GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Mechanical Engineering/Manufacturing Engineering
Subject Code: BE04000201
Subject Name: Operation Research

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Basic Science Course

Prerequisite:	Nil
Rationale:	Operations Research now a day widely used in decision making for the real-life problems. Managers and decision makers get ideas for optimizing and approximating industrial problems. They not only strive to devise appropriate measures for problem solving but also apply scientific techniques to monitor the organizations' ongoing activities such as Production mix, Transportation, Queuing, Assignment, Replacement, Inventory, game problem and Network analysis.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Describe characteristics, scope, formulation, solution of linear programming problem.	Remember, Understand, Evaluate
2	Formulate and solve transportation, travelling salesman, transshipment, and assignment problems of Operation Research.	Application, Evaluate
3	Evaluate simple models of Queuing, Inventory and Replacement problems.	Application, Evaluate
4	Illustrate game and decision theory problems.	Application, Evaluate
5	Draw Network of PERT, CMP with different time calculations and network crashing.	Application, Evaluate

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	SL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	TW/SL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

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Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Operations Research and Linear Programming:** Origin of Operation Research, Historical Standpoint, Methodology, Different Phases, Characteristics, Scope and Application of Operations Research. **Linear Programming Problem:** Introduction, Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods, Analytical Methods: Simplex, Big M and Two Phase, Sensitivity Analysis, Primal and Dual Problems, Economic Interpretation.	10	20
2.	**Transportation and Assignment:** Transportation Problems definition, Linear form, Solution methods: Northwest corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced and profit maximization problems. Transshipment Problems. Assignment Problems and Travelling salesman Problem.	08	15
4.	**Queuing Theory:** Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Preliminary examples of M/M/1:∞/FCFA	04	10
5.	**Inventory Control:** Inventory classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands, ABC analysis and VED analysis.	04	10
6.	**Replacement theory:** Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.	04	10
7	**Game Theory:** Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods.	04	10
8	**Decision Theory:** Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, hurwicz criterion, Decision tree.	04	10
9	**Project Management:** PERT and CPM Network theory, Critical Path calculation, float calculation and its importance. Resource allocation, Cost reduction by Crashing of activity.	07	15
	Total	**45**	**100%**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**25**	**15**	**20**	**25**	**05**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Operations Research: An Introduction by Hamdy Taha, Pearson
2. Operations Research by A M Natarajan, P Balasubramani, A Tamilarasi, Pearson Education Inc
3. Operations Research by P Mariappan, Pearson
4. Operations Research by H N Wagner, Prentice Hall.
5. Optimization in Operations Research by Ronald Rardin, Pearson Education Inc.
6. Operations Research by R. Panneerselvam, Prentice Hall of India Pvt. Ltd.
7. Quantitative Techniques in Management by N D Vohra, Tata McGraw-Hill

(b) Open-source software and website:

Nil

List of Experiments:

Following experiments are suggested for Laboratory work

1. Exercise on definition, formulation of linear programing problems.
2. Exercise on Graphical solution of linear programing problems
3. Exercise and case problems on Simplex, Big M and Two-phase LP Problems
4. Exercise and case problems on Dual and Primal LP Problems
5. Exercise and case problems on Sensitivity Analysis
6. Exercise and case problems on Transportation and Transshipment Problems.
7. Exercise and case problems on Assignment and Travelling salesman Problems
8. Exercise and case problems on Queuing theory
9. Exercise and case problems on Game theory
10. Exercise on Inventory model
11. Exercise on Replacement theory
12. Exercise and case problems on PERT/CPM/crashing of network

Major Equipment:

Not Require any equipment

List of Open Source Software/learning website:

1. http://nptel.ac.in/courses/

List of suggested activities for Problem Based Learning:

Sr. No	Name of the Activity	No. of Hours	Evaluation Criteria
1	Manufacturing Industry (Machine tools) visit	Visit: 5h, Report preparation: 5h Total: 10h	Based on the report submitted. Report should contain observations and calculations based on Industry/ lab data.
2	Technical Video based learning related to the subject	Duration of video: 5h Report preparation: 5h Total: 10h	Report /presentation based on the video learning outcomes.
3	Assignment writing Numerical based assignment is preferable.	5 assignments of 4h each. Total:20h	Based on the assignment submitted.
4	Problem solving/Coding using c, c++, Pyhon, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignments of 2h each. Total: 10h	Based on the coding solution submitted.
5	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding. Total: 10h/ problem	Based on the depth of the solution submitted.
7	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video: 5h Report preparation: 5h Total: 10h	Based on quiz report submitted
8	Discussion on research paper based on relevant subject	5 research paper : 20h	Summarize research paper and evaluation critical parameters
9	Poster/chart/PowerPoint preparation on technical topics	Duration:6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working : 12h Non-working: 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society /environment/health/other issue	Duration: 15 h for industrial exposure Problem identification and tentative solution: 10h Total:25 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration: t h each	Based on performance in group discussion, technical depth, knowledge etc.

13	Real world case studies-based learning	Duration of data collection/study: 5h Report preparation: 5h Total: 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14	Application Software development	Duration: 10 h	Depending on the complexity of the Application/Software
15	Depending on the complexity of the Application/Software	Duration 2 hrs. For attending the lecture/session - 2 hrs. and for report writing 2 h.	Based on the proof of attendance and report submitted
16	Blog or Technical Article Writing	10h (Research - 6h, Writing - 4h)	Based on originality, technical content, references cited, and clarity of communication.
17	Annotated Video Explanation of Concept / Problem	10h (Preparation * Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
18	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
19	Tech Blog/YouTube Channel Curation	10h (Content curation * Analysis)	Summary report on curated content and learning outcomes.
20	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
21	Maintenance or Troubleshooting Logbook	10h (For example: lab instruments, computer hardware)	Based on documented cases, approach, and resolution.

Activity Note

- All activities should be related to the subject.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, the total number of hours is fixed.
- For a course, min 3 activities must be carried out as per the availability of faculties and students. There is no limit to the maximum number of activities.
- Rubrics for the evaluation can be prepared by the respective faculty members.
- Subject teachers can add the relevant activities from the above list other than those mentioned in the syllabus, with the consent of the head of the department and DQAC.
- Subject coordinator shall identify activities from the above list as per the subject needs, they will also declare a list of activities wise hours, evaluation scheme and rubrics to students at the beginning of the semester.

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