INSTITUTEOFAERONAUTICALENGINEERING

(Autonomous)

Dundigal, Hyderabad-500043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**ENGINEERING OPTIMIZATION**				
Course Code	AME516				
Programme	B.Tech				
Semester	V	ME			
Course Type	PROFESSIONAL ELECTIVE -I				
Regulation	**IARE - R18**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mrs. T Vanaja, Assistant Professor				
Course Faculty	Mrs. 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.

COURSE OUTCOMES (COs):

CO 1	Define and use optimization terminology and concepts, and understand how to classify an optimization problem
CO 2	Apply optimization methods to engineering problems, including developing a model, defining an optimization problem, applying optimization methods, exploring the solution, and interpreting results.
CO 3	Understand and apply unconstrained optimization theory for continuous problems, including the necessary and sufficient optimality conditions and algorithms such as: steepest descent, Newton's method, conjugate gradient, and quasi-Newton methods.
CO 4	Understand and apply methods for computing derivatives such as: finite differentiating, symbolic differentiation, complex step, algorithmic differentiation, and analytic methods.
CO 5	Understand and apply constrained optimization theory for continuous problems, including the Kuhn-Tucker conditions and algorithms such as: generalized reduced gradient, sequential quadratic programming, and interior-point methods.

COURSE LEARNING OUTCOMES (CLOs):

AME516.01	Understand implement basic optimization algorithms in a computational setting and apply existing optimization software packages to solve engineering problems .
AME516.02	Apply optimization techniques to determine a robust design.
AME516.03	Apply optimization methods, exploring the solution, and interpreting results.
AME516.04	Evaluate model engineering minima/maxima problems as optimization problems.
AME516.05	Solve Matlab to implement optimization algorithms.
AME516.06	Evaluate and measure the performance of an algorithm. .
AME516.07	Describe mathematical translation of the verbal formulation of an optimization problem.
AME516.08	Explain design algorithms, the repetitive use of which will lead reliably to finding an approximate solution.
AME516.09	Demonstrate the ability to choose and justify optimization techniques that are appropriate for solving realistic engineering problems.
AME516.10	Demonstrate clearly a problem, identify its parts and analyze the individual functions.
AME516.11	Explain Feasibility study for solving an optimization problem.
AME516.12	Understand the gradient and its applications.
AME516.13	Compare, study and solve optimization problems.
AME516.14	Understand optimization techniques using algorithms.
AME516.15	Understand the various direct and indirect search methods.
AME516.16	Understand the Investigate, study, develop, organize and promote innovative solutions for various applications.
AME516.17	Understand evolutionary algorithms.
AME516.18	Enable nonlinear problem through its linear approximation.
AME516.19	Enable students to understand optimal estimation in environmental engineering; production planning in industrial engineering; transportation problem.

TUTORIAL QUESTION BANK

S No	QUESTIONS	Blooms Taxonomy Level	Course Outcomes	Course Learning Outcomes (CLOs)
	UNIT- I			
	INTRODUCTION TO OPTIMIZATION			
	Part - A (Short Answer Questions)			
1	What is the definition of objective function?	Remember	CO 1	AME516.01
2	Define design constraints.	Understand	CO 1	AME516.01
3	Explain non negativity constraints.	Remember	CO 1	AME516.02
4	Define variable bounds.	Remember	CO 1	AME516.02
5	Explain flowchart of the optimal design procedure.	Remember	CO 1	AME516.03
6	List the different types of constraints with examples.	Remember	CO 1	AME516.03
7	Classify the optimization problems.	Remember	CO 1	AME516.03
8	Define the term formulation in optimization.	Remember	CO 1	AME516.03
9	Define the term decision variables.	Remember	CO 1	AME516.03
10	Define the term equality and inequality constraints.	Remember	CO 1	AME516.03
11	List out the applications of optimization techniques.	Remember	CO 1	AME516.03
12	Explain the steps involved in formulating a optimization problem.	Remember	CO 1	AME516.03
13	Define the term feasible solution	Understand	CO 1	AME516.03
14	Differentiate between optimal solution and feasible solution.	Understand	CO 1	AME516.03
15	Explain the effect of constraints on feasible region.	Remember	CO 1	AME516.03
16	Explain some relevant examples of optimization in various fields of industry.	Understand	CO 1	AME516.03
17	Define different types of optimization problems.	Understand	CO 1	AME516.03
18	List out the applications of optimization technique in mechanical engineering.	Remember	CO 1	AME516.03
19	Define the term optimization and its importance in engineering.	Understand	CO 1	AME516.03
20	Explain the effect of constraints on feasible region.	Remember	CO 1	AME516.03
	Part - B (Long Answer Questions)			
1	State the optimizationproblem. Classify and explain various types ofoptimization problemswithexamples.	Understand	CO 1	AME516.02
2	Explain the following with suitableexamples: Designvector b) Objective function c)Constraints.	Understand	CO 1	AME516.02
3	A company produces two types of hats. Each hat of first type requires twice as much as labour time as second type. If all hats are of the second type only, the company can produce a total of 500 hats a day. The market limits daily sales of the first and second type to 150 and 250 hats. Assuming that the profits per hat are Rs.8 for type A and Rs.5 for type B formulate.	Understand	CO 1	AME516.02
4	A farmer has 100 acre farm. He can sell all tomatoes, lettuce, or radishes he can raise. The price he can obtain is Rs 1.00 per kg for tomatoes, Rs 0.75 a head for lettuce and Rs 2.00 per kg for radishes. The average yield per acre is 2000 kg of tomatoes, 3000 heads of lettuce and 1000 kgs of radishes. Fertilizer is available at Rs 0.50 per kg and the amount required per acre is 100 kgs each for tomatoes and lettuce, and 50 kgs for radishes. Labour required for sowing and harvesting per acre is 5 man-days for tomatoes and radishes, and 6 man-days for lettuce. A total of 400 man-days of labour are available at Rs 20.00 per man-day. Formulate this as a Linear-Programming model to maximize the farmers total profit.	Understand	CO 1	AME516.02
5	Classify and explain various types ofoptimization problemswithexamples.	Understand	CO 1	AME516.02
6	Let us consider a company making single product. The estimated demand for the product for the next four months are 1000,800,1200,900 respectively. The company has a regular time capacityof 800 per month and an overtime capacity of 200 per month. The cost of regular time production is Rs.20 per unit and the cost of overtime production is Rs.25 per unit. The company can carry inventory to the next month and the holding cost is Rs.3/unit/month the demand has to be met every month. Formulate a linear programming problem for the above situation	Understand	CO 1	AME516.03
7	Explain the historical development of optimization techniques.	Understand	CO 1	AME516.03
8	Explain engineering applications of optimization techniques.	Understand	CO 1	AME516.03

