

**SECONDSEMESTER 2019 – 2020**

# Course Handout Part II

07-08-2020

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

*Course No.* : **CE G514**

## Course Title : **Structural Optimization**

## Instructor-in-Charge : **A. VASAN**

*Chamber No.*: **D-117**

**Course Description:**

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell’s conjugate direction method, Cauchy’s method, Newton’s method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhun- Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

**1. Scope and Objective of the Course:**

This objective of this course is to present the techniques and applications of engineering optimization in a simple manner. The ever-increasing demand on engineers to lower production costs to withstand competition has promoted engineers to look for rigorous methods of decision making, such as optimization methods, to design and produce both economically and efficiently. Optimization techniques, having reached a degree of maturity over the past several years, are being used in a wide spectrum.

**Course Outcomes**: After successful completion of this course, the student will be able to:

1. Formulate engineering design problems as mathematical optimization model
2. Choose the best suited optimization technique as well as software tool for solving the formulated optimization mathematical model
3. Solve real world application problems using nontraditional optimization algorithms
4. Develop a report that describes the formulated optimization model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making process

Student Learning Outcomes (SLOs) assessed in this course – **(a), (b), (c), (d), (e), (f), (h), (j),** and **(k).**

**2 (a) Textbook**

T1. Singiresu S. Rao, “Engineering Optimization: Theory and Practice”, New Age International Publishers, Fourth Edition, 2013.

**(b) Reference books**

R1. Deb K, “Optimization for Engineering Design: Algorithms and Examples”, Prentice Hall, New Delhi, 1995.

R2. Deb K, “Multiobjective Optimization Using Evolutionary Algorithms”, John Wiley & Sons Limited, 2010.

**3. Course Plan:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Lecture No.** | **Topics to be covered** | **Learning objectives** | **Reference** | **SLO** |
| 1-3 | Statement of an Optimization Problem, Classification, Applications, Optimization Literature | To understand optimization and formulate mathematical optimization model | T1 | a, c, e, j |
| 4-8 | Single Variable Optimization, Multivariable Optimization with and without constraints, Kuhn-Tucker Conditions (KKT) | To develop single and multivariable optimization models and solve using KKT conditions | T1 | a, c, e |
| 9-16 | Graphical Method, Analytical Method, Two Phase Simplex Method, Zj-C­­j Method, Primal Dual Algorithm, Big M Method, Special Cases | To solve LP models using various methods | T1 | a, c, e |
| 17-21 | Unimodal Function, Elimination Methods, Interpolation Methods, Direct Search Methods, Indirect Search Methods | To solve simple nonlinear functions using various techniques | T1 | a, c, e |
| 22-27 | Unconstrained Minimization Problem, Constrained Minimization, Primal Dual Relationships | To solve simple optimization model functions using various techniques | T1, R1 | a, c, e |
| 28-34 | Bellman’s principle of optimality, multistage decisions processes, concept of sub optimization, conversion of final value problem to initial value problem | To understand multistage decisions processes using dynamic programming | T1 | a, c, e |
| 35-38 | Multiobjective Optimization, Introduction to Nontraditional Optimization Algorithms such as Genetic Algorithms, Particle Swarm Optimization, Cuckoo Search Optimization etc | To introduce Multiobjective optimization and nontraditional optimization and understand their working | T1, R2 | a, b, c, e, k |
| 39-42 | Methods of Optimum Structural elements, minimum weight design of truss members, optimum reinforced design of RCC slabs and beams, principles of optimization of design of multi-storey structuresetc | To apply various optimization techniques to solve various practical structural engineering problems | T1, Journal Papers | a, b, c, d, e, f, h, j, k |

**Student Learning Outcomes (SLOs):**

SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

1. an ability to apply knowledge of mathematics, science and engineering
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. an ability to function on multidisciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively
8. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
9. a recognition of the need for, and an ability to engage in life-long learning
10. a knowledge of contemporary issues
11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

# **4. Evaluation Scheme**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S. No.** | **Evaluation Component** | **Duration (min)** | **Weightage (%)** | **Date & Time** | **Remarks** |
| 1 | Midsem Test | 90 | 25 | 3/3, 11.00 -12.30 PM | OB |
| 2 | Surprise Quiz  (At least 8)\* | - | 10 | - | OB |
| 3 | Seminar  (2nos) | - | 10 | - | OB |
| 4 | Project  (3 reviews) | - | 20 | - | OB |
| 5 | Compre Exam | 180 | 35 | 04/05 , AN | OB |

\* *Best (n-1) would be considered. n is the total number of surprise quizzes conducted.*

**5. Chamber Consultation Hour:** Thursday 04.30 PM – 05.00 PM

**6. Notices:** Notices concerning this course will be displayed on Google Classroom Course page.

**7. Make-up Policy:** Prior permission for all make ups are a must. For medical emergencies, requests have to be forwarded by the Chief Warden to the satisfaction of IC.

**8. 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**