SEMESTER S5

OPTIMISATION TECHNIQUES

Course Code	PBIET504	CIE Marks	60
Teaching Hours/Week (L:T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To enable students to solve large scale optimization problems with single as well as multiple objectives.
2. To enable students to apply advanced tools and techniques to handle linear, non - linear problems and network models.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Linear Programming:** Advanced solution techniques - Revised simplex method, dual simplex method, two phase method, interior point method, sensitivity analysis. **Integer programming**: Formulation and solution techniques - Introduction to dynamic programming and software tools for linear programming.	11
2	**Queuing theory**: Markovian queue models, single server & multiple server models. **Game theory**: Practical application of game theory, two–person, zero -sum games, solution with and without saddle point, rules of dominance, other solution methods.	11
3	**Nonlinear programming:** Definition, formulation of non-linear programming problems (NLPs), Convex and non-convex functions, solving NLPs with one variable (unconstrained maximization and minimization), unconstrained maximization and minimization with several variables, the method of steepest descent, Newton's method and quasi - Newton method, conjugate gradient and conjugate direction methods. **Constrained optimization methods:** Lagrange multipliers, Kuhn-Tucker condition, method of feasible directions, pareto optimality and trade-off curves.	11

KTU SPECIAL

4	**Network problems:** Introduction to graph theory and basic definitions. Minimum spanning tree problem - Prim's algorithm, Kruskal's algorithm, Shortest path problems - Dijkstra's algorithm, Floyd's algorithm, successive shortest path algorithm. Maximum flow problems, flow augmenting path, labelling algorithm, maximum flow and minimum cut, shortest augmenting path algorithm, minimum cost flow problem, network simplex method. **Travelling salesman problem (TSP)**: Branch and bound and heuristic algorithms for the TSP, Chinese postman problem. **Vehicle Routing Problems:** Optimal solutions, Little's algorithm and heuristic solutions, savings based algorithm, Holmes and Parker refinement.	**11**

Suggestion on Project Topics: Each student team can choose some simple close to real life projects from the areas discussed in the syllabus, such as

- Production Planning problem
- Cutting Stock Problem
- Fixed Charge Problem
- Resource allocation
- Scheduling
- Parameter optimization
- Analysis of practical problems using network models
- Portfolio optimization

KTU SPECIAL

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	**30**	**12.5**	**12.5**	**60**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 subdivisions. • Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Apply advanced tools to solve linear and linear integer programming problems and analyse the sensitivity of solutions to dynamic situations.	**K4**
CO2	Apply queuing and game theory to develop solutions for industrial and allied areas.	**K3**
CO3	Solve the constrained and unrestricted nonlinear optimization problems using gradient non-gradient based techniques.	**K3**
CO4	Construct appropriate network models and build optimal solutions to industrial problems.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	-	-	2	2	3	-	3
CO2	3	3	2	3	3	-	-	2	2	3	-	3
CO3	3	3	2	3	3	-	-	2	2	3	-	3
CO4	3	3	2	3	3	-	-	2	2	3	-	3

KTU SPECIAL

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Operations Research: Theory And Application	Sharma J. K	Laxmi Publications	6th Edition, 2017
2	Engineering Optimization: Theory and Practice	Singaresu S. Rao	New Age International	3rd Edition, 2004
3	Operations Research	Srinivasan G.	Prentice Hall India	2nd Edition, 2010
4	Quantitative Methods in Management	Vohra N. D.	Tata McGrew Hill	5th Edition, 2017
5	Introduction to Management Science	Bernard W. Taylor	Pearson Education	11th Edition, 2013
6	Principles of Operations Research with Applications to Managerial Decisions	Harvey M. Wagner	Prentice Hall India	2nd Edition, 1975

KTU SPECIAL

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Operations Research	Frederick S. Hillier, Gerald J. Lieberman	Tata McGrew Hill	11th Edition, 2020
2	Optimization in Operations Research	Ronald L. Rardin	Pearson Education	2nd Edition, 2016
3	Introduction to Operations Research	Hamdy A. Taha	Pearson Education	10th Edition, 2019
4	Operations Research: Applications and Algorithms	Wayne L. Winston	Duxbury Press	4th Edition, 2003
5	Convex Optimization	Stephen Boyd, Lieven Vandenberghe	Cambridge University Press	1st Edition, 2004
6	Convex Optimization Algorithms	Dimitri P Bertsekas	Athena Scientific	1st Edition, 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-mg43/
2	https://archive.nptel.ac.in/noc/courses/noc17/SEM2/noc17-ma18/
3	https://archive.nptel.ac.in/courses/112/106/112106131/
4	https://archive.nptel.ac.in/courses/112/106/112106131/

PBL Course Elements

L: Lecture (3 Hrs.)	**R: Project (1 Hr.), 2 Faculty Members**		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

KTU SPECIAL

Assessment and Evaluation for Project Activity

Sl. No	**Evaluation for**	**Allotted Marks**
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

1. **Project Planning and Proposal (5 Marks)**
   - Clarity and feasibility of the project plan
   - Research and background understanding
   - Defined objectives and methodology

2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**

- Active participation and individual contribution
- Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. **Final Presentation (5 Marks)**

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

KTU SPECIAL

6. **Project Quality, Innovation, and Creativity (3 Marks)**

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches