INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**OPTIMIZATION TECHNIQUES LABORATORY**				
Course Code	AMEB15				
Programme	B.Tech				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	1	-	-	2	1
Chief Coordinator	Mrs. TVanaja, Assistant Professor				
Course Faculty	Dr. Paidi Raghavulu, Professor Ms. T Vanaja, Assistant Professor				

I. COURSEOVERVIEW:

Introduction to optimization techniques using both linear and non-linear programming. The focus of the course is on convex optimization though some techniques will be covered for non-convex function optimization too. After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimization problems.

II. COURSEPRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS002	I	Linear Algebra and Differential Equations	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Optimization techniques laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONALMETHODOLOGIES:

✘	Chalk & Talk	✘	Quiz	✘	Assignments	✘	MOOCs
✔	LCD / PPT	✘	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATIONMETHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS.

The emphasis on the experiments is broadly based on the following criteria:

20 %	To test the preparedness for the experiment.
20 %	To test the performance in the laboratory.
20 %	To test the calculations and graphs related to the concern experiment.
20 %	To test the results and the error analysis of the experiment.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Table 1: Assessment pattern for CIA

Component	**Laboratory**		**Total Marks**
Type of Assessment	Day to dayperformance	Final internal lab assessment	
CIA Marks	20	10	30

Continuous Internal Examination(CIE):
One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hoursduration.

Preparation	**Performance**	**Calculations and Graph**	**Results and Error Analysis**	**Viva**	**Total**
2	2	2	2	2	10

VI. HOW PROGRAM OUTCOMES AREASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Engineering knowledge: Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering.	3	Lab exercises
PO 2	**Problem analysis:** An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering..	2	Lab exercises
PO 4	Conduct investigations of complex problems: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Lab exercises

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES AREASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	Professional Skills: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Lab exercises
PSO 2	Modelling and Simulation Practices: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	Successful Career and Entrepreneurship: To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES(COs):

The course should enable the students to:	
I	Understand the basic concepts of Python programming.
II	Apply Python programming skills in solving matrix operations
III	Apply Python concepts in solving linear programming problems.
IV	Apply optimization techniques through TORA.
V	Evaluate optimization problems using Lingo/ Excel solver.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the basic principles and concepts of python	CLO 1	Evaluate the determinant and inverse of a matrix.
		CLO 2	Perform matrix operations using python programming skills.
		CLO 3	Understand the programming skills of python.
CO 2	Explore the applicability of programming skills in Python.	CLO 4	Analyze the parameter optimization using TORA.
		CLO 5	Evaluate matrix operations like subtraction, addition and inverse of a matrix.
		CLO 6	Understand the programming skills of python to solve matrix operations

COs	Course Outcome	CLOs	Course Learning Outcome
CO 3	Summarize various optimization techniques like LPP models.	CLO 7	Understand the concept of linear programming problem models.
		CLO 8	Apply the concepts of transportation problems.
		CLO 9	Understand the applications of assignment problems.
CO 4	Analyze the transportation, inventory and assignment problems.	CLO 10	Apply the TORA concept in solving game theory.
		CLO 11	Determine the solution of a dynamic programming problem using TORA/EXCEL SOLVER.
		CLO 12	Understand the applicability of TORA in queuing problems
CO 5	Explain the concepts of sequencing, game theory and dynamic programming.	CLO 13	Evaluate the decision variables through TORA/EXCEL SOLVER.
		CLO 14	Apply the concepts of scheduling problems.
		CLO 15	Understand the applications of optimization techniques.

X. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AMEB15.01	CLO 1	Evaluate the determinant and inverse of a matrix.	PO 1	3
AMEB15.02	CLO 2	Perform matrix operations using python programming skills.	PO 1	3
AMEB15.03	CLO 3	Understand the programming skills of python.	PO 1	3
AMEB15.04	CLO 4	Analyze the parameter optimization using TORA.	PO 1, PO 2, PO 4	2
AMEB15.05	CLO 5	Evaluate matrix operations like subtraction, addition and inverse of a matrix.	PO 1	2
AMEB15.06	CLO 6	Understand the programming skills of python to solve matrix operations	PO 1, PO 2, PO 4	2
AMEB15.07	CLO 7	Understand the concept of linear programming problem models.	PO 1, PO 2	2
AMEB15.08	CLO 8	Apply the concepts of transportation problems.	PO 1, PO 2	2
AMEB15.09	CLO 9	Understand the applications of assignment problems.	PO 1, PO 2	2
AMEB15.10	CLO 10	Apply the TORA concept in solving game theory .	PO 1	2
AMEB15.11	CLO 11	Determine the solution of a dynamic programming problem using TORA/EXCEL SOLVER.	PO 1	3
AMEB15.12	CLO 12	Understand the applicability of TORA in queuing problems	PO 1, PO 2	3
AMEB15.13	CLO 13	Evaluate the decision variables through TORA/EXCEL SOLVER.	PO 1	3

AMEB15.14	CLO14	Apply the concepts of scheduling problems.	PO 1, PO 2	2
AMEB15.15	CLO15	Understand the applications of optimization techniques.	PO 1, PO 2	2

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3												1		
CLO 4	3	2		1									1		
CLO 5	2														
CLO 6	2	2		1											
CLO 7	2	2											1		
CLO 8	2	2											1		
CLO 9	2	2													
CLO 10	2														
CLO 11	3														
CLO 12	3	3													
CLO 13	3														
CLO 14	2														
CLO 15	3														

3 = High; 2 = Medium; 1 = Low

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 4	PSO1	PSO2	PSO3
CO 1	3	2		3		2
CO 2		2	1			**2**
CO 3	3	2				2

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 4	PSO1	PSO2	PSO3
CO 4	3	2		3		
CO 5		2	1			

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO 1, PO 2, PO 4	SEE Exams	PO 1, PO 2, PO 4	Assignments	-	Seminars	-
Laboratory Practices	PO 1, PO 2, PO 4	Student Viva	PO 1, PO 2, PO 4	Mini Project	-	Certification	-

XIV. ASSESSMENT METHODOLOGIES –INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

LIST OF EXPERIMENTS	
Week-1	**MATRIX OPERATIONS**
Write a Python program to find out whengiven an array of size **N**,the task is to partition the given array into two subsets such that the average of all the elements in both subsets is equal. If no such partition exists print -1. Otherwise, print the partitions. If multiple solutions exist, print the solution where the length of the first subset is minimum. If there is still a tie then print the partitions where the first subset is lexicographically smallest.	
Week-2	**MATRIX OPERATIONS**
Write a Python program to find out when given an array of positive elements, you have to flip the sign of some of its elements such that the resultant sum of the elements of array should be minimum non-negative (as close to zero as possible). Return the minimum no. of elements whose sign needs to be flipped such that the resultant sum is minimum non-negative. Note that the sum of all the array elements will not exceed 10^4.	
Week-3	**MINIMUM COST PATH**
Write a Python program to find out when given a two dimensional grid, each cell of which contains integer cost which represents a cost to traverse through that cell. The task is to find the maximum cost path from the bottom-left corner to the top-right corner.	
Week-4	**FINDING MAXIMUM IN AN INTEGER ARRAY**
Write a Python program to find out when given an array of non-negative integers **arr[]**, the task is to find a pair **(n, r)** such that ${}^{n}\mathbf{P}_{r}$ is maximum possible and $\mathbf{r} \leq \mathbf{n}$.	
Week-5	**ARRAY SORTING**
Write a Python program to find out when given an array **arr[]** of **N** integers, the task is to sort the array in non-decreasing order by performing the minimum number of operations. In a single operation, an element of the array can either be incremented or decremented by **1**. Print the minimum number of operations required.	

Week-6	LINEAR PROGRAMMING PROBLEM

A store sells men's and women's tennis shoes. It makes a profit of $1 per pair of men's shoes and $1.20 per pair of women's shoes. It takes two minutes of a salesperson's time and two minutes of a cashier's time to sell a pair of men's shoes. It takes three minutes of a salesperson's time and one minute of a cashier's time per pair of women's shoes. The store is open eight hours per day, during which time there are two salespersons and one cashier on duty. How many pairs of shoes of each type should the store sell in order to maximize profit each day?

Week-7	QUEUING PROBLEM

A super market has two girls ringing up sales at the counters. If the service time for each customer is exponential with mean 4 minutes, and if people arrive 3 in a poison fashion at the 10/hour. a. What is the probability of having to wait for the service? b. What is the expected percentage of idle time for each girl? c. Find the average length and average number of units in the system.

