INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**OPTIMIZATION TECHNIQUES**				
Course Code	AMEB12				
Programme	B. Tech.				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	2	1
Chief Coordinator	Dr. Paidi Raghavulu, Professor, ME				
Course Faculty	Dr. Paidi Raghavulu, Professor, ME Mrs. T. Vanaja Assistant Professor , ME				

I. COURSE OVERVIEW:

The Optimization Techniques is also called Operations research for short and it is a scientific approach to decision making which seeks to determine how best to design and operate a system under conditions requiring allocation of scarce resources. Optimization Technique as a research field, primarily has a set or collection of algorithms which act as tools for problems solving in chosen application areas. OT has extensive applications in engineering, business and public systems and is also used by manufacturing and service industries to solve their day to day problems. . This course facilitates to learn various models to optimize a problem.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHSB02	I	Linear Algebra and Calculus	4
UG	AHSB11	II	Mathematical Transformation Techniques	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 modules and each module 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 module. 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 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**			**Total Marks**
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	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 20 marks of 2 hours duration consisting of five descriptive type questions out of which four 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 - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

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.	3	Presentation on real-world problems
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	2	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	Assignments
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	Term Paper

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:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Problem Solving Skills:** 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 :

The course should enable the students to:	
I	Formulate the mathematical model of real time problems and optimize with LLP techniques.
II	Establish the problem formulation and optimization by using transportation, assignment models.
III	Apply Sequencing and replacement models for optimized decisions
IV	Apply Game theory, Inventory models for effective operational control.
V	Visualize application of Waiting line, Dynamic programming, Simulation models in real time applications..

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Formulate the mathematical model of real time problems and optimize with LLP techniques.	CLO 1	Understand the characteristics, phases, types of operation research models and its applications.
		CLO 2	Visualize modeling principles scope, decision making, general methods for solving OR models.
		CLO 3	Understand linear programming concepts, problem formulation and graphical models.
		CLO 4	Understand simplex method and artificial variable techniques.
		CL05	Comprehend two-phase method and Big-M method of linear programming.
CO 2	Establish the problem formulation and optimization by using transportation, assignment models	CLO 6	Apply to build and solve transportation models of balanced .
		CLO 7	Understand the degeneracy model problem of transportation, unbalanced type-maximization.
		CLO 8	Apply to build assignment models for optimal solution.
		CLO 9	Understand variants of assignment model and travelling salesman model.

COs	Course Outcome	CLOs	Course Learning Outcome
CO 3	Apply Sequencing and replacement models for optimized decisions.	CL10	Understand the flow shop sequencing model of 'n' jobs through two machines and three machines.
		CLO 11	Comprehend job shop sequencing of two jobs through 'm' machines.
		CLO 12	Understand the concept of replacement of items that deteriorate with time when money value is not counted .
		CLO 13	Understand the concept of replacement of items that deteriorate with time when money value is n counted .
		CLO 14	Visualize the replacement of items that fail completely and group replacement.
CO 4	Apply Game theory, Inventory models for effective operational control.	CLO 15	Understand minimax (maximini) criterion, optimal strategy , solution od games with saddle point
		CLO 16	Visualize dominance principle while solving game theory problem.
		CLO 17	Apply to solve m * 2 , 2 *n model of games and graphical method.
		CLO 18	Understand the concepts of deterministic inventory model and purchase inventory model with one price break and multiple price breaks.
		CLO 19	Visualize stochastic inventory models – demand may be discrete variable or continuous variable.
CO 5	Visualize application of Waiting line, Dynamic programming, Simulation models in real time applications..	CLO 20	Understand the concepts of waiting line model of single channel and multi server model.
		CLO 21	Visualize dynamic programming concepts and models
		CLO 22	Comprehend the simulation models, phases of simulation, application of simulation
		CLO 23	Visualize the application of simulation for inventory and queuing problems.

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
AMEB12.01	CLO 1	Understand the characteristics, phases, types of operation research models and its applications.	PO 1, PO 2	3
AMEB12.02	CLO 2	Visualize modeling principles scope, decision making, general methods for solving OR models.	PO 1, PO 2	2
AMEB12.03	CLO 3	Understand linear programming concepts, problem formulation and graphical models.	PO 1, PO 2	3
AMEB12.04	CLO 4	Understand simplex method and artificial variable techniques.	PO 3	3
AMEB12.05	CLO 5	Comprehend two-phase method and Big-M method of linear programming.	PO 2, PO 3	2
AMEB12.06	CLO 6	Apply to build and solve transportation models of balanced .	PO 2	2
AMEB12.07	CLO 7	Understand the degeneracy model problem of transportation, unbalanced type-maximization.	PO 3	3
AMEB12.08	CLO 8	Apply to build assignment models for optimal solution.	PO 1, PO 2	2
AMEB12.09	CLO 9	Understand variants of assignment model and travelling salesman model.	PO 2	1
AMEB12.10	CLO 10	Understand the flow shop sequencing model of 'n' jobs through two machines and three machines.	PO 1, PO 6	2