9	Explain the statement of optimization problem and it algorithm.	Understand	CO 1	AME516.03
10	Explain about design constraints and their significance in optimization techniques.	Understand	CO 1	AME516.03
11	What is objective function and on what base the criteria for selecting objective function will be?	Understand	CO 1	AME516.03
12	How will be optimization techniques are classified based on the nature of design variables?	Understand	CO 1	AME516.03
13	Classify the optimization techniques based on the existence of constraints.	Understand	CO 1	AME516.03
14	How do you classify the optimization problems based on the nature of equations involved?	Understand	CO 1	AME516.03
15	Explain the difference between linear programming and non linear programming.	Understand	CO 1	AME516.03
16	State linear programming problem in standard form.	Understand	CO 1	AME516.03
17	Explain optimization of a transit schedule.	Understand	CO 1	AME516.03
18	Explain optimization of ammonia reactor.	Understand	CO 1	AME516.03
19	Explain the optimization process involved in optimizing a suspension of a car.	Understand	CO 1	AME516.03
20	What is integer programming problem and its algorithm?	Understand	CO 1	AME516.03
Part - C (Problem Solving and Critical Thinking Questions)				
1	A calculator company produces a handheld calculator and a scientific calculator. Long-term projections indicate an expected demand of at least 150 scientific and 100 handheld calculators each day. Because of limitations on production capacity, no more than 250 scientific and 200 handheld calculators can be made daily.To satisfy a shipping contract, a minimum of 250 calculators must be shipped each day. If each scientific calculator sold, results in a 20 rupees loss, but each handheld calculator produces a 50 rupees profit; then how many of each type should be manufactured daily to maximize the net profit?	Understand	CO 1	AME516.02
2	A part-time graduate student in engineering is enrolled in a four-unit mathematics course and a three-unit design course. Since the student has to work for 20 hours a week at a local software company, he can spend a maximum of 40 hours a week to study outside the class. It is known from students who took the courses previously that the numerical grade (g) in each course is related to the study time spent outside the class as gm = tm/6 and gd = td /5, where g indicates the numerical grade (g = 4 for A, 3 for B, 2 for C, 1 for D, and 0 for F), t represents the time spent in hours per week to study outside the class, and the subscripts m and d denote the courses, mathematics and design, respectively. The student enjoys design more than mathematics and hence would like to spend at least 75 minutes to study for design for every 60 minutes he spends to study mathematics. Also, as far as possible, the student does not want to spend more time on any course beyond the time required to earn a grade of A. The student wishes to maximize his grade point P, given by P = 4gm + 3gd , by suitably distributing his study time. Formulate	Understand	CO 1	AME516.02
3	An oil refinery produces four grades of motor oil in three process plants. The refinery incurs a penalty for not meeting the demand of any particular grade of motor oil. The capacities of the plants, the production costs, the demands of the various grades of motor oil, and the penalties are given in the following table: Production cost ($/day) to manufacture motor oil of grade: Process Capacity of the plant plant (kgal/day) 1 2 3 4 1 100 750 900 1000 1200 2 150 800 950 1100 1400 3 200 900 1000 1200 1600 Demand (kgal/day) 50 150 100 75 Penalty (per each kilogallon shortage) $10 $12 $16 $20 Formulate the problem of minimizing the overall cost as an LP problem	Understand	CO 1	AME516.02
4	Two copper-based alloys (brasses), A and B, are mixed to produce a new alloy, C. The composition of alloys A and B and the requirements of alloy C are given in the following table: Problems 57 Composition by weight Alloy Copper Zinc Lead Tin A 80 10 6 4 B 60 20 18 2 C ≥ 75 ≥ 15 ≥ 16 ≥ 3 If alloy B costs twice as much as alloy A, formulate the problem of determining the amounts of A and B to be mixed to produce alloy C at a minimum cost.	Understand	CO 1	AME516.03
5	A cylindrical pressure vessel with hemispherical ends (Fig. 1.30) is required to hold at least 20,000 gallons of a fluid under a pressure of 2500 psia. The thicknesses of the cylindrical and hemispherical parts of the shell should be equal to at least those recommended by section VIII of the ASME pressure vessel code,	Understand	CO 1	AME516.03

	which are given by tc = (pR /Se + 0.4p), th = (pR/ (Se + 0.8p)			
6	Formulate the problem as a mathematical programming problem assuming that the cross-sectional dimensions of the beam are restricted as $x1 \leq x2$, $0.04m \leq x1 \leq 0.12m$, and $0.06m \leq x2 \leq 0.20$ m.	Understand	CO 1	AME516.03
7	The layout of a processing plant, consisting of a pump (P), a water tank (T), a compressor (C), and a fan (F), is shown in Fig. 1.26. The locations of the various units, in terms of their (x, y) coordinates, are also indicated in this figure. It is decided to add a new unit, a heat exchanger (H), to the plant. To avoid congestion, it is decided to locate H within a rectangular area defined by $\{-15 \leq x \leq 15, -10 \leq y \leq 10\}$. Formulate the problem of finding the location of H to minimize the sum of its x and y distances from the existing units, P , T , C, and F.	Understand	CO 1	AME516.03
8	Two copper-based alloys (brasses), A and B, are mixed to produce a new alloy, C. The composition of alloys A and B and the requirements of alloy C are given in the following table: Problems 57 Composition by weight Alloy Copper Zinc Lead Tin A 80 10 6 4 B 60 20 18 2 C ≥ 75 ≥ 15 ≥ 16 ≥ 3 If alloy B costs twice as much as alloy A, formulate the problem of determining the amounts of A and B to be mixed to produce alloy C at a minimum cost.	Understand	CO 1	AME516.03
9	There are two different sites, each with four possible targets (or depths) to drill an oil well. The preparation cost for each site and the cost of drilling at site i to target j are given below: Drilling cost to target j Site i 1 2 3 4 Preparation cost 1 4 1 9 7 11 2 7 9 5 2 13 Formulate the problem of determining the best site for each target so that the total cost is minimized.Find (i) k (ii) p(X<3) (iii) $p(X \geq 5)$	Understand	CO 1	AME516.03
10	A beam-column of rectangular cross section is required to carry an axial load of 25 lb and a transverse load of 10 lb, as shown in Fig. 1.24. It is to be designed to avoid the possibility of yielding and buckling and for minimum weight. Formulate the optimization problem by assuming that the beam-column can bend only in the vertical (xy) plane. Assume the material to be steel with a specific weight of 0.3 lb/in3 , Young's modulus of 30 × 106 psi, and a yield stress of 30,000 psi. The width of the beam is required to be at least 0.5 in. and not greater than twice the depth. Also, find the solution of the problem graphically. Hint: The compressive stress in the beam-column due to Py is Py /bd and that due to Px is Pxld 2Izz = 6Px l bd2 The axial buckling load is given by (Py)cri = π 2EIzz 4l 2 = π 2Ebd3 48l 2	Understand	CO 1	AME516.03
UNIT-II				
SINGLE VARIABLE OPTIMIZATION				
Part – A (Short Answer Questions)				
1	Briefly explain single variable optimization and its advantages.	Understand	CO 2	AME516.05
2	What are the different methods for solving single variable optimization problems?	Understand	CO 2	AME516.07
3	Explain the algorithm of asingle variable problem.	Understand	CO 2	AME516.05
4	Explain the term local minima.	Understand	CO 2	AME516.07
5	Explain about unimodal function.	Remember	CO 2	AME516.05
6	What is an inflection point?	Understand	CO 2	AME516.05
7	Define the term global minima and global maxima.	Remember	CO 2	AME516.07
8	Determine the binomial distribution for which the mean is 4 and variance 3	Understand	CO 2	AME516.05
9	Write an equation for local minima?	Understand	CO 2	AME516.09
10	Give a simple equation representing local minima and local maxima.	Understand	CO 2	AME516.07
11	Draw neat diagram showing the local and global minima.	Remember	CO 2	AME516.09
12	Define the term unimodal function with an example.	Remember	CO 2	AME516.05
13	Explain the direct search methods used in single variable optimization.	Understand	CO 2	AME516.05
14	Explain the different types of direct search methods.	Understand	CO 2	AME516.05
15	what are the different gradients methods used to solve single variable problems?	Understand	CO 2	AME516.05
16	What are the properties of a single variable problem?	Remember	CO 2	AME516.09
17	What are the limitations of fibonacci search method?	Remember	CO 2	AME516.07
18	Explain about the golden search method.	Remember	CO 2	AME516.05
19	What are the different region eliminatIon methods explain?	Remember	CO 2	AME516.05
20	Explain in brief exhaustive search method.	Remember	CO 2	AME516.05

Part - B (Long Answer Questions)				
1	Explain the considerations for fibonacci method in solving single variable optimization techniue..	Understand	CO 2	AME516.05
2	Write an algorithm for exhaustive search method in solving single variable problems.	Understand	CO 2	AME516.07
3	Write an algorithm for interval halving search method in solving single variable problems.	Understand	CO 2	AME516.07
4	Write an algorithm for fibonacci search method in solving single variable problems..	Understand	CO 2	AME516.07
5	Write an algorithm for golden search method in solving single variable problems.	Understand	CO 2	AME516.09
6	Minimize f (x) = 0.65 − [0.75/(1 + x 2)] − 0.65x tan−1 (1/x) in the interval [0,3] by the Fibonacci method using n = 6.	Understand	CO 2	AME516.09
7	Minimize the function f (x) = 0.65 − [0.75/(1 + x 2)] − 0.65x tan−1 (1/x) using the golden section method with n = 6.	Understand	CO 2	AME516.05
8	Find the minimum of f = x(x − 1.5) in the interval (0.0, 1.0) using interval halving methd?	Understand	CO 2	AME516.09
9	Find the minimum of f = x(x − 1.5) in the interval (0.0, 1.0) using exhaustive search method?	Understand	CO 2	AME516.09
10	Derive the one-dimensional minimization problem for the following case: Minimize f (X) = (x2 1 − x2) 2 + (1 − x1) 2 (E1) from the starting point X1 = [−2 −2]along the search direction S = [1.00 0.25]	Understand	CO 2	AME516.09
11	Consider the following function f(x) = x^2+54/x, with initial interval (0,5) and solve using golden section search method.	Understand	CO 2	AME516.05
12	Consider the following function f(x) = x^2+54/x, with initial interval (0,5) and solve using fibonacci search method.	Understand	CO 2	AME516.07
13	Consider Figure 2 below. The cross-sectional area of a gutter with equal base and edge length of 2 is given by A= 4sinɵ (1+cosɵ) with an initial interval [0,π/2], ε =0.2 using golden section search method.	Understand	CO 2	AME516.07
14	Consider the following function f(x) = x^2+54/x, with initial interval (0,5) and solve using quadratic estimation method.	Understand	CO 2	AME516.09
15	Consider Figure 2 below. The cross-sectional area of a gutter with equal base and edge length of 2 is given by A= 4sinɵ (1+cosɵ) with an initial interval [0,π/2], ε =0.2 using golden section search method.	Understand	CO 2	AME516.07
16	Consider Figure 2 below. The cross-sectional area of a gutter with equal base and edge length of 2 is given by A= 4sinɵ (1+cosɵ) with an initial interval [0,π/2], ε =0.2 using exhaustive search method.	Understand	CO 2	AME516.09
17	Consider Figure 2 below. The cross-sectional area of a gutter with equal base and edge length of 2 is given by A= 4sinɵ (1+cosɵ) with an initial interval [0,π/2], ε =0.2 using Fibonacci search method.	Understand	CO 2	AME516.05
18	Minimize f(x) = 100-x^2 with an initial interval [60,150] quadratic estimation method.	Understand	CO 2	AME516.07
19	Minimize f(x) = 100-x^2 with an initial interval [60,150] using exhaustive search method.	Understand	CO 2	AME516.09
20	Minimize f(x) = 100-x^2 with an initial interval [60,150] using golden section search method.	Understand	CO 2	AME516.05
Part - C (Problem Solving and Critical Thinking Questions)				
1	Write an algorithm for fibonacci search method in solving single variable problems..	Understand	CO 2	AME516.07
2	Find the minimum of f = x(x − 1.5) in the interval (0.0, 1.0) using exhaustive search method?	Understand	CO 2	AME516.07
3	Derive the one-dimensional minimization problem for the following case: Minimize f (X) = (x2 1 − x2) 2 + (1 − x1) 2 (E1) from the starting point X1 = [−2 −2]along the search direction S = [1.00 0.25]	Understand	CO 2	AME516.09
4	Write an algorithm for interval halving search method in solving single variable problems.	Understand	CO 2	AME516.09
5	Consider Figure 2 below. The cross-sectional area of a gutter with equal base and edge length of 2 is given by A= 4sinɵ (1+cosɵ) with an initial interval [0,π/2], ε =0.2 using exhaustive search method.	Understand	CO 2	AME516.09

6	Find the minimum of $f = x(x - 1.5)$ in the interval (0.0, 1.0) using exhaustive search method?	Understand	CO 2	AME516.05
7	Consider the following function $f(x) = x^2+54/x$, with initial interval (0,5) and solve using fibonacci search method.	Understand	CO 2	AME516.05
8	Minimize $f(x) = 0.65 - [0.75/(1 + x^2)] - 0.65x \tan^{-1}(1/x)$ in the interval [0,3] by the Fibonacci method using n = 6.	Understand	CO 2	AME516.09
9	Minimize $f(x) = (x-3)x^3(x-6)^4$ using golden section search method.	Understand	CO 2	AME516.09
10	Write an algorithm for interval halving search method in solving single variable problems.	Understand	CO 2	AME516.05
MODULE -III				
MULTI VARIABLE UNCONSTRAINED OPTIMIZATION				
Part - A (Short Answer Questions)				
1	Define multi variable optimization.	Remember	CO 3	AME516.13
2	Explain constrained optimization.	Remember	CO 3	AME516.13
3	Explain the difference between non linear and linear optimization.	Understand	CO 3	AME516.13
4	Explain unconstrained optimization.	Remember	CO 3	AME516.13
5	Define local minima for multi variable unconstrained optimization.	Remember	CO 3	AME516.13
6	Define gradient based method.	Understand	CO 3	AME516.13
7	Explain optimality criteria for multi variable optimization.	Understand	CO 3	AME516.13
8	Explain about unidirectional search.	Remember	CO 3	AME516.13
9	Define inflection point.	Understand	CO 3	AME516.13
10	Explain exploratory move in hookejeeve's method.	Understand	CO 3	AME516.13
11	Explain pattern move in hookejeeve's method.	Understand	CO 3	AME516.15
12	Define gradient of a function.	Remember	CO 3	AME516.15
13	What is zeroth order methods?	Remember	CO 3	AME516.11
14	Define expansion factor used in simplex.	Understand	CO 3	AME516.11
15	What is termination parameter in optimization?	Remember	CO 3	AME516.11
16	Define contraction parameter used in simplex.	Remember	CO 3	AME516.11
17	Explain about nelder mead's method.	Understand	CO 3	AME516.11
18	What are the different types of gradient based methods?	Remember	CO 3	AME516.15
19	Define descent direction.	Remember	CO 3	AME516.15
20	Explain about steepest descent method.	Understand	CO 3	AME516.11
Part – B (Long Answer Questions)				
1	Write an algorithm for simplex search method?	Understand	CO 3	AME516.13
2	Write an algorithm for Neldermead's simplex method?	Understand	CO 3	AME516.13
3	Write an algorithm for Hook Jeeve's pattern search method?	Understand	CO 3	AME516.13
4	Explain exploratory move used in HookJeeve's pattern search method.	Understand	CO 3	AME516.13
5	Explain pattern move used in Hook Jeeve's pattern search method.	Understand	CO 3	AME516.13
6	Write an algorithm for HookJeeve's pattern search method.	Understand	CO 3	AME516.13
8	Explain about uni directional method.	Understand	CO 3	AME516.13
9	Write an algorithm for rosen brock's method	Understand	CO 3	AME516.13
10	Explain centroid, reflection , expansion and contraction of simplex.	Understand	CO 3	AME516.13
11	Write an algorithm for caushy's method?	Understand	CO 3	AME516.15
12	Write an algorithm for steepest descent method?	Understand	CO 3	AME516.15
13	Write an algorithm for conjugate gradient method?	Understand	CO 3	AME516.15
14	Explain about steepest descent method.	Understand	CO 3	AME516.15
15	Explain about termination criteria used in conjugate gradient method.	Understand	CO 3	AME516.11
16	Explain about termination criteria used in powell method.	Understand	CO 3	AME516.15
17	Explain the use of exploratory and pattern moves.	Understand	CO 3	AME516.15
18	Explain about variable metric method.	Understand	CO 3	AME516.15
19	List out the advantages of steepest descent method.	Understand	CO 3	AME516.11
20	Explain the algorithm for powell method in multivariable optimization.	Understand	CO 3	AME516.11
Part – C (Problem Solving and Critical Thinking)				
1	$F(x) = (x_1^2-x_2^2)^2+x_2^2$, perform five iterations of a unidirectional search using [0,2] as the initial point.	Understand	CO 3	AME516.13

2	$F(x) = (x_1^2-x_2^2)^2+x_2^2$, solve using of a unidirectional search using [-1,-1] as the initial point.	Understand	CO 3	AME516.13
3	Minimize the function $f(x) = 10-x_1+x_1x_2+x_2^2$, use (0,2), (0,0) and (1,1) as the initial simplex of three points.complete two iterations of nelder mead’s simplex search algorithm to find new simplex. Assume beta = 0.5 and gama = 2.	Understand	CO 3	AME516.13
4	Minimize the function $f(x) = f(x_1,x_2) = (x_1^2+x_2-11)^2+(x_1+x_2^2-7)^2$using hook jeeve’s pattern search method with x = (0,0) and step sixe = (0.5,0.5) and alpha = 2.	Understand	CO 3	AME516.13
5	Minimize the function $f(x) = f(x_1,x_2) = (x_1^2+x_2-11)^2+(x_1+x_2^2-7)^2$using simplex search methoduse (0,2), (0,0) and (1,1) as the initial simplex of three points.	Understand	CO 3	AME516.13
06	Minimize the function $f(x) = f(x_1,x_2) = (x_1^2+x_2-11)^2+(x_1+x_2^2-7)^2$using powell conjugate method use (0,4) as initial point and two search directions (1,0) and (0,1) .	Understand	CO 3	AME516.15
07	Minimize the function $f(x) = f(x_1,x_2) = (x_1^2+x_2-11)^2+(x_1+x_2^2-7)^2$using caushy’s method.	Understand	CO 3	AME516.15
08	Minimize the function $f(x) = f(x_1,x_2) = (x_1^2+x_2-11)^2+(x_1+x_2^2-7)^2$using steepest descent method.	Understand	CO 3	AME516.15
09	Minimize the function $f(x) = f(x_1,x_2) = (x_1^2+x_2-11)^2+(x_1+x_2^2-7)$	Understand	CO 3	AME516.15
10	Write an algorithm for rosen brock’s method of optimization.			
UNIT -IV				
MULTI VARIABLE CONSTRAINED OPTIMIZATION				
Part – A (Short Answer Questions)				
1	Explain objective function and its importance.	Remember	CO 4	AME516.16
2	Define constrained and unconstrained optimization.	Remember	CO 4	AME516.16
3	Define optimal point in constrained optimization.	Remember	CO 4	AME516.16
4	Define maxima and minima in nonlinear programming.	Remember	CO 4	AME516.16
5	What is the difference between linear and nonlinear programming?	Understand	CO 4	AME516.16
6	Define equality constraints.	Remember	CO 4	AME516.16
7	Explain about inequality constraints.	Understand	CO 4	AME516.16
8	What are slack variables?	Understand	CO 4	AME516.16
9	What are surplus variables?	Understand	CO 4	AME516.16
10	What is the criteria in choosing design variables.	Understand	CO 4	AME516.16
11	What is the effect of constraints on objective function?	Remember	CO 4	AME516.16
12	What are the necessary conditions for maxima or minima?	Understand	CO 4	AME516.20
13	Explain about the lagrangian multiplier.	Understand	CO 4	AME516.19
14	What is the purpose of lagrangian function?	Understand	CO 4	AME516.20
15	What are the sufficient conditions for extrema of objective function?	Remember	CO 4	AME516.20
16	Write the hessian matrix and explain each of the parameter?	Understand	CO 4	AME516.20
17	Expalin about the problems involving not all equality constraints.	Understand	CO 4	AME516.20
18	Explain Kuhn tucker conditions for a minimization problem	Remember	CO 4	AME516.19
19	Explain sufficient and necessary conditions of Kuhn tucker conditions.	Remember	CO 4	AME516.20
20	Explain wolfe’s method for solving a maximization problem.	Understand	CO 4	AME516.19
Part – B (Long Answer Questions)				
1	Explain neccesary conditions for lagrange multipliers method.	Understand	CO 4	AME516.16
2	Explain sufficient conditions for maxima and minima in using lagrange multipliers method.	Understand	CO 4	AME516.16
3	Solve the following problem by using the method of lagrangian multipliers. Minimize $Z = x_1^2+x_2^2+x_3^2$, subject to the constraints i) $x_1+x_2+3x_3 = 2$, ii) $5x_1+2x_2+x_3 = 5$, and $x_1,x_2>0$	Understand	CO 4	AME516.16
4	Optimize $Z = x_1^2+x_2^2+3x_3^2+10x_1+8x_2+6x_3-100$, subject to the constraints $g(x) =x_1+x_2+x_3 = 20; x_1,x_2,x_3>0$	Understand	CO 4	AME516.16
5	Min $Z = -2x_1^2 + 5x_1x_2 -4x_1^2 + 18x_1$ subject to $x_1+x_2 =7$; $x_1,x_2>0$	Understand	CO 4	AME516.16
6	Use the method of Lagrange Multipliers to solve the following NLP problem i) Optimize $Z= x_1^2-10x_1+x_2^2-6x_2+x_3^2-4x_3$ subject to $x_1+x_2+x_3=7$ and $x_1,x_2,x_3>0$	Understand	CO 4	AME516.16
7	Explain the sufficient conditions of Kuhn-tucker method.	Understand	CO 4	AME516.16
8	Find the optimum value of the optimum function when subject to the following constraints Max $Z= 10x_1-x_1^2+10x_2-x^2$, Sub to $x_1+x_2\leq14;-x_1+x_2\leq6; x_1,x_2\geq0$.	Understand	CO 4	AME516.16

