SCHEME OF COURSE WORK

Course Details:

Course Title	**: Optimization Methods in Engineering**		
Course Code	**:15ME2104**	**L P C**	**3 - 0 - 3**
Program:	**: M.Tech.**		
Specialization:	**: CAAD**		
Semester	**. 1st**		
Prerequisites	**:**		
Courses to which it is a prerequisite	**:**		

Course Outcomes (COs): The student will be able to

CO-1	Solve optimization problems using classical optimization techniques
CO-2	Solve simple non-linear multivariable optimization problems
CO-3	Solve optimization problems using geometric programming
CO-4	Explain the working of different operators used in genetic algorithms for optimization
CO-5	Explain concepts of stochastic programming & select a suitable technique for a specific engineering problem

Program Outcomes (POs): A postgraduate of CAAD will have the

PO-1	Ability to apply fundamental principles in the areas of analysis & design of mechanical components & systems
PO-2	Ability to apply creative and innovative skills in the area of mechanical design
PO-3	Ability to identify, formulate and solve complex mechanical design problems
PO-4	Ability to carry out the research related to computer aided analysis and design
PO-5	Knowledge of advanced modeling and analysis tools
PO-6	Ability to function in multidisciplinary teams during collaboration with educational institutions, industry and R&D organizations
PO-7	Ability to apply knowledge of the engineering, financial and management principles to execute projects
PO-8	Ability to effectively convey technical material through oral and/or written communication
PO-9	Recognition of the need for and ability to engage in lifelong learning
PO-10	Understanding of professional and ethical responsibility
PO-11	Ability to conduct a thorough survey and analyze critically to plan, design, and test components and systems implementing new thoughts

Course Outcome Versus **Program Outcomes:**

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO-1	S			M							
CO-2			M	M							
CO-3	M						M				
CO-4	M						M				
CO-5			S	M							

S - Strongly correlated, *M* - *Moderately* correlated, *Blank* - *No correlation*

Assessment Methods:	Assignment / Seminar / Test / End Exam

Teaching-Learning and Evaluation

Week	Topic / Contents	Course Outcomes	Sample questions	Teaching-Learning Strategy	Assessment and Schedule
1	Basic principles of optimization Classification of optimization methods, Classical optimization techniques -Single variable optimization methods	CO-1	▫ Explain the following terms: Design Vector, Design constraint ▫ Find the maxima and minima of given function f(x)	▫ Lecture/ Discussion ▫ Problem solving	Assignment (Week 5-12)
2	One dimensional unconstrained optimization: Unimodal function, Bisection method, Quadratic search,	CO-1	▫ Minimize the given function f(x) by bisection method	▫ Lecture/ Discussion ▫ Problem solving	Assignment (Week 5-12) Test 1 (Week 9)
3	One dimensional unconstrained optimization: Cubic search, unrestricted search, Dichotomous search	CO-1	▫ Minimize the given function f(x) by Quadratic search, Cubic sarch	▫ Lecture/ Discussion ▫ Problem solving	Assignment (Week 5-12)
4	Fibonacci method, Golden Section method, Newtons method, Modified Newtons method	CO-1	▫ Minimize the given function f(x) by ▫ Fibonacci method / Golden section method / Newtons method	▫ Lecture/ Discussion ▫ Problem solving	Assignment (Week 5-12) Test 1 (Week 9)
5	Non- linear multivariable optimization without constraints – Univariate method, Pattern search method, Rosenbrock's rotating coordinates method	CO-2	▫ Outline of Univariate method, Pattern search method, Rosenbrock's rotating coordinates method	▫ Lecture/ Discussion ▫ Problem solving	Q&A session (Week 6)
6	Non- linear multivariable optimization without constraints – Hooke & Jeeves method and Powells method, Newtons method and steepest descent method	CO-2	▫ Minimize f(X) by Newtons method ▫ Minimize f(X) by steepest descent method	▫ Lecture/ Discussion ▫ Problem solving	Test 1 (Week 9)
7	Multivariable with equality constraints, direct substitution method, method of Lagrange multipliers	CO-2	▫ Minimize f(X) subject to constraint h(X)=0 by direct substitution method ▫ Minimize f(X) subject to constraint h(X)=0 by method of Lagrange multipliers	▫ Lecture/ Discussion ▫ Problem solving	Assignment (Week 5-12) Test 1 (Week 9)
8	Non-linear multivariable optimization with constraints: Penalty approach- Interior and exterior penalty function methods	CO-2	▫ Compare the exterior and interior penalty function methods ▫ Minimize given f(X) subject to constraints using interior penalty function approach	▫ Lecture/ Discussion ▫ Problem solving	Assignment (Week 5-12) Test 2 (Week 18)
9	**Test 1**				
10	Geometric programming (GP): Solution by differential calculus; GP: Arithmetic-geometric inequality; Optimization of zero degree difficulty problems without constraints	CO-3	▫ Give examples of posynomial functions ▫ Derive orthogonality and normality conditions in solving GP problem	▫ Lecture/ Discussion ▫ Problem solving	Assignment (Week 5-12)
11	Optimization of zero degree difficulty problems with constraints	CO-3	▫ Minimize the given function f(X) subject to the given constraints using GP	▫ Lecture ▫ Problem solving	Assignment (Week 5-12) Test 2 (Week 18)
12	Optimization of single degree difficulty problems without constraints	CO-3	▫ Minimize the given function f(X) subject to the given constraints using GP	▫ Problems solving ▫ Seminars	Assignment (Week 5-12)
13	Genetic algorithms (GA): Principle, reproduction & crossover operators, mutation, termination criteria	CO-4	▫ Discuss the basic operations used in GAs	▫ Lecture ▫ Power Point Presentation	Test 2 (Week 18)
14	GA for constrained optimization, drawbacks of GA	CO-4	▫ Discuss in detail how the operations are performed for constrained optimization	▫ Lecture ▫ Power Point Presentation	Report (Week 14 - 18)
15	Basic concepts of stochastic programming	CO-5	▫ Demonstrate stochastic dynamic programming	▫ Lecture/Discussion ▫ Power Point Presentation	Report (Week 14 - 18)
16	Basic concepts of Multi-stage optimization and Multi-objective optimization	CO-5	▫ Outline the basic concepts of Multi-stage optimization and Multi-objective optimization	▫ Discussion ▫ Problems solving ▫ Seminars	Report (Week 14 - 18)
17	Engineering applications: Minimization of weight of a cantilever beam, truss, shaft; optimal design of springs	CO-5	▫ Design optimization of springs ▫ Design of a truss for minimum weight ▫ Design of a beam/shaft for minimum weight	▫ Discussion ▫ Problems solving ▫ Seminars	Report (Week 14 - 18) Test 2 (Week 18)
18	**Test 2**				
19/20	**END EXAM**				