



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	ENGINEERING OPTIMIZATION
Course Code	:	AME516
Program	:	B.Tech
Semester	:	V
Branch	:	Mechanical Engineering
Section	:	A& B
Course Faculty	:	Ms. T Vanaja, Assistant Professor

COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
II	Develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.
III	Apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

DEFINITIONS AND TERMINOLOGY QUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
UNIT-I						
1	What is uni modal function?	A uni modal function is one that has only one peak maximum or valley minimum in a given interval. Thus a function of one variable is said to be unimodal, if given that two values of the variable are on the same side of the optimum, the one nearer the optimum gives the better functional value.	Understand	CO 1	CLO 1	AME516.01
2	What is single variable optimization?	Single variable function involve only one variable the optimization procedures are simple and easier to understand. Min $f(x)$, where $f(x)$ is the objective function and x is a real variable.	Remember	CO 1	CLO 1	AME516.01
3	What are design variables?	A design optimization problem usually involves many design parameters of which some are highly sensitive to the proper working of the design. These parameters are called as design	Remember	CO 1	CLO 1	AME516.01

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		variables.				
4	What are constraints?	The constraints represent some functional relationships among the design variables and other design parameters satisfying certain physical phenomenon and certain resource limitations.	Remember	CO 1	CLO 1	AME516.01
5	What is objective function?	The function to be minimized or maximized is called the objective function and the set of alternatives is called the feasible region (or constraint region).Linear programming is an extremely powerful tool for addressing a wide range of applied optimization problems.	Remember	CO 1	CLO 1	AME516.01
6	What are variable bounds?	In general all the design variables are restricted with maximum and minimum limits called as variable bounds.	Remember	CO 1	CLO 2	AME516.02
7	What are the steps involved in optimization?	Choose design variables, formulate constraints, formulate objective function, set up variables bounds and choose an optimization algorithm to obtain a solution.	Remember	CO 1	CLO 2	AME516.02
8	What is a linear programming problem?	The problem which consists of all its terms in linear equations including objective function constraints and variables.	Remember	CO 1	CLO 2	AME516.02
9	What is gradient based method?	This method uses the derivative information of the objective function, first order and second order derivatives.	Remember	CO 1	CLO 2	AME516.02
10	What is direct search method?	This method uses only the objective function values, no derivative information of objective function is required to find the optimal solution.	Remember	CO 1	CLO 2	AME516.02
11	what is optimization?	Task involving either minimization or maximization of an objective of various engineering problems.	Remember	CO 1	CLO 3	AME516.03
12	what are inequality constraints?	Inequality constraints state the functional relationships among the design variables are either greater than or smaller than or equal to a resource value.	Remember	CO 1	CLO 3	AME516.03
13	What are the equality constraints?	Equality constraints state that the functional relationships should exactly match a resource value.	Understand	CO 1	CLO 3	AME516.03
14	What are specialized optimization problems?	Integer programming methods can solve optimization problems with integer design variables. Geometric programming methods solve optimization problems with objective functions and constraints written	Remember	CO 1	CLO 3	AME516.03

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		in special form.				
15	What is constrained optimization?	These algorithms use the single variable and multi variable optimization algorithms repeatedly and simultaneously maintain the search effort inside the feasible region.	Remember	CO 1	CLO 3	AME516.03
UNIT-II						
1	What is local minima?	A maximum or minimum is said to be local if it is the largest or smallest value of the function, respectively, within a given range. However, a maximum or minimum is said to be global if it is the largest or smallest value of the function, respectively, on the entire domain of a function.	Remember	CO 2	CLO 4	AME516.04
2	What is global minima?	A maximum or minimum is said to be local if it is the largest or smallest value of the function, respectively, within a given range. However, a maximum or minimum is said to be global if it is the largest or smallest value of the function, respectively, on the entire domain of a function.	Remember	CO 2	CLO 4	AME516.04
3	What is inflection point?	An inflection point is a point on a curve at which the sign of the curvature (i.e., the concavity) changes. The first derivative test can sometimes distinguish inflection points from extrema for differentiable functions. The second derivative test is also useful.	Understand	CO 2	CLO 4	AME516.04
4	What is optimality criteria?	There are three different types of optimal points are: (i) Local Optimal point: A point or solution x^* is said to be a local optimal point, if no point in the neighbourhood has a function value smaller than $f(x^*)$. (ii) Global Optimal point: A point or solution x^{**} is said to be a global optimal point, if no point in the entire search space has a function value smaller than $f(x^{**})$.	Understand	CO 2	CLO 4	AME516.04
5	What are specialized optimization algorithms?	Two of these algorithms - integer programming and geometric programming - are often used in engineering design problems. Integer programming methods can solve optimization problems with integer design variables. Geometric programming methods solve optimization problems with objective functions and	Understand	CO 2	CLO 4	AME516.04

