering

EVALUATION STRATEGY

Target (s)

a. Percentage of Pass : 95%

Assessment Method (s) (Maximum Marks for evaluation are defined in the Academic Regulations)

a. Daily Attendance
b. Assignments
c. Online Quiz (or) Seminars
d. Continuous Internal Assessment
e. Semester / End Examination

List out any new topic(s) or any innovation you would like to introduce in teaching the subjects in this semester

Case Study of any one existing application

Signature of HOD

Date:

Signature of faculty

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COURSE COMPLETION STATUS

Actual Date of Completion & Remarks if any

Units	Remarks	Objective No. Achieved	Outcome No. Achieved
Unit 1	Completed on 30.06.2023	1	1
Unit 2	Completed on 19.07.2023	2	2
Unit 3	Completed on 14.08.2023	3	3
Unit 4	Completed on 06.09.2023	4	4
Unit 5	Completed on 06.10.2023	5	5

Signature of HOD

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Mappings

1. Course Objectives-Course Outcomes Relationship Matrix

(Indicate the relationships by mark "X")

Course-Outcomes / Course-Objectives	1	2	3	4	5
1	H		M		
2		H			
3			H		
4				H	
5					H

2. Course Outcomes-Program Outcomes (POs) & PSOs Relationship Matrix

(Indicate the relationships by mark "X")

P-Outcomes / C-Outcomes	a	b	c	d	e	f	g	h	i	j	k	l	PSO 1	PSO 2
1	H			M									H	
2		M	H			M							H	H
3					H				M		M			M
4						M	H						M	
5										H				

Department of Mechanical Engineering

Rubric for Evaluation

Performance Criteria	Unsatisfactory	Developing	Satisfactory	Exemplary
	1	2	3	4
Research & Gather Information	Does not collect any information that relates to the topic	Collects very little information some relates to the topic	Collects some basic Information most relates to the topic	Collects a great deal of Information all relates to the topic
Fulfill team role's duty	Does not perform any duties of assigned team role.	Performs very little duties.	Performs nearly all duties.	Performs all duties of assigned team role.
Share Equally	Always relies on others to do the work.	Rarely does the assigned work - often needs reminding.	Usually does the assigned work - rarely needs reminding.	Always does the assigned work without having to be reminded
Listen to other team mates	Is always talking—never allows anyone else to speak.	Usually doing most of the talking-- rarely allows others to speak	Listens, but sometimes talks too much.	Listens and speaks a fair amount.

Department of Mechanical Engineering

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Anurag ENGINEERING COLLEGE
An Autonomous Institution
(Approved by AICTE, New Delhi & Affiliated to JNTUH)

Accredited with NAAC A+ GRADE

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www.anurag.ac.in +91 9963122270

III B.TECH VI SEMESTER I MID EXAMINATIONS - MARCH 2024

Branch : B.Tech. (ME) **Subject : OPERATION RESEARCH,ME604PC** **Max. Marks : 20M**
Date : 19.03.2024 AN **Time : 90 Minutes**

PART – A

ANSWER ALL THE QUESTIONS. **5 X 1M = 5M**

Q.No.	Question	CO	BTL
1.	Write any one definition of operations research?	CO 1	L1
2.	Write General form of LPP.	CO 1	L2
3.	What do you mean by unbalanced Transportation problem?	CO 2	L1
4.	What is meant by Balanced Assignment problem?	CO 2	L1
5.	Define Total elapsed time?	CO 3	L1

PART - B

ANSWER ALL THE QUESTIONS. **3 X 5M = 15M**

Q.No.	Question	CO	BTL
6.	A company manufactures two products A and B. The resources are the capacities Machine-1, Machine-2, and Machine-3. The available capacities are 50,25,and 15 hours respectively. Product A requires 1 hour of Machine-2 and 1 hour of Machine-3. Product B requires 2 hours of Machine-1, 2 hours of Machine-2 and 1 hour of Machine-3. The profit contribution of products A and B are Rs 5 and Rs 4 respectively. Formulate the linear programming model	CO 1	L3
	OR		
7.	Explain Graphical method of solving LPP	CO 1	L4
8.	Determine an initial basic feasible solution of the following transportation problem by north west corner method	CO 2	L4