Week-8	SEQUENCING PROBLEM

We have five jobs each of which must go through two machines in the order BA, processing times are given in the table below

Job No.	1	2	3	4	5
Machine A	10	2	18	6	20
Machine B	4	12	14	16	8

Determine a sequence for the five jobs that will minimize the total elapsed time. Also compute idle times for each of the machine

Week-9	GAME THEORY

Using the dominance property obtain the optimal strategy for both the players and determine the value of game. The payoff matrix for player A is given

Player-A	Player-B				
	I	II	III	IV	V
I	2	4	3	8	4
II	5	6	8	7	8
III	6	7	9	8	7
IV	4	2	8	4	3

Week-10	ASSIGNMENT OROBLEM

A Company has three plants at locations A,B and C which supply to warehouses located at D,E,F,G and H. monthly plant capacities are 800,500 and 900 respectively. Monthly warehouse requirements are 400, 500,400 and 800 units respectively. Unit transportation cost in rupees is given below.

		Ware houses				
		D	E	F	G	H
Plant	A	5	8	6	6	3
	B	4	7	7	6	5
	C	8	4	6	6	4

Determine an optimum distribution for the company in order to minimize the total transportation cost.

WeeK-11	DYNAMIC PROGRAMMING PROBLEM

Given an array **arr[]** of **N** integers, the task is to sort the array in non-decreasing order by performing the minimum number of operations. In a single operation, an element of the array can either be incremented or decremented by **1**. Print the minimum number of operations required.

Week-12	INVENTORY PROBLEM

A dealer supplies you the following information with regards to an product that he deals in annual demand =10,000 units, ordering cost Rs.10/order, Price Rs.20/unit. Inventory carrying

cost is 20% of the value of inventory per year. The dealer is considering the possibility of allowing some back orders to occurs. He has estimated that the annual cost of back orderingwill be 25% of the value of inventory. a. What should be the optimum no of units he should buy in 1lot? b. What qty of the product should be allowed to be backordered c. What would be the max qty of inventory at any time of year Would you recommend to allow backordering? If so what would be the annual cost saving by adopting the policy of backordering.

Week-13	**EXAMINATIONS**

Examinations
Text Books:
1. Kalavathy.S, "Operations Research using C Programmes", vikas publishing house Pvt Ltd., New Delhi, 3rd Edition,2010. 2. Hamdy A. Taha, "Operations ResearchAn Introduction", Pearson,10thEdition, 2017.
Reference Books:
1. Eric Matthes,"Python crash course", 2nd Edition. 2. Paul Barry," Head- First Python", 2nd Edition.

XVI. COURSEPLAN:

The course plan is meant as a guideline. Probably there may be changes.

Week No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction to python and optimization techniques.	CLO 1	T1:1.4 R1:1.2
2	Matrix operations using python programming.	CLO 2	T1:1.5 R1:2.4
3	Matrix operations using python programming.	CLO 3	T1:2.5 R1:2.5
4	Writing python programme to find maximum in a given array.	CLO 4	T2:2.5 R1:2.6
5	Sorting an array incremental or decremental using python programming.	CLO 4	T1:2.7
6	Introduction and solutions of linear programming problems.	CLO 4	T1:1.3 R2:1.3
7	Introduction of queuing problems and its basic feasible solution.	CLO 5	T1:1.5 R1:1.3
8	Introduction to sequencing problems and type of sequencing problems.	CLO 6	T1:1.5 R1:1.8
9	Theory of games introduction and calculating saddle point.	CLO 7	T1:2.2 R3:1.1
10	Introduction to assignment problem and variations in its solutions.	CLO 8	T1:1.3 R1:1.2
11	Introduction to dynamic programming problems.	CLO 9	T1:2.10 R2:1.7
12	Introduction to inventory problems and types of inventory problems.	CLO 10	T1:1.2 R1:2.2
13	Solving optimization techniques problems and revision and examinations.	CLO 11	T2:2.5 R1:2.5

XVII.GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSIONREQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Learn to take data and transform it into graphic drawings	NPTEL	PO 4, PO 2	PSO 1
2	Students will become familiar with office practices and standards.	NPTEL	PO 2	PSO 1

Prepared by:

Mrs. T. Vanaja, Assistant Professor **HOD, ME**