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		constraints written in a special form.				
6	What is single variable optimization?	The algorithms described in this section can be used to solve minimization problems of the following type: Minimize $f(x)$ Where $f(x)$ is the objective function and x is a real variable. The purpose of an optimization algorithm is to find a solution x , for which the function $f(x)$ is minimum.	Remember	CO 2	CLO 5	AME516.05
7	What is multi variable optimization?	These algorithms demonstrate how the search for the optimum point progresses in multiple dimensions. Depending on whether the gradient information is used or not used, these algorithms are also classified into direct and gradient-based techniques.	Remember	CO 2	CLO 5	AME516.05
8	What is constrained optimization?	These algorithms use the single variable and multivariable optimization algorithms repeatedly and simultaneously maintain the search effort inside the feasible search region. These algorithms are mostly used in engineering optimization problems.	Remember	CO 2	CLO 5	AME516.05
9	What is optimization algorithm?	The formulation of engineering design problems differ from problem to problem. They are (i) Linear terms for constraints and objective function (ii) Non linear terms for constraints and objective function. The terms are not explicit functions of the design variables. No single optimization algorithm which will work in all optimization problems equals efficiently.	Remember	CO 2	CLO 5	AME516.05
10	What are the two methods used in optimization?	These algorithms are classified into two categories i. Direct methods ii. Gradient based methods 39 Direct methods do not use any derivative information of the objective function; only objective function values are used to guide the search process. However, gradient-based methods use derivative information (first and/or second order) to guide the search process.	Remember	CO 2	CLO 5	AME516.05
11	What is bracketing method?	The minimum of a function is found in two phases. Initially an approximate method is used to find a lower and an upper bound of the minimum. Next, a	Remember	CO 2	CLO 6	AME516.06

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		sophisticated technique is used to search within these two limits to find the optimal solution.				
12	What is exhaustive search method?	It is the simplest of all search methods. The optimum of a function is bracketed by calculating the function values at a number of equally spaced points. Usually the search begin from a lower bound on the variable and three consecutive function values are compared at a time based on the assumption of unimodality of the function. Based on the outcome of comparison, the search is either terminated or continued by replacing one of the three points with a new point.	Remember	CO 2	CLO 6	AME516.06
13	What is region elimination method?	Once the minimum point is bracketed, a more sophisticated algorithm is used to improve the accuracy of the solution. Region elimination methods are used for this purpose. The fundamental rule for region elimination method	Remember	CO 2	CLO 6	AME516.06
14	What is rule to eliminate region?	Consider a unimodal function drawn in Fig.9. The two points x_1 and x_2 lie in the interval (a,b) and satisfy $x_1 < x_2$. For minimization, the following conditions apply • If then the minimum does not lie in (a, x_1) • If then the minimum does not lie in (x_2 , b) • If then the minimum does not lie in (a, x_1) and (x_2 , b)	Remember	CO 2	CLO 6	AME516.06
15	What is interval halving method?	The region in the interval (a, b). Three points divide the search space into four regions. The fundamental rule for region elimination is used to eliminate a portion of search space based on function values at three chosen points	Remember	CO 2	CLO 6	AME516.06
UNIT -III						
1	What is golden section search method?	In golden section search method, the search space (a, b) is first linearly mapped to a unit interval search space (0,1). Two points at from either end of search space are chosen so that at every iteration the eliminated region is to that in the previous iteration.This can be achieved by equating This yields the golden number $\tau = 0.618$	Understand	CO 3	CLO 7	AME516.07

