CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **Bachelor of Technology (Mechanical Engineering)**

Semester: **VI**

Course Code: **202090609**

Course Title: **Optimization Techniques**

Course Group: **Professional Elective Course – II**

Course Objectives: This course is designed for giving exposure of conventional and modern optimization techniques to complex Mechanical Engineering Applications.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	2	0	4	50 / 18	50 / 17	25 / 9	25 / 9	150 / 53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Introduction to Optimization:** Introduction and Historical Development, Formulation of Optimization Problem, Classification of Optimization Problems, Engineering Applications of Optimization	03
2	**Multi-Criteria Decision Making:** Analytical Hierarchy Process (AHP), Technique for Order Performance by Similarity to Ideal Solution (TOPSIS), Grey Relation Analysis (GRA).	05
3	**Single Variable Optimization:** Introduction, Unimodal Functions Elimination Methods: Unrestricted search, Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Method, Golden Section Method, Comparison of Elimination Methods Interpolation Methods: Quadratic & Cubic Interpolation methods, Karush-Kuhn-Tucker conditions	12

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4	**Multi Variable Optimization:** Unconstrained Optimization Techniques Direct Search Methods: Random Search Methods, Grid Search Method, Univariate method, Powell's method Indirect Search Methods: Steepest descent method, Fletcher-Reeves method, Newton's method. Constrained Optimization Techniques Direct Methods: Random search Methods, Complex Method, Sequential Linear Programming, Indirect Method: Basic Approach of the Penalty Function Method, Interior Penalty Function Method, Exterior Penalty Function Method	**16**
5	**Modern Optimization Methods:** Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Neural Network based Optimization, Application of the techniques to solve Mechanical Engineering Problems. **Topology Optimization:** Problem formulation and parameterization of design, solution methods, topology optimization as a design tool, combining topology and shape design, buckling problems, stress constraints.	**09**
	Total	**45**

List of Practicals / Tutorials:

1	To understand structure of optimization problem and various applications of optimization problems.
2	To identify and evaluate capabilities of different Single and Multi-Variable Optimization Techniques.
3	To solve a multi-criteria decision problem using AHP and TOPSIS/GRA.
4	To solve and understand Single variation optimization problems.
5	To solve and understand Multivariable Optimization problems with equality constraints.
6	To solve and understand Multivariable Optimization problems with inequality constraints.
7	To apply Interpolation methods in problems for single variable optimization.
8	To study and apply various Multi variable Optimization techniques.
9	To understand and select modern optimization methods with case studies.
10	To understand Topology Optimization technique with a Case Study.

Reference Books:

1	Engineering Optimization: Theory and Practice, S. S. Rao, 4th Edition, John Wiley & Sons.
2	Nonlinear optimization with engineering applications, Michael C. Bartholomew-Biggs, Springer.
3	Introduction to Optimum Design, J S Arora, Mc-Graw Hill.
4	Engineering Optimization: Methods and Applications, V. Reklaitis, A. Ravindran, K. M. Ragsdell, Wiley.
5	Modern heuristic optimization techniques: theory and applications, Kwang Y. Lee, Mohamed A. El-Sharkawi, Kluwer.

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Supplementary learning Material:	
1	NPTEL resources

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods

Internal Evaluation:

The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20%	15%	15%	20%	15%	15%	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Students will be able to formulate and solve a problem of Mechanical Engineering using Optimization Techniques.	**40**
CO-2	Students will understand the importance of decision-making process to select optimization tool for solving a problem.	**40**
CO-3	Students will be able to analyze how modern evolutionary algorithms work for solving complex problems.	**20**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	June-2022
Last Reviewed on (Month-Year):	--
Next Review on (Month-Year):	June-2025

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