INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTOR

Course Title	**OPTIMIZATION TECHNIQUES**				
Course Code	AHS012				
Programme	B.Tech				
Semester	V	CSE | IT | EEE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	2	1	3	-	-
Chief Coordinator	R.M.Noorullah, Associate Professor, CSE				
Course Faculty	Dr. K. Suvarchala, Professor, CSE Dr. J. Sireesha Devi, Associate Professor, CSE Mrs. G Geethavani, Assistant Professor, CSE Mrs. Shalini, Assistant Professor, CSE Mr. J. Tirupathi, Assistant Professor, CSE Mrs. Dhanalakshmi, Assistant Professor, IT				

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the methods of optimization techniques, precise mathematical concept, study how to design algorithms, establish their correctness, study their efficiency and memory needs. The goal is to maintain a balance between theory, numerical computation, and problem setup for solution by optimization software and applications to engineering systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS003	I	Computational Mathematics and Integral Calculus	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Optimization Techniques	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

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

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Presentation on real-world problems, Assignment
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	Assignment , Seminar
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignment
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Seminar

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity.	1	Seminar
PSO 2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	-	-
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:

I	Learn fundamentals of linear programming through optimization
II	Apply the mathematical results and numerical techniques of optimization theory to concrete Engineering Problems
III	Understand and apply optimization techniques to industrial applications.
IV	Apply the dynamic programming and quadratic approximation to electrical and electronic problems and applications.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the concept of Linear programming optimization problem and apply various techniques to formulate, solve LP problems	CLO 1	Explain the various characteristics and phases of linear programming.
		CLO 2	Formulate the various linear programming problems by using graphical and simplex methods
		CLO 3	Understand the artificial variable techniques like. two phase and Big-M methods
CO 2	Investigate and develop innovative solutions using assignment and transport techniques for various optimization problems	CLO 4	Explain Transportation problem and the formulation of the problem by using optimal solution.
		CLO 5	Solve the assignment problems by using optimal solutions and the variance of assignment problems.
		CLO 6	Describe the travelling sales man problem by using assignment method.
CO 3	Demonstrate applications of Game theory and sequencing techniques in emerging areas of Industry	CLO 7	Explain the sequencing and the types of sequencing methods.
		CLO 8	Use n jobs through two machines and n jobs through three machines to solve an appropriate problem.
		CLO 9	Use two jobs through m machines to solve an appropriate problem.
		CLO 10	Understand basic concepts and Terminology of game theory.
		CLO 11	Determine appropriate technique to solve Game problem.
		CLO 12	Solve the problems by using dominance principle and Graphical method.
CO 4	Explore the concepts of principle of optimality and apply dynamic programming algorithms to solve real time applications.	CLO 13	Understand the Bellman's principle of optimality.
		CLO 14	Describe heuristic problem-solving methods with stages.
		CLO 15	Understand the mapping of real-world problems to algorithmic solutions.
		CLO 16	List out the various applications of dynamic programming.
		CLO 17	Define the shortest path problem with approximate solutions.
CO 5	Enrich the knowledge on applying quadratic approximation solutions for constrained optimization problems of various engineering streams.	CLO 18	Explain the linear programming problem with approximate solutions.
		CLO 19	Define the various quadratic approximation methods for solving constraint problems..
		CLO 20	Explain the direct quadratic approximation for solving the constraint problems.
		CLO 21	Explain the quadratic approximation method by using lagrangian function.
		CLO 22	Describe the variable metric methods for constrained optimization.

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
AHS012.01	CLO 1	Explain the various characteristics and phases of linear programming.	PO 1	3
AHS012.02	CLO 2	Formulate the various linear programming problems by using graphical and simplex methods	PO 1, PO 3	3
AHS012.03	CLO 3	Understand the artificial variable techniques like two phase and Big-M methods.	PO 1	2
AHS012.04	CLO 4	Explain Transportation problem and the formulation of the problem by using optimal solution.	PO 2	3
AHS012.05	CLO 5	Solve the assignment problems by using optimal solutions and the variance of assignment problems.	PO 2	3
AHS012.06	CLO 6	Describe the travelling sales man problem by using assignment method.	PO 2, PO 3	2
AHS012.07	CLO 7	Explain the sequencing and the types of sequencing methods.	PO 10, PO 3	2
AHS012.08	CLO 8	Use n jobs through two machines and n jobs through three machines to solve an appropriate problem.	PO 10	1
AHS012.09	CLO 9	Use two jobs through m machines to solve an appropriate problem.	PO 2	3
AHS012.10	CLO 10	Understand basic concepts and Terminology of game theory	PO 2	3
AHS012.11	CLO 11	Determine appropriate technique to solve a game problem.	PO 1	3
AHS012.12	CLO 12	Solve the problems by using dominance principle and Graphical method.	PO 1 , PO 3	3
AHS012.13	CLO 13	Understand the Bellman's principle of optimality.	PO 1	3
AHS012.14	CLO 14	Describe heuristic problem-solving methods with stages.	PO 1, PO 2	3
AHS012.15	CLO 15	Understand the mapping of real-world problems to algorithmic solutions.	PO 2 , PO 3	2
AHS012.16	CLO 16	List out the various applications of dynamic programming.	PO 2	2
AHS012.17	CLO 17	Define the shortest path problem with approximate solutions.	PO 1, PO 2, PO 3	3
AHS012.18	CLO 18	Explain the linear programming problem with approximate solutions.	PO 1, PO 2, PO 3	2
AHS012.19	CLO 19	Define the various quadratic approximation methods for solving constraint problems.	PO 1, PO 2	3
AHS012.20	CLO 20	Explain the direct quadratic approximation for solving the constraint problems.	PO 1, PO 2	2
AHS012.21	CLO 21	Explain the quadratic approximation method by using lagrangian function.	PO 1 , PO 3	3
AHS012.22	CLO 22	Describe the variable metric methods for constrained optimization.	PO 1 , PO 3	2

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)						
	PO 1	PO 2	PO 3	PO 10	PSO1	PSO2	PSO3
CO 1	3		3		1		
CO 2		3	2				
CO 3	3	3	3	1	1		
CO 4	3	3	2		1		
CO 5	2	2	2		1		

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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		3										1		
CLO 3	2												1		
CLO 4		3													
CLO 5		3													
CLO 6		2	2												
CLO 7			2							1					
CLO 8										1					
CLO 9		3											1		
CLO 10		3											1		
CLO 11	3														
CLO 12	3		3												
CLO 13	3														
CLO 14	2	3											1		
CLO 15		2	2												

CLO 16		2													
CLO 17	3	3	2										1		
CLO 18	2	2	2										1		
CLO 19	2	3											1		
CLO 20	2	2											1		
CLO 21	3		3												
CLO 22	2		2												

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 10 PSO 1	SEE Exams	PO 1, PO 2 PO 3, PO 10 PSO 1	Assignments	PO 1, PO 2 PO 3, PO 10 PSO 1	Seminars	PO 1, PO 2 PO 3, PO 10 PSO1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. SYLLABUS

UNIT I	**LINEAR PROGRAMMING**	**Classes:09**
Definition, characteristics and phases, types of models, operations research models, applications, linear programming problem formulation, graphical solution, simplex method; Artificial variables techniques: Two-phase method, Big-M method.		
UNIT II	**TRANSPORTATION AND ASSIGNMENT PROBLEMS**	**Classes:09**
Transportation problem, formulation, optimal solution, unbalanced transportation problem, degeneracy, assignment problem, formulation, optimal solution, variants of assignment problem, traveling salesman problem.		
UNIT III	**SEQUENCING AND THEORY OF GAMES**	**Classes:09**
Sequencing: Introduction, flow-shop sequencing, n jobs through two machines, n jobs through three machines, job shop sequencing two jobs through m machines. Theory of games: Introduction, terminology, solution of games with saddle points and without saddle points, 2 x 2 games, dominance principle, m x 2 and 2 x n games, graphical method.		
UNIT IV	**DYNAMIC PROGRAMMING**	**Classes:09**
Introduction: Terminology, Bellman's principle of optimality, applications of dynamic programming shortest path problem, linear programming problem.		
UNIT V	**QUADRATIC APPROXIMATION**	**Classes:09**