9	Determine X1 and X2 so as to maximize Z= $12x_1 +21x_2- +2x_1x_2-2x_1^2-2x_2^2$ subject to $x_2 \leq 8$; $x_1+x_2 \leq 10$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.16
10	Max Z= $10x_1-x_1^2+10x_2-x^2$, Sub to $x_1+x_2 \leq 8$; $-x_1+x_2 \leq 5$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.16
11	Min Z = $x_1^2 +x_2^2 +x_3^2$ subject to $4x_1 +x_2^2 +2x_3 = 14$ and $x_1,x_2,x_3 \geq 0$.	Understand	CO 4	AME516.19
12	Max Z= $10x_1-x_1^2+10x_2-x^2$, Sub to $x_1+x_2 \leq 9$; $x_1-x_2 \geq 6$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.19
13	Max Z = $2x_1-x_1^2+x_2$ subject to $2x_1+3x_2 \leq 6$; $2x_1+x_2 \leq 4$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.19
14	Write the Kuhn-tucker conditions for the given problem Min Z = $x_1^2 + x_2^2 + x_3^2$ subject to $2x_1+x^2-x^3 \leq 0$; $1-x_1 \leq 0$; $2-x_2 \leq 0$; $x_3 \geq 0$.	Understand	CO 4	AME516.19
15	Explain Wolfe's method to solve quadratic programming problem.	Understand	CO 4	AME516.19
16	Use Wolfe's method to solve the following QPP Max Z = $4x_1+6x_2-2X_1^2-2x_1x_2-2x_2^2$ subject to $x_1+2x_2 \leq 2$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.20
17	Use Wolfe's method to solve the following QPP Max Z = $2x_1+x_2-x_1^2$ subject to $2x_1+3x_2 \leq 6$; $2x_1+x_2 \leq 4$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.20
18	Explain Beale's method procedure step-by-step.	Understand	CO 4	AME516.20
19	Use Beale's method to solve QPP Max Z = $2x_1 +3x_2-2x_2^2$ subject to $x_1+4x_2 \leq 4$; $x_1+x_2 \leq 2$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.19
20	Use Beale's method to solve QPP Min Z = $-4x_1+x_1^2-2x_1x_2+2x_2^2$ subject to $2x_1+x_2 \geq 6$; $x_1-4x_2 \geq 0$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.20
Part – C (Problem Solving and Critical Thinking)				
1	Max Z = $2x_1+3x_2-2x_1^2$ subject to $x_1+4x_2 \leq 4$; $x_1+x_2 \leq 2$; $x_1+x_2 \geq 0$; Use Wolfe's method.	Understand	CO 4	AME516.16
2	Solve the following problem by using the method of Lagrangian multipliers. Minimize Z = $x_1^2+x_2^2+x_3^2$, subject to the constraints i) $x_1+x_2+3x_3 = 2$, ii) $5x_1+2x_2+x_3 = 5$, and $x_1,x_2>0$	Understand	CO 4	AME516.16
3	Min Z = $6-6x_1+2x_1^2-2x_1x_2+2x_2^2$ subject to $x_1+x_2 \leq 6$; $x_1, x_2 \geq 0$; use Wolfe's method.	Understand	CO 4	AME516.16
4	Max Z = $10x_1+25x_2-10x_1^2-x_2^2-4x_1x_2$ subject to $x_1+2x_2 \leq 10$; $x_1+x_2 \leq 9$; $x_1, x_2 \geq 0$ use Beale's method.	Understand	CO 4	AME516.16
5	Min Z = $x_1^2 +x_2^2 +x_3^2$ subject to $4x_1 +x_2^2 +2x_3 = 14$ and $x_1,x_2,x_3 \geq 0$.	Understand	CO 4	AME516.16
6	Use Wolfe's method to solve the following QPP Max Z = $4x_1+6x_2-2X_1^2-2x_1x_2-2x_2^2$ subject to $x_1+2x_2 \leq 2$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.19
7	Min Z = $6-6x_1+2x_1^2-2x_1x_2+2x_2^2$ subject to $x_1+x_2 \leq 2$; $x_1, x_2 \geq 0$; use Beale's method.	Understand	CO 4	AME516.19
8	Min Z = $-4x_1+x_1^2-2x_1x_2+2x_2^2$ subject to $2x_1+x_2 \geq 6$; $x_1-4x_2 \geq 0$; $x_1, x_2 \geq 0$, use Beale's method.	Understand	CO 4	AME516.20
9	Use the Kuhn-tucker conditions to solve QPP Max Z = $-2x_1^2+3x_1+4x_2$ subject to $x_1+2x_2 \leq 4$; $x_1+x_2 \leq 2$; $x_1, x_2 \geq 0$.	Understand	CO 4	AME516.20
10	Using the method of Lagrangian multipliers Min Z = $x_1^2+x_2^2+x_3^2$ subject to $4x_1+x_2^2+2x_3=14$; $x_1, x_2, x_3 \geq 0$.	Understand	CO 4	AME516.20
MODULE -V				
GEOMETRIC AND INTEGER PROGRAMMING				
Part - A (Short Answer Questions)				
1	Define integer programming.	Understand	CO 5	AME516.21
2	What are the applications of integer programming?	Remember	CO 5	AME516.22
3	What are the types of integer programming problems?	Understand	CO 5	AME516.21
4	Define mixed integer programming problem.	Remember	CO 5	AME516.21
5	Definepure integer programming problem.	Remember	CO 5	AME516.21
6	Classify interger programming problems.	Remember	CO 5	AME516.22
7	Explain Gomory's cutting plane method.	Understand	CO 5	AME516.22
8	Define slack variables.	Understand	CO 5	AME516.21
9	Define surplus variables.	Understand	CO 5	AME516.21
10	Explain non linear programming.	Understand	CO 5	AME516.22
11	Explain the difference between constrained and unconstrained optimization.	Remember	CO 5	AME516.21
12	Explain the difference between in euquality and equality constraints.	Understand	CO 5	AME516.21
13	What is the test for optimality for Gomory's cutting plane method.	Remember	CO 5	AME516.21
14	Explain Branch and Bound method.	Understand	CO 5	AME516.21
15	Explain the initialization considerations in Branch and Bound method	Remember	CO 5	AME516.22
16	Define nodes in Branch and Bound method.	Understand	CO 5	AME516.22
17	Explain geometric programming.	Remember	CO 5	AME516.21

