

SCHEME OF COURSE WORK

Course Details:

Course Title	: Optimization Methods in Engineering		
Course Code	:13ME2104	L P C	4 - 0 - 3
Program:	: M.Tech.		
Specialization:	: CAD/CAM		
Semester	: 1 st		
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 CAD/CAM will have the

PO-1	Ability to apply fundamentals in the areas of computer aided design and manufacturing
PO-2	Ability to apply creative and innovative skills to analyze computer aided design and manufacturing problems
PO-3	Ability to identify, formulate and solve design and manufacturing problems
PO-4	Ability to carry out the research related to design and manufacturing
PO-5	Familiarity with existing and recent CAD/CAM software
PO-6	Ability to collaborate with educational institutions, industry and R&D organizations in multidisciplinary teams
PO-7	Ability to apply project and finance management skills to manage projects
PO-8	Ability to prepare technical reports and communicate effectively
PO-9	Awareness of the need for and ability to engage in lifelong learning
PO-10	Ethical attitude and accountability to the society
PO-11	Ability to conduct a thorough survey and analyze critically to plan, design and implement new thoughts into action

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
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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	<ul style="list-style-type: none"> ▫ Explain the following terms: Design Vector, Design constraint ▫ Find the maxima and minima of given function $f(x)$ 	<ul style="list-style-type: none"> ▫ Lecture / Discussion ▫ Problem solving 	Assignment (Week 5 - 12)
2	One dimensional unconstrained optimization: Unimodal function, Bisection method, Quadratic search,	CO-1	<ul style="list-style-type: none"> ▫ Minimize the given function $f(x)$ by bisection method 	<ul style="list-style-type: none"> ▫ 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	<ul style="list-style-type: none"> ▫ Minimize the given function $f(x)$ by Quadratic search, Cubic search 	<ul style="list-style-type: none"> ▫ Lecture / Discussion ▫ Problem solving 	Assignment (Week 5 - 12)
4	Fibonacci method, Golden Section method, Newtons method, Modified Newtons method	CO-1	<ul style="list-style-type: none"> ▫ Minimize the given function $f(x)$ by Fibonacci method / Golden section method / Newtons method 	<ul style="list-style-type: none"> ▫ 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	<ul style="list-style-type: none"> ▫ Outline of Univariate method, Pattern search method, Rosenbrock's rotating coordinates method 	<ul style="list-style-type: none"> ▫ 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	<ul style="list-style-type: none"> ▫ Minimize $f(X)$ by Newtons method ▫ Minimize $f(X)$ by steepest descent method 	<ul style="list-style-type: none"> ▫ Lecture / Discussion ▫ Problem solving 	Test 1 (Week 9)
7	Multivariable with equality constraints, direct substitution method, method of Lagrange multipliers	CO-2	<ul style="list-style-type: none"> ▫ 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 	<ul style="list-style-type: none"> ▫ 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	<ul style="list-style-type: none"> ▫ Compare the exterior and interior penalty function methods ▫ Minimize given $f(X)$ subject to constraints using interior penalty function approach 	<ul style="list-style-type: none"> ▫ 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	<ul style="list-style-type: none"> ▫ Give examples of posynomial functions ▫ Derive orthogonality and normality conditions in solving GP problem 	<ul style="list-style-type: none"> ▫ Lecture / Discussion ▫ Problem solving 	Assignment (Week 5 - 12)
11	Optimization of zero degree difficulty problems with constraints	CO-3	<ul style="list-style-type: none"> ▫ Minimize the given function $f(X)$ subject to the given constraints using GP 	<ul style="list-style-type: none"> ▫ Lecture ▫ Problem solving 	Assignment (Week 5 - 12) Test 2 (Week 18)
12	Optimization of single degree difficulty problems without constraints	CO-3	<ul style="list-style-type: none"> ▫ Minimize the given function $f(X)$ subject to the given constraints using GP 	<ul style="list-style-type: none"> ▫ Problems solving ▫ Seminars 	Assignment (Week 5 - 12)
13	Genetic algorithms (GA): Principle, reproduction & crossover operators, mutation, termination criteria	CO-4	<ul style="list-style-type: none"> ▫ Discuss the basic operations used in GAs 	<ul style="list-style-type: none"> ▫ Lecture ▫ Power Point Presentation 	Test 2 (Week 18)
14	GA for constrained optimization, drawbacks of GA	CO-4	<ul style="list-style-type: none"> ▫ Discuss in detail how the operations are performed for constrained optimization 	<ul style="list-style-type: none"> ▫ Lecture ▫ Power Point Presentation 	Report (Week 14 - 18)
15	Basic concepts of stochastic programming	CO-5	<ul style="list-style-type: none"> ▫ Demonstrate stochastic dynamic programming 	<ul style="list-style-type: none"> ▫ Lecture/Discussion ▫ Power Point Presentation 	Report (Week 14 - 18)
16	Basic concepts of Multi-stage optimization and Multi-objective optimization	CO-5	<ul style="list-style-type: none"> ▫ Outline the basic concepts of Multi-stage optimization and Multi-objective optimization 	<ul style="list-style-type: none"> ▫ 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	<ul style="list-style-type: none"> ▫ Design optimization of springs ▫ Design of a truss for minimum weight ▫ Design of a beam/shaft for minimum weight 	<ul style="list-style-type: none"> ▫ Discussion ▫ Problems solving ▫ Seminars 	Report (Week 14 - 18) Test 2 (Week 18)
18	Test 2				
19/20	END EXAM				