	D1	D2	D3	Supply
S1	8	5	6	120
S2	15	10	12	120
S3	3	9	10	80
Dem	150	80	50	

OR

9.	There are 5 jobs to be assigned to 5 machines and associated cost matrix is as follows	CO 2	L4

	I	II	III	IV	V
A	11	17	8	16	20
B	9	7	12	6	15
C	13	16	15	12	16
D	21	24	17	28	26
E	14	10	12	11	15

Find the optimum assignment and associated cost using the assignment technique

10.	Explain the procedure for solving n jobs through 2 machines problem	CO 3	L4
	OR		
11.	Explain the procedure for solving n jobs through k machines problem	CO 3	L4

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III B.TECH VI SEMESTER II MID EXAMINATIONS - JUNE 2024

Branch : B.Tech. (ME)
Date : 19-Jun-2024 **Session : Afternoon** **Max. Marks : 20M**
Subject : OPERATION RESEARCH,ME604PC **Time : 90 Min**

PART - A

ANSWER ALL THE QUESTIONS **5 X 1M = 5M**

Q.No	Question	CO	BTL
1.	What are the costs involved in failure and replacement analysis?	CO3	L2
2.	Define Ordering cost in inventory models	CO4	L1
3.	Define zero-sum game.	CO4	L2
4.	State bellman's principle of optimality.	CO5	L2
5.	Write different types of services in waiting lines.	CO5	L2

PART - B

ANSWER ALL THE QUESTIONS **3 X 5M = 15M**

Q.No	Question	CO	BTL
6.	The cost of machine is Rs.6100 and its scrap value is Rs. 100.The maintenance costs found from experience is given below. When should the machine be replaced?	CO3	L3

Year	1	2	3	4	5	6	7	8
Maintenance	100	250	400	600	900	1200	1600	2000

OR

7.	Explain group replacement policy.	CO3	L4
8.	Determine the solution of the game and their strategies whose pay off matrix A is given below	CO4	L3

		PLAYER B		
		B1	B2	B3
PLAYER A	A1	-4	6	3
	A2	-3	-3	6
	A3	2	-3	4

OR

9.	A company uses 24000 units of a raw material which costs Rs.12.50 per unit. Placing each order costs Rs. 22.50 and the carrying cost is 5.4% per year of the average inventory. Find the economic order quantity and the total inventory cost (including the cost of material)	CO4	L4
10.	In a bank, cheques are cashed at a single 'Teller' counter. Customers arrive, at the counter in a Poisson manner at an average rate of 30 customers per hour. The teller takes, on an average a minute and a half to cash cheque.The service time has been shown to be exponentially distributed. (i) Calculate the % of time the Teller is busy and (ii) Also calculate the average time a customer is expected to wait	CO5	L4

OR

Page : 1

11. Solve the following lpp dynamic programming

Min Z = $X_1^2 + X_2^2 + X_3^2$

$X_1 + X_2 + X_3 \geq 15$, $X \geq 0$ for i= 1,2,3

Department of Mechanical Engineering

First Internal Examination Marks

Programme**: B.Tech** Year: **III** Course: **Theory** **A.Y: 2023-24**

Course: OPERATIONS RESEARCH Section: A Faculty Name: S JEEVAN REDDY

S. No	Roll No	Assignment Marks (5)	Subjective Marks (20)	Total Marks (25)
1	21C11A0301	5	19	24
2	21C11A0302	5	12	17
3	21C11A0305	5	11	16
4	21C15A0305	5	16	21
5	22C15A0301	5	12	17
6	22C15A0302	5	13	18
7	22C15A0303	5	18	23
8	22C15A0304	5	19	24
9	22C15A0305	5	12	17

No. of Absentees: 00

Total Strength: 09

Department of Mechanical Engineering

Signature of Faculty

: **Signature of HoD**

Second Internal Examination Marks

Programme**: B.Tech** Year: **III** Course: **Theory** **A.Y: 2023-24**

Course: Operations research Section: A Faculty Name: S.Jeevan reddy

S. No	Roll No	Assignment Marks (5)	Subjective Marks (20)	Total Marks (25)
1	21C11A0301	5	19	24
2	21C11A0302	5	17	22
3	21C11A0305	5	19	24
4	21C15A0305	5	20	25
5	22C15A0301	5	17	22
6	22C15A0302	5	19	24
7	22C15A0303	5	14	19
8	22C15A0304	5	19	24
9	22C15A0305	5	13	18

No. of Absentees: 00

Total Strength: 09

Department of Mechanical Engineering

Signature of Faculty

Signature of HoD