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
2	What is Nelder-Mead method ?	The Nelder-Mead method uses a geometrical shape called a simplex as its 'vehicle' of sorts to search the domain. This is why the technique is also called the Simplex search method. In layman's terms, a simplex is the n-dimensional version of a 'triangle'.	Remember	CO 3	CLO 7	AME516.07
3	what is uni variate method?	Generates trial solution for one decision variable keeping all others fixed. Best solution for each of the decision variables keeping others constant are obtained. The whole process is repeated iteratively till convergence.	Remember	CO 3	CLO 7	AME516.07
4	What is powell conjugate method?	conjugate direction method, is an algorithm proposed by Michael J. D. Powell for finding a local minimum of a function. The function need not be differentiable, and no derivatives are taken. The function must be a real-valued function of a fixed number of real-valued inputs.	Remember	CO 3	CLO 8	AME516.08
5	What is optimization algorithm?	The formulation of engineering design problems differ from problem to problem. They are (i) Linear terms for constraints and objective function (ii) Non linear terms for constraints and objective function. The terms are not explicit functions of the design variables. No single optimization algorithm which will work in all optimization problems equals efficiently.	Remember	CO 3	CLO 8	AME516.08
6	What is region elimination method?	Once the minimum point is bracketed, a more sophisticated algorithm is used to improve the accuracy of the solution. Region elimination methods are used for this purpose. The fundamental rule for region elimination method	Understand	CO 3	CLO 8	AME516.08
7	What is optimality criteria?	There are three different types of optimal points are: (i) Local Optimal point: A point or solution x^* is said to be a local optimal point, if no point in the neighbourhood has a function value smaller than $f(x^*)$. (ii) Global Optimal point: A point or solution x^{**} is said to be a global optimal point, if no point in the entire search space has a	Remember	CO 3	CLO 8	AME516.08

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		function value smaller than $f(x^{**})$.				
8	What is rule to eliminate region?	Consider a unimodal function drawn in Fig.9. The two points x_1 and x_2 lie in the interval (a,b) and satisfy $x_1 < x_2$. For minimization, the following conditions apply <ul style="list-style-type: none"> • If then the minimum does not lie in (a, x_1) • If then the minimum does not lie in (x_2, b) • If then the minimum does not lie in (a, x_1) and (x_2, b) 	Understand	CO 3	CLO 8	AME516.08
9	What is rosen brock's method?	In mathematical optimization, the Rosenbrock function is a non-convex function, introduced by Howard H. Rosenbrock in 1960, which is used as a performance test problem for optimization algorithms	Remember	CO 3	CLO 9	AME516.09
10	What is steepest descent?	The method of steepest descent, also called the gradient descent method, starts at a point and, as many times as needed, moves from to by minimizing along the line extending from in the direction of , the local downhill gradient. from a starting point for some small until a fixed point is reached.	Remember	CO 3	CLO 9	AME516.09
11	What is gradient based method?	This method uses the derivative information of the objective function, first order and second order derivatives.	Remember	CO 3	CLO 9	AME516.09
12	What are the two methods used in optimization?	These algorithms are classified into two categories i. Direct methods ii. Gradient based methods 39 Direct methods do not use any derivative information of the objective function; only objective function values are used to guide the search process. However, gradient-based methods use derivative information (first and/or second order) to guide the search process.	Remember	CO 3	CLO 10	AME516.010
13	What is direct search method?	This method uses only the objective function values, no derivative information of objective function is required to find the optimal solution.	Remember	CO 3	CLO 10	AME516.010
14	What is multi variable optimization?	These algorithms demonstrate how the search for the optimum point progresses in multiple dimensions. Depending on whether the gradient information is used or not used, these algorithms are also	Remember	CO 3	CLO 10	AME516.010

