Reg. No.																

Question Paper Code	14190

M.E. / M.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

First Semester

M.E - CAD/CAM

24PCDMA101 - OPTIMIZATION TECHNIQUES IN DESIGN

Regulations - 2024

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	Which of the following is a technique used for unconstrained minimization in optimization problems? (a) Gradient Descent (b) Lagrange Multipliers (c) Simplex Method (d) Interior Point Method	1	K1	CO1
2.	In multivariable unconstrained optimization, the point of minimum is found if _____ (a) Gradient vector = 0 and Hessian is positive definite (b) Gradient vector = 1 and Hessian is negative (c) Gradient vector = 0 and Hessian is negative definite (d) Gradient vector is non-zero	1	K1	CO1
3.	Which of the following correctly distinguishes between equality and inequality constraints in optimization problems? (a) Equality constraints allow only greater-than conditions; inequality constraints allow equalities (b) Equality constraints are expressed as equations; inequality constraints are expressed as inequalities (c) Equality constraints are always linear; inequality constraints are always nonlinear (d) Equality constraints are used only in unconstrained problems; inequality constraints are used in constrained problems	1	K1	CO2
4.	What is the primary purpose of using Lagrange multipliers in optimization problems? (a) To solve unconstrained minimization problems (b) To linearize nonlinear equations (c) To find extrema of functions subject to constraints (d) To eliminate redundant variables in a system	1	K1	CO2
5.	Which of the following best describes multistage optimization in dynamic systems? (a) Optimization performed in a single step using static parameters (b) Optimization involving multiple decision stages over time (c) Optimization restricted to linear programming problems (d) Optimization that ignores intermediate constraints and states	1	K1	CO3
6.	Which of the following operations is fundamental to the working of genetic algorithms? (a) Back propagation (b) Gaussian Elimination (c) Mutation (d) Gradient Descent	1	K1	CO3
7.	Which of the following is a primary objective in the optimization of simple truss members? (a) Maximizing the number of joints (b) Increasing the num r of redundant members (c) Maximizing the cross-sectional area of all members (d) Minimizing the total weight of the structure	1	K1	CO4
8.	What is a common objective in the optimization-based design of mechanical springs? (a) Maximizing the number of coils (b) Minimizing the spring stiffness (c) Minimizing the material volume while satisfying stress and deflection constraints (d) Maximizing the wire diameter regardless of load conditions	1	K1	CO4

9.	In the optimization of a single degree of freedom mechanical system, which of the following is typically minimized? (a) Natural frequency (b) Damping ratio (c) Mass-to-stiffness ratio (d) Objective function subject to design constraints	*1*	*K1*	*CO5*
10.	What is the primary goal in the optimization design of a vibration absorber in mechanical systems? (a) To increase the natural frequency of the primary system (b) To amplify the transmitted force to the base (c) To minimize the amplitude of vibration at resonance (d) To eliminate damping from the system	*1*	*K1*	*CO5*

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11.	Write the fundamental principles of optimization, and what are the key elements involved in an optimization problem?	*2*	*K2*	*CO1*
12.	Compare the Interpolation method and the Golden Section method used in one-dimensional optimization.	*2*	*K2*	*CO1*
13.	How do direct and indirect methods differ in solving constrained optimization problems?	*2*	*K2*	*CO2*
14.	Distinguish between equality and inequality constraints.	*2*	*K2*	*CO2*
15.	State any two engineering examples of serial systems that can be solved by stochastic programming.	*2*	*K2*	*CO3*
16.	What are the basic operations used in neural network?	*2*	*K2*	*CO3*
17.	Define transverse load. Give any two examples.	*2*	*K2*	*CO4*
18.	What are all key parameters to be consider while designing a shaft?	*2*	*K2*	*CO4*
19.	Explain about degrees of freedom.	*2*	*K2*	*CO5*
20.	What are all key parameters to be consider for simple linkage mechanism problems?	*2*	*K2*	*CO5*
21.	What are the basic operations used in fuzzy logic?	*2*	*K2*	*CO3*
22.	Explain the operations of Genetic algorithms.	*2*	*K2*	*CO3*

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23.	a)	Apply the Kuhn-Tucker conditions to solve the following constrained optimization problem: Minimize: $Z = 2x_1 + x_1x_2 + 3x_2$ Subject to: $x_1^2 + x_2 < 3$	*11*	*K3*	*CO1*
		OR			
	b)	Why is a convex function guaranteed to have a single global minimum within its domain? Explain with reasoning.	*11*	*K2*	*CO1*
24.	a)	Prove that the shortest distance between two points is not a straight line. Show that the necessary conditions yield a minimum and not a maximum.	*11*	*K3*	*CO2*
		OR			
	b)	Formulate and derive the necessary conditions for optimality, and determine the solution for the following constrained optimization problem. Minimize: $f(x) = 4x_1x_2$ Subject to: $16 - x_1^2 - x_2^2 \geq 0$	*11*	*K3*	*CO2*
25.	a)	Identify how the stochastic programming has been applied to solve the following types of engineering problems. (a) Design of simply supported Beam (b) Optimal Layout (Geometry) of a Truss	*11*	*K3*	*CO3*
		OR			

b) Two discrete fuzzy sets, A and B are defined as follows: *11 K3 CO3*
A = {(60, 0.1) (62, 0.5) (64, 0.7) (66, 0.9) (68, 1.0) (70, 0.8)}
B = {(60, 0.0) (62, 0.2) (64, 0.4) (66, 0.8) (68, 0.9) (70, 1.0)}
Determine the union and intersection of these sets.

26. a) Construct an optimization in design of truss. *11 K2 CO4*

OR

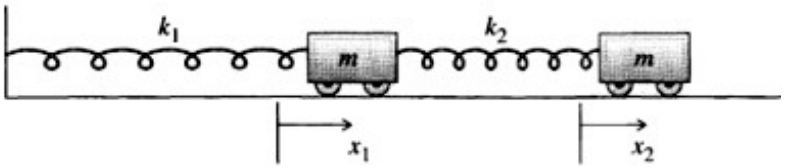
b) A shaft is transmitting 50 kW at 100 rpm. Find a suitable diameter and length of the shaft, if the maximum torque transmitted exceeds the mean by 30%. Take maximum allowable shear stress as 60 MPa. *11 K3 CO4*

27. a) Construct an optimization problem for slider crank mechanism. *11 K2 CO5*

OR

b) Apply and explain about vibration absorbers and the need of optimization in their design. *11 K2 CO5*

28. a) Two carts with equal mass m can move on a horizontal track. The left cart is attached to a fixed wall by a spring with force constant k1 and the two carts are attached to each other by a spring with force constant k2. Assume that K1 = 3k2/2 by writing k1 = 3 k and k2 = 2 k (with the same constant k for both carts). The displacement from the equilibrium positions of the two carts is x1 and x2 respectively (Refer figure below). *11 K3 CO4*



OR

b) Derive the expression for torsional rigidity of the shaft. *11 K3 CO4*