Quadratic approximation methods for constrained problems: Direct quadratic approximation, quadratic approximation of the Lagrangian function, variable metric methods for constrained optimization.
Text Books:
1. A Ravindran, "Engineering Optimization", JohnWiley&Sons Publications, 4thEdition, 2009. 2. Hillier, Liberman, "Introduction to Operation Research", Tata McGraw-Hill, 2nd Edition,2000.
Reference Books:
1. Dr. J K Sharma, "Operation Research", Mac Milan Publications, 5thEdition, 2013. 2. Ronald L. Rardin, "Optimization in Operation Research", Pearson Education Pvt. Limited, 2005. 3. N V S Raju, "Operation Research", S M S Education, 3rdRevised Edition.

XVI. COURSE PLAN:

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

Lecture No	Topics to be covered	Reference
1	Introduction, Characteristics and phases, Types of Models	T1:1.1-1.2
2-3	Operations Research Models and Applications, Linear Programming Problem Formulation, LPP solution by Graphical solution	T1:1.3 R2:1.5
4	LPP solution by Simplex Method	T1: 1.3, 1.4
5-7	Artificial Variable Techniques by Two Phase Method, Artificial Variable Techniques by M Method, Transportation Problem: Introduction, assumptions and description, Formulation and Solution of Transportation Problem	T1:3.1,3.3, T1:3.5-3.6, T1:3.8, R2:3.7
7-8	NWCM method problems, Row Minima Method Problems	T1 :6.1
8-9	Column Minima Method Problems, Least Cost Method Problems	T1: 2.5
9-11	VAM or Penalty Method Problems, Degeneracy in Transportation Problems	T1: 6.2
12-13	Unbalanced Transportation Problems	T1:11.3.6
14-18	Assignment Problem definition, method formulation and solution, Hungarian Method of Assignment Problem	T1: 6.3,6.4 R2: 6.5
19-20	Variations of the Assignment problems – unbalance problems, Travelling Salesman Problem, Processing n jobs through one machine problems	T1: 4.1 T1:4.3,4.5 T1:4.6,4.9
21-25	Processing n jobs through two machines problems, Processing n jobs through three machines problems, Processing n jobs through m machines problems, Characteristics of Games, Game Models, Terminology, Formulation	T1:5.1-5.3 T1:5.5 T1:5.7-5.9
26-28	Rules of Game Theory(with saddle point and without saddle point), 2X2 Games Problems, 3X3 Games Problems, 2Xn Games or mX2 Games Problems	T1: 7.1-7.5 R2: 7.5-7.8
29-33	Graphical method for 2Xn Games or mX2 Games Problems, Introduction, Characteristics, Formulation of Dynamic Programming Problems, Bellman's Principles of Optimality Problem	T1: 8.1-8.3 R2: 8.6-8.8
34-35	Bellman's Principles of Optimality Problem	T1:11.1
36-39	Applications of Dynamic Programming, Shortest path problem by using Dynamic Programming Problem	T1:11.1-11.2
40-42	Solution of LPP by using Dynamic Programming Problem, Types of Non-Linear Programming Problems, Direct Quadratic Approximation Problems	T2:10.1-10.2
43-45	Quadratic Approximation by Lagrangian Function Problems, Constrained External problem with more than one equality constraint problems	T2:10.2-10.3

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

S No.	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	Skip lists, Problem reductions, Polynomial time and intractability	Seminars/ NPTEL	PO 1	PSO 1
2	Encourage students to write programs based on the taught algorithms to solve problems.	NPTEL	PO 1	PSO 1

Prepared by:

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