MCQs (As per GATE Syllabus)

1. Optimization is the process of
A. Improving only performance
B. Minimizing cost or maximizing profit under constraints
C. Increasing system complexity
D. Trial and error method

Answer: B

2. The function to be optimized is called
A. Decision variable
B. Constraint function
C. Objective function
D. Design variable

Answer: C

3. Variables whose values are to be determined in an optimization problem are called
A. Slack variables
B. Objective variables
C. Decision variables
D. Control variables

Answer: C

4. In unconstrained optimization, the solution is obtained by
A. Setting the first derivative equal to zero
B. Using slack variables
C. Using simplex method
D. Using penalty method

Answer: A

5. A necessary condition for minimum of a function is
A. First derivative $\neq 0$
B. First derivative $= 0$
C. Second derivative < 0
D. Function is linear

Answer: B

6. For a function to have a minimum, the second derivative should be
A. Zero
B. Negative
C. Positive
D. Infinite

Answer: C

7. In a transportation problem with m sources and n destinations, the number of basic variables in a non-degenerate solution is:

A) m + n
B) m × n
C) m + n – 1
D) m – n + 1
Answer: C
8. A transportation problem is said to be balanced when:

A) Total cost is minimum
B) Total supply equals total demand
C) Number of sources equals number of destinations
D) All routes have equal cost

Answer: B

9. The Hungarian method is used to solve:

A) Game theory problems
B) Non-linear programming
C) Assignment problems
D) Sequencing problems

Answer: C

10. Linear programming problems have
A. Nonlinear objective and constraints
B. Linear objective and nonlinear constraints
C. Linear objective and linear constraints
D. No constraints

Answer: C

11. The graphical method of LP can be used when the number of decision variables is
A. One
B. Two
C. Three
D. More than three

Answer: B

12. The feasible region of an LP problem is
A. Area violating constraints
B. Area satisfying all constraints
C. Unbounded area
D. Only corner points

Answer: B

13. The optimal solution of a linear programming problem occurs at
A. Center of feasible region
B. Any point on constraint
C. Corner point of feasible region
D. Origin only

Answer: C

14. Slack variables are introduced in LP to
A. Increase objective function
B. Convert inequalities into equalities
C. Reduce constraints
D. Eliminate decision variables

Answer: B

15. Steepest descent method is based on
A. Random search
B. Gradient information
C. Trial and error
D. Linear approximation

Answer: B

16. In optimization, a local minimum is
A. The best solution in entire domain
B. Best solution in a small neighborhood
C. Always global minimum
D. Always infeasible

Answer: B

17. A global minimum is
A. Maximum value of function
B. Best value among all feasible solutions
C. Best value in local region only
D. Unconstrained solution

Answer: B

18. Optimization in engineering mainly aims at
A. Increasing material usage
B. Reducing efficiency
C. Minimizing cost and maximizing performance
D. Eliminating constraints

Answer: C

19. Constraints in an optimization problem represent
A. Objective function
B. Design limitations
C. Decision variables
D. Performance index

Answer: B

20. Which of the following is NOT an optimization technique?
A. Simplex method
B. Lagrange multiplier
C. Genetic algorithm
D. Finite element method

Answer: D

Short Answer Interview Questions

1. What is optimization?
Optimization is the process of finding the best solution under given constraints.

2. Explain the use of slack variable and surplus variable

Slack Variable:
Added to a ≤ constraint to convert it into an equation. It represents unused resources.
Example:
$2x+3y \leq 10$, can be written as $2x + 3y + s = 10$, where $s \geq 0$

Surplus Variable:
Subtracted from a ≥ constraint to convert it into an equation. It represents excess over the minimum requirement.
Example:
$2x+3y \geq 10$, can be written as $2x + 3y - s = 10$, where $s \geq 0$

3. Differentiate between standard and canonical form of LPP.

Standard Form	Canonical Form
All constraints are equalities.	Constraints are of ≤ type.
Slack/surplus variables are added.	Slack variables are added only.
Objective function can be max./min. type.	Objective functions are max. type only.
Used for solving by simplex method.	Used for formulating LPP before conversion. And solving by dual simplex method

4. Differentiate between simplex method and dual simplex method.

Simplex Method	Dual Simplex Method
Starts with feasible solution.	Starts with infeasible solution.
Improves optimality step by step.	Restores feasibility first.
Used when RHS values are positive.	Used when RHS has negative values.
Moves toward optimal solution maintaining feasibility	Moves toward feasibility maintaining optimality.