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		classified into direct and gradient-based techniques.				
15	What is powell conjugate method?	conjugate direction method, is an algorithm proposed by Michael J. D. Powell for finding a local minimum of a function. The function need not be differentiable, and no derivatives are taken. The function must be a real-valued function of a fixed number of real-valued inputs.	Remember	CO 3	CLO 10	AME516.010
UNIT -IV						
1	What is classical optimization?	The classical optimization techniques are very useful to obtain the optimal solution of problems involving continuous and differentiable functions. Such types of techniques are analytical in nature to obtain maximum and minimum points for unconstrained and constrained continuous objective functions.	Remember	CO 3	CLO 11	AME516.011
2	What is rule to eliminate region?	Consider a unimodal function drawn in Fig.9. The two points x_1 and x_2 lie in the interval (a, b) and satisfy $x_1 < x_2$. For minimization, the following conditions apply • If then the minimum does not lie in (a, x_1) • If then the minimum does not lie in (x_2, b) • If then the minimum does not lie in (a, x_1) and (x_2, b)	Remember	CO 3	CLO 11	AME516.011
3	what is hooke jeeve's method?	A combination of exploratory and pattern moves – Exploratory – find the best point in the vicinity of the current point – Pattern – Jump in the direction of change, if better then continue, else reduce size of exploratory move and continue	Remember	CO 3	CLO 11	AME516.011
4	What are the different gradient based methods?	Methods in Gradient Search. – Decent Direction – Cauchy's (steepest decent) method – Newton's Method – Marquardt's Method – Conjugate gradient method – Variable-metric method.	Remember	CO 3	CLO 11	AME516.011
5	What is steepest descent method?	In nonlinear function the steepest decent direction at any point may not exactly pass through the true minimum. • The steepest decent direction is a direction which is a local best direction • It is not guaranteed	Remember	CO 3	CLO 12	AME516.012

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		that moving along the steepest decent direction will always take the search closer to the true minimum				
6	What is region elimination method?	Consider a unimodal function drawn in The two points x_1 and x_2 lie in the interval (a,b) and satisfy $x_1 < x_2$. For minimization, the following conditions apply • If then the minimum does not lie in (a, x_1) • If then the minimum does not lie in (x_2, b) • If then the minimum does not lie in (a, x_1) and (x_2, b)	Remember	CO 3	CLO 12	AME516.012
7	what is lagrangian multiplier?	In mathematical optimization, the method of Lagrange multipliers is a strategy for finding the local maxima and minima of a function subject to equality constraints (i.e., subject to the condition that one or more equations have to be satisfied exactly by the chosen values of the variables)	Remember	CO 3	CLO 12	AME516.012
8	What is optimality criteria?	There are three different types of optimal points are: (i) Local Optimal point: A point or solution x^* is said to be a local optimal point, if no point in the neighbourhood has a function value smaller than $f(x^*)$. (ii) Global Optimal point: A point or solution x^{**} is said to be a global optimal point, if no point in the entire search space has a function value smaller than $f(x^{**})$.	Remember	CO 3	CLO 12	AME516.012
9	What is Kuhn tucker conditions?	In mathematical optimization, the Karush–Kuhn–Tucker (KKT) conditions, also known as the Kuhn–Tucker conditions, are first derivative tests (sometimes called first-order) necessary conditions for a solution in nonlinear programming to be optimal, provided that some regularity conditions are satisfied.	Remember	CO 3	CLO 13	AME516.013
10	what is Beale's method ?	Beale's method is that it reduces to the LP simplex method for purely linear problems, which most QP simplex methods do not. In general the simplex method deals with the minimization or local minimization of an objective function C , of n variables x .	Remember	CO 3	CLO 13	AME516.013

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
11	what is wolfe's method?	Wolfe method is one method for solving quadratic programming problems by means of transforming the quadratic programming problems into a linear programming problem.	Remember	CO 3	CLO 13	AME516.013
12	What is Quadratic programming ?	Quadratic programming (QP) is the process of solving a special type of mathematical optimization problem—specifically, a (linearly constrained) quadratic optimization problem, that is, the problem of optimizing (minimizing or maximizing) a quadratic function of several variables subject to linear constraints	Remember	CO 3	CLO 13	AME516.013
13	What is constrained optimization?	These algorithms use the single variable and multi variable optimization algorithms repeatedly and simultaneously maintain the search effort inside the feasible region.	Remember	CO 3	CLO 14	AME516.014
14	what are inequality constraints?	Inequality constraints state the functional relationships among the design variables are either greater than or smaller than or equal to a resource value.	Remember	CO 3	CLO 14	AME516.014
15	What are the equality constarints?	Equality constraints state that the functional relationships should exactly match a resource value.	Remember	CO 3	CLO 14	AME516.014