18	Write the general mathematical form of geometric programming.	Understand	CO 5	AME516.23
19	Explain steps involved in branch and bound method.	Remember	CO 5	AME516.23
20	Define dual problem for any given LPP	Understand	CO 5	AME516.23
	Part - B (Long Answer Questions)			
1	Slove the following LPP using Gomory's cutting plane method Max Z = x_1+x_2 subject to $3x_1+2x_2\leq5$; $x_2\leq2$; x_1, $x_2\geq0$, are integers.	Understand	CO 5	AME516.21
2	Explain steps of Gomory'sall integer programming algorithm.	Understand	CO 5	AME516.21
3	Solve the following integer LPP using cutting plane method Max Z = $2x_1+20x_2-10x_3$ subject to $2x_1+20x_2+4x_3\leq15$; $6x_1+20x_2+4x_3\geq20$; x_1, x_2, $x_3\geq0$ and are integers.	Understand	CO 5	AME516.21
4	Max Z = x_1+2x_2 subject to $2x_2\leq7$; $x_1+x_2\leq7$; $2x_1\leq11$; x_1, $x_2\geq0$ and are integers, solve using cutting plane algorithm.	Understand	CO 5	AME516.21
5	Max Z = $2x_1+1.7x_2$ subject to $4x_1+3x_2\leq7$; $x_1+x_2\leq4$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.22
6	Max Z = $3x_1+2x_2+5x_3$ subject to $5x_1+3x_2+7x_3\leq28$; $4x_1+5x_2+5x_3\leq30$; x_1, x_2, $x_3\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.22
7	Max Z = $3x_1+4x_2$ subject to $3x_1+2x_2\leq8$; $x_1+4x_2\geq10$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.21
8	Max Z = $4x_1+3x_2$ subject to $x_1+2x_2\leq4$; $2x_1+x_2\leq6$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.21
9	Solve the following all-integer programming problem using the Branch and Bound method, Max Z = $3x_1+5x_2$ subject to the constraints, $2x_1+4x_2\leq25$; $x_1\leq8$; $2x_2\leq10$; x_1, $x_2\geq0$ and are integers.	Understand	CO 5	AME516.23
10	Solve the following all-integer programming problem using the Branch and Bound method, Min Z = $3x_1+2.5x_2$ subject to the constraints $x_1+2x_2\geq20$; $3x_1+2x_2\geq15$; x_1, $x_2\geq0$ and are integers.	Understand	CO 5	AME516.23
11	When n>n+1 solve the following NLP, Min $f(x) = 5x_1x_2x_2^{-1}+2x1^{-1}x2+5x1+x2^{-1}$ using the geometric programming method	Understand	CO 5	AME516.23
12	Solve the following integer LPP using cutting plane method Max Z = $2x_1+20x_2-10x_3$ subject to $2x_1+20x_2+4x_3\leq15$; $6x_1+20x_2+4x_3\geq20$; x_1, x_2, $x_3\geq0$ and are integers.	Understand	CO 5	AME516.23
13	Max Z = $3x_1+4x_2$ subject to $3x_1+2x_2\leq0$; $x_1+4x_2\geq12$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.23
14	Max Z = $2x_1+1.7x_2$ subject to $4x_1+3x_2\leq7$; $x_1+x_2\leq4$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.23
15	Solve the following all-integer programming problem using the Branch and Bound method, Min Z = $3x_1+5x_2$ subject to the constraints7 $x_1+2x_2\geq20$; $3x_1+5x_2\geq15$; x_1, $x_2\geq0$ and are integers.	Understand	CO 5	AME516.23
16	Solve the following all-integer programming problem using the Branch and Bound method, Min Z = $3x_1+2.5x_2$ subject to the constraints $6x_1+2x_2\geq20$; $5x_1+7x_2\geq16$; x_1, $x_2\geq0$ and are integers.	Understand	CO 5	AME516.21
17	Max Z = $5x_1+9x_2$ subject to $5x_1+1x_2\leq11$; $x_1+4x_2\geq15$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.22
18	Max Z = $4x_1+2.4x_2$ subject to $4x_1+3x_2\leq7$; $x_1+x_2\leq4$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.21
19	Solve the following all-integer programming problem using the Branch and Bound method, Min Z = $3x_1+2.5x_2$ subject to the constraints $x_1+2x_2\geq20$; $3x_1+2x_2\geq15$; x_1, $x_2\geq0$ and are integers.	Understand	CO 5	AME516.23
20	Max Z = $2x_1+3x_2$ subject to $3x_1+2x_2\leq0$; $x_1+4x_2\geq12$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.21
	Part – C (Problem Solving and Critical Thinking)			
1	Solve the following integer LPP using cutting plane method Max Z = $4x_1+40x_2-9x_3$ subject to $2x_1+20x_2+4x_3\leq15$; $6x_1+20x_2+4x_3\geq20$; x_1, x_2, $x_3\geq0$ and are integers.	Understand	CO 5	AME516.21
2	Max Z = x_1+2x_2 subject to $2x_2\leq7$; $x_1+x_2\leq7$; $2x_1\leq11$; x_1, $x_2\geq0$ and are integers, solve using cutting plane algorithm.	Understand	CO 5	AME516.22

3	Solve the following integer LPP using cutting plane method Max Z = $2x_1+20x_2-10x_3$ subject to $2x_1+20x_2+4x_3\leq15$; $6x_1+20x_2+4x_3\geq20$; x_1, x_2, $x_3\geq0$ and are integers.	Understand	CO 5	AME516.21
4	Max Z = $3x_1+4x_2$ subject to $2x_1+1x_2\leq8$; $x_1+3x_2\geq10$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.22
5	Max Z = $4x_1+8x_2$ subject to $3x_1+2x_2\leq6$; $x_1+4x_2\geq9$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.23
6	When n>n+1 solve the following NLP, Min $f(x) = 5x_1x_2x_2^{-1}+2x1^{-1}x2+5x1+x2^{-1}$ using the geometric programming method	Understand	CO 5	AME516.23
7	Max Z = $2x_1+1.7x_2$ subject to $4x_1+3x_2\leq7$; $x_1+x_2\leq4$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.23
8	Max Z = $5x_1+9x_2$ subject to $5x_1+1x_2\leq11$; $x_1+4x_2\geq15$; x_1, $x_2\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.21
9	Max Z = $3x_1+2x_2+5x_3$ subject to $5x_1+3x_2+7x_3\leq28$; $4x_1+5x_2+5x_3\leq30$; x_1, x_2, $x_3\geq0$ and are integers, solve using cutting plane method.	Understand	CO 5	AME516.22
10	Solve the following all-integer programming problem using the Branch and Bound method, Max Z = $3x_1+5x_2$ subject to the constraints, $2x_1+4x_2\leq25$; $x_1\leq8$; $2x_2\leq10$; x_1, $x_2\geq0$ and are integers.	Understand	CO 5	AME516.21

Prepared by:
Ms. T Vanaja, Assistant Professor

HOD, ME