5. Explain the conditions for basic feasible solutions of transportation problem.

- Number of allocations must be **m + n – 1**, where m = rows and n = columns.
- Allocated cells must be independent (no closed loop).
- All allocations must satisfy supply and demand constraints.
- All allocated values must be non-negative.

6. Explain the advantage of VAM method over other methods in transportation problem.

- The solution is usually closer to optimal solution.
- Reduces number of iterations in optimality test.
- More accurate than North-West Corner and Least Cost methods, as it always gives a basic feasible solution.
- Minimizes total transportation cost more effectively at initial stage.

7. **Demonstrate the steps involved in solving an assignment problem using the Hungarian method.**
Row reduction, column reduction, zero assignment, and adjustment until optimal assignment is found.

8. **Differentiate balanced and unbalanced assignment problems with solution approach**.
Answer: Balanced has equal agents and tasks; unbalanced requires adding dummy rows/columns.

9. **Explain the impact of changes in objective function coefficients on the optimal solution using sensitivity analysis**.
If the change lies within allowable limits, the basis remains unchanged; outside limits, a new optimal solution is obtained.

10. Analyze the effect of change in RHS of constraints on feasibility and shadow price.
Within permissible range, shadow price remains constant; beyond that, feasibility or optimal basis changes.

11. Examine the working steps of the branch-and-bound method in integer programming.
The problem is relaxed, branched into sub-problems, bounds are computed, and non-promising branches are pruned.

12. **Illustrate the principle of optimality in dynamic programming with suitable reasoning.**
An optimal decision sequence ensures that remaining decisions constitute an optimal solution for the sub-problem.

13. **Explain the structure and components of a single-server queuing model.**
Includes arrival rate (λ), service rate (μ), queue discipline, and system capacity.

14. **Analyze the role of Poisson and exponential distributions in queuing models.**
Poisson models random arrivals; exponential models service time due to memoryless property.

15. **Evaluate system performance measures in an M/M/1 queue.**
Key measures include L, Lq, W, Wq derived using λ and μ relationships.

16. Define balking in queuing
A customer decides **not to enter the queue** after observing it (usually due to long waiting line or delay).

17. Define reneging
A customer **joins the queue but leaves before receiving service** because of excessive waiting time.

18. Define jockeying
A customer **switches from one queue to another** in a multi-server system expecting faster service.

19. **Explain the characteristics that distinguish nonlinear programming from linear programming.**
Objective function or constraints are nonlinear, leading to curved feasible regions.

20. **Analyze the procedure of Golden Section search method for unimodal functions.**
The interval is reduced systematically using golden ratio until convergence to optimum.

21. **Apply Lagrange multiplier technique to solve equality constrained optimization problems**.
Form Lagrangian, differentiate partially, and solve simultaneous equations.

22. **Examine the Kuhn–Tucker optimality conditions for inequality constraints**.
Conditions include stationarity, primal feasibility, dual feasibility, and complementary slackness.

23. **Classify quadratic programming problems based on definiteness of the Hessian matrix**.
Positive definite gives minimum; negative definite gives maximum; indefinite gives saddle point.

24. **Interpret the maxi-min and mini-max principles in decision making under conflict.**
Maxi-min maximizes minimum gain; mini-max minimizes maximum loss.

25. **Apply dominance theory to reduce a payoff matrix in game theory**.
Eliminate dominated strategies to simplify the matrix before solving.

26. What is a local minimum and global minimum?
Minimum value in a small neighborhood of a point is called as local min., lowest value over the entire feasible region is called as global min..

27. **State Bellman's principle of optimality**
An optimal policy has the property that, regardless of the initial state and decision, the remaining decisions must constitute an optimal policy for the state resulting from the first decision.

28. What is a convex function?
A function having a single global minimum.

29. What is multi-objective optimization?
Optimization involving more than one objective function.

30. Give one application of optimization in engineering.
Minimum weight design of machine components.