COURSE PLAN

School : Engineering

Department : Mechanical Engineering

Course Code : ME539 (Elective)

Course Name : Optimization Techniques in Engineering

Course Structure (L-T-P-CH-Cr): 3-0-0-3-3

Instructor: Dr. Dilip Datta

1. **Abstract:**
   This is a course on classical optimization techniques, mainly for solving single-objective optimization problems in continuous and convex search space. Both exact and approximate approaches for solving unconstrained and constrained as well as linear and nonlinear problems are discussed in detail. Some specialized techniques for solving problems in discrete space are also included in the curriculum.

2. **Objective:**
   The main objective of the course is to impart knowledge to the students on selection and application of appropriate classical exact and approximate techniques for solving different classes of linear and nonlinear single-objective optimization problems, without or with constraints, in continuous and convex search space as well as in discrete search space.

3. **Prerequisite of the Course:**
   Being inter-disciplinary in nature, the course can be opted by any student having mathematical background at least up to 10+2 standard, as well as some computer programming knowledge/skill.

4. **Course Outline + Suggested Reading:**

Module	***Topic***
1	Introduction to optimization.
2	Exact methods for optimizing unconstrained functions.
3	Exact methods for optimizing constrained functions.
4	Approximate methods for optimizing unconstrained single-variable functions.
5	Approximate methods for optimizing unconstrained multi-variable functions.
6	Approximate methods for optimizing constrained functions.
7	Integer/discrete programming problems

***Suggested Reading*:**

a) K. Deb. *Optimization for Engineering Design: Algorithms and Examples.* PHI, 2/e, 2012.

b) J.S. Arora. *Introduction to Optimum Design*. Elsevier, 3/e, 2012.

5. (a) Time Plan:

SN	*Contents*	*L+T*
1	**Introduction to optimization**: What is optimization; optimization problem formulation; basic terminologies – design variable, objective function, constraint, local and global optimization, convex and non-convex search space, feasible and infeasible design, descent and feasible direction.	2+0
2	**Exact methods for optimizing unconstrained functions**: Conditions for optimizing continuous single-variable functions and their proof; conditions for optimizing continuous multi-variable functions.	2+1
3	**Exact methods for optimizing constrained functions**: Nonlinear problems – Kuhn-Tucker conditions, sensitivity analysis; linear programming problems – simplex methods.	5+2
4	**Approximate methods for optimizing unconstrained single-variable functions**: Direct search methods – bracketing and refining an optimum point; gradient-based methods.	2+1
5	**Approximate methods for optimizing unconstrained multi-variable functions**: Direct search methods; gradient-based methods – function derivatives through numerical methods, descent direction, unidirectional search.	5+2
6	**Approximate methods for optimizing constrained functions**: Direct search methods; transformation (penalty function) methods; linearized search techniques; feasible direction method; quadratic programming.	7+3
7	**Integer/discrete programming problems**: Penalty function method; branch-and-bound method.	2+1
	Total contacts	**25+10**

(b) Evaluation Plan:

Component		**Date**	**Marks**
Type A	Test I	22-08-2013 to 30-08- 2013	20
	Test II	16-09-2013 to 24-09-2013	20
	Test III (Major I)	01-10-2013 to 10-10-2013	25
	Test IV	11-11-2013 to 21-11-2013	20
Type B	Assignment I	04-09-2013 to 09-09-2013	25
	Assignment II	17-10-2013 to 22-10-2013	30
End Semester (Major II)	---	02-12-2013 to 11-12-2013	60
		Total	**200**

6. Pedagogy:

(a) Teaching-learning methods will be adopted in a way to support the discussion on each module by 1 or 2 tutorial/hand-on class(es) for better understanding.

(b) Learning of the students will be evaluated through computer assignments, class test/quiz, and examinations.

(c) Teaching of the instructor will be evaluated by the students through a questionnaire.

7. Expected Outcome:

On completion of the course, students will learn how to select and apply appropriate classical exact and approximate techniques to different classes of single-objective optimization problems.