UNIT -V

1	What is integer programming?	Integer programming is the class of problems that can be expressed as the optimization of a linear function subject to a set of linear constraints over integer variables.	Remember	CO 2	CLO 15	AME516.015
2	What is geometric program?	A geometric program is composed of an objective function that is subjected to constraints. All of the components must be in the nature of monomials and posynomials.	Remember	CO 2	CLO 15	AME516.015
3	What is cutting plane method?	Cutting planes were proposed by Ralph Gomory in the 1950s as a method for solving integer programming and mixed-integer programming problems	Remember	CO 2	CLO 15	AME516.015
4	what is Branch-and-bound?	Branch-and-bound algorithm consists of a branching rule that defines how to generate successors, a bounding rule that defines how	Remember	CO 2	CLO 15	AME516.015

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		to compute a bound, and an elimination rule that recognizes and eliminates subproblems, which cannot result in an optimal solution				
5	What is optimality criteria?	There are three different types of optimal points are: (i) Local Optimal point: A point or solution x^* is said to be a local optimal point, if no point in the neighbourhood has a function value smaller than $f(x^*)$. (ii) Global Optimal point: A point or solution x^{**} is said to be a global optimal point, if no point in the entire search space has a function value smaller than $f(x^{**})$.	Understand	CO 2	CLO 16	AME516.016
6	What is objective function?	The function to be minimized or maximized is called the objective function and the set of alternatives is called the feasible region (or constraint region). Linear programming is an extremely powerful tool for addressing a wide range of applied optimization problems.	Understand	CO 2	CLO 16	AME516.016
7	What are constraints?	The constraints represent some functional relationships among the design variables and other design parameters satisfying certain physical phenomenon and certain resource limitations.	Understand	CO 2	CLO 16	AME516.016
8	what are inequality constraints?	Inequality constraints state the functional relationships among the design variables are either greater than or smaller than or equal to a resource value.	Understand	CO 2	CLO 16	AME516.016
9	What are the equality constraints?	Equality constraints state that the functional relationships should exactly match a resource value.	Understand	CO 2	CLO 16	AME516.016
10	What is constrained optimization?	These algorithms use the single variable and multi variable optimization algorithms repeatedly and simultaneously maintain the search effort inside the feasible region.	Understand	CO 2	CLO 17	AME516.017
11	What is optimization algorithm?	The formulation of engineering design problems differ from problem to problem. They are (i) Linear terms for constraints and objective function (ii) Non linear terms for constraints and objective function. The terms are not explicit functions of the design variables. No single optimization algorithm which will work in all optimization problems equals efficiently.	Remember	CO 2	CLO 17	AME516.017

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
12	What is multi variable optimization?	These algorithms demonstrate how the search for the optimum point progresses in multiple dimensions. Depending on whether the gradient information is used or not used, these algorithms are also classified into direct and gradient-based techniques.	Remember	CO 2	CLO 17	AME516.017
13	What are specialized optimization algorithms?	Two of these algorithms - integer programming and geometric programming - are often used in engineering design problems. Integer programming methods can solve optimization problems with integer design variables. Geometric programming methods solve optimization problems with objective functions and constraints written in a special form.	Remember	CO 2	CLO 18	AME516.018
14	what is the method to solve IPP?	Branch-and-bound algorithm consists of a branching rule that defines how to generate successors, a bounding rule that defines how to compute a bound, and an elimination rule that recognizes and eliminates subproblems, which cannot result in an optimal solution	Remember	CO 2	CLO 18	AME516.018
15	What is the method to solve GPP?	Cutting planes were proposed by Ralph Gomory in the 1950s as a method for solving integer programming and mixed-integer programming problems	Remember	CO 2	CLO 18	AME516.018

Signature of the Faculty

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