**SECOND SEMESTER 2023-2024**

**Course Handout (Part II)**

**Date:9/01/2024**

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

# Course Number : ME F320

**Course Title : Engineering Optimization**

# Instructor In-charge : C P KIRAN, Anirudh U, Abhishek Sarkar, Pardha Sardahi G, V. Muralidhar, Vashista K

**Course Description :** Engineers, scientists, analysts and managers are often faced with the challenge of making trade-offs between different factors in order to achieve desirable outcomes. Optimization is the process of choosing these trade-offs in the best way. Optimization problems, having reached a degree of maturity over the past several years, are encountered in physical sciences, engineering, economics, industry, planning, and many other areas of human activity. The objective of the course is to familiarize the students with standard methods of solving optimization problems.

This course deals with the following topics: Formulation of optimization problems, classical optimization techniques, nonlinear optimization methods for problems with and without constraints, simplex method, duality and sensitivity concepts, revised simplex methods, transportation models, travelling-salesman models, assignment models, network models, integer programming, genetic algorithm and other evolutionary optimization techniques, goal programming and multi-objective optimization. Use of application software in solving optimization problems.

# Text Books:

**T1:** HA Taha, Operations Research: An Introduction, Pearson Education/PHI, 10/E, 2019.

# References:

**R1:** SS Rao, Engineering Optimization: Theory and Practice, New Age International (P) Limited, Third Edition, 1996

**R2:** FS Hillier and GJ Lieberman, Introduction to Operations Research, TMH, 8/E, 2006.

**R3:** WL Winston, Operations Research: Applications and Algorithms, Thomson Learning, 4th Ed., 2004

**R4:** A Ravindran, DT Philips and JJ Solberg, Operations Research: Principles and Practice, John Wiley & Sons, Singapore, Second Edition, 1987

**R5:** GC Onwubolu and BV Babu, New Optimization Techniques in Engineering, Springer-Verlag, Heidelberg, Germany, First Edition, 2004.

**R6:** Kalyanmoy Deb, optimization for engineering design: algorithms and examples, PHI, Second edition, 2012.

# Course Plan:

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| **Lect. No.** | **Topic to be Covered** | **Learning Objectives** | **Chapter in the Text Book** |
| 1 | Introduction | Introduction to optimization | T1 (1) |
| 2-3 | Modeling with  Linear Programming | Two variable LP model, Graphical LP solution | T1(2.1-3) |
| 4-10 | Simplex Method | LP model in equation form, Transition from graphical | T1 (3.1-6) |

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|  |  | to algebraic solution, Simplex method, Generalized  simplex tableau in matrix form, Artificial starting solution, Special cases, Sensitivity analysis |  |
| 11-14 | Duality and Post optimal Analysis | Dual problem, Primal-Dual relationships, Economic  interpretation of duality, Dual simplex algorithm, Post- optimal analysis | T1 (4.1-5) |
| 15-17 | Transportation Model and its Variants | Demand forecasting in supply chain, Aggregate planning in the supply chain, Planning supply and demand in the supply chain: Managing predictable  variability; Coordination in Supply Chain | T1 (5.1, 5.3-  4) |
| 18-20 | Network Models | Definition, CPM and PERT | T1 (6.1, 6.5) |
| 21-23 | Goal Programming | Goal programing formulation, Goal programming algorithms | T1 (8.1-2) |
| 24-26 | Integer Linear Programming | Applications, Branch-and-bound algorithm, Cutting- plane algorithm | T1 (9.1-2) |
| 27-29 | Inventory Models | Deterministic Inventory Models, Static Economic- Order Quantity (EOQ) mod | T1 (11.1, 11.3) |
| 30 | Review of Basic Probability | Random variables, Poisson, Exponential and Normal Distribution | T1 (12.2-4) |
| 31-34 | Queuing System | Definition, Birth and Death process, Role of Exponential Distribution, Generalized Poisson Queuing Models, Specialized Poisson Queues: M/M/1  and M/M/c with infinite and finite system capacitie | T1 (15.1-6) |
| 35-38 | Classical and Nonlinear Optimization | Unconstrained problems, Constrained problems: Equality constraints – Lagrangean method, Ineauality constraints –Karush-Kuhn-Tucker (KKT) Conditions,  Quadratic Programming | T1 (18.1-2,19.2.2) |
| 39-42 | Evolutionary Optimization | Introduction to Evolutionary Optimization Techniques (Genetic Algorithms, Simulated Annealing, etc.) | R6-Ch 6 |

1. **Evaluation Component**

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| **S. No.** | **Evaluation**  **Component** | **Duration** | **Max. Marks** | **Date & Time** | **Nature** |
| 1 | Mid-Semester Examination | 90 Min | 25% | 13/03 - 2.00 - 3.30PM | CB |
| 2 | Surprise Quizzes  +Software based assignment |  | (5+5)10% |  | OB |
| 3 | Class/Tutorial |  | 25% |  | OB |

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|  | assignments |  |  |  |  |
| 4 | Comprehensive Examination | 180min | 40% | 11/05 AN | CB |

1. **Chamber Consultation**: To be announced in the class.
2. **Notices:** All notices concerning this course will be displayed on the CMS only.
3. **Make-Up Policy:** Make-up will be granted only to the genuine cases with prior permission from the IC. For cases related to illness, proper documentary evidence is essential. No makeup is allowed for quizzes, assignments, etc..
4. **Academic Honesty and Integrity Policy: *Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.***

# Instructor -in - Charge