AMEB12.11	CLO 11	Comprehend job shop sequencing of two jobs through 'm' machines.	PO 1, PO 2	2
AMEB12.12	CLO 12	Understand the concept of replacement of items that deteriorate with time when money value is not counted	PO 1 PO 6	3
AMEB12.13	CLO 13	Understand the concept of replacement of items that deteriorate with time when money value is n counted .	PO 1, PO 3	3
AMEB12.14	CLO 14	Visualize the replacement of items that fail completely and group replacement.	PO 6	3
AMEB12.15	CLO 15	Understand minimax (maximini) criterion, optimal strategy , solution od games with saddle point	PO 1, PO 2, PO 3	3
AMEB12.16	CLO 16	Visualize dominance principle while solving game theory problem.	PO 1, PO 2, PO 3	3
AMEB12.17	CLO 17	Apply to solve m * 2 , 2 *n model of games and graphical method.	PO 1, PO 2, PO 6	3
AMEB12.18	CLO 18	Understand the concepts of deterministic inventory model and purchase inventory model with one price break and multiple price breaks.	PO 1, PO 2	3
AMEB12.19	CLO 19	Visualize stochastic inventory models – demand may be discrete variable or continuous variable.	PO 2	3
AMEB12.20	CLO 20	Understand the concepts of waiting line model of single channel and multi server model.	PO 2	2
AMEB12.21	CLO 21	Visualize dynamic programming concepts and models	PO 3, PO 6	2
AMEB12.22	CLO 22	Comprehend the simulation models, phases of simulation, application of simulation	PO 2, PSO 1	2
AMEB12.23	CLO 23	Visualize the application of simulation for inventory and queuing problems.	PO1, PO 3	2

3= High; 2 = Medium; 1 = Low

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

Course Outcomes (COs)	Program Outcomes and Program Specific Outcomes					
	PO 1	PO 2	PO 3	PO 6	PSO 1	PSO 2
CO 1	3	2	3		2	2
CO 2	2	3		3	2	2
CO 3	2	2	2	3	2	2
CO 4	3		3	2	2	2
CO 5	3	2	3	1	2	2

3= High; 2 = Medium; 1 = Low

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

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	3													
CLO 2	2	2													
CLO 3		3													
CLO 4			3										1		
CLO 5		2	2												
CLO 6		2													
CLO 7			3												
CLO 8	2		2												
CLO 9		3													
CLO 10	3					3									
CLO 11	2	2											1		
CLO 12	3					3							1		
CLO 13	2		2												
CLO 14						2									
CLO 15	3	3	3												
CLO 16	2	2	2										1		
CLO 17	3	3				3							1		
CLO 18		2				2							1		
CLO 19		2											1		
CLO 20		2											1		
CLO 21			2			2									
CLO 22		2											1		
CLO 23	2		2												

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3,PO6, PS01	SEE Exams	PO1, PO2, PO3,PO6, PS01	Assignments	-	Seminars	PO1, PO2, PO3,PO6, PS01
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO2, PO3,PO6, PS01						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. SYLLABUS

Module-I	**DEVELOPMENT OF O.R AND ALLOCATION**
Development, definition, characteristics and phases, types of operation research models, applications; Allocation: linear programming, problem formulation, graphical solution, simplex method, artificial variables techniques, two–phase method, big-M method.	
Module-II	**TRANSPORTATION AND ASSIGNMENT PROBLEM**
Transportation problem: Formulation, optimal solution, unbalanced transportation problem, Degeneracy; Assignment problem, formulation, optimal solution, variants of assignment problem, traveling salesman problem.	
Module-III	**SEQUENCING AND REPLACEMENT**
Sequencing: Introduction, flow, shop sequencing, n jobs through two machines, n jobs through three machines, job shop sequencing, two jobs through 'm' machines. Replacement: Introduction: Replacement of items that deteriorate with time, when money value is not counted and counted, replacement of items that fail completely, group replacement.	
Module-IV	**THEORY OF GAMES AND INVENTORY**
Theory Of Games: Introduction – Terminology, Solution of games with saddle points and without saddle points, 2×2 games, dominance principle, m X 2 & 2 X n games, Graphical method. Inventory: Introduction**,** Single item**,** Deterministic models**,** Purchase inventory models with one price break and multiple price breaks, Stochastic models, demand may be discrete variable or continuous variable, Single period model and no setup cost.	
Module-V	**WAITING LINES, DYNAMIC PROGRAMMIMG AND SIMULATION**
Waiting Lines: Introduction, Terminology, Single Channel, Poisson arrivals and exponential service times with infinite population and finite population models, Multichannel, Poisson arrivals and exponential service times with infinite population. Dynamic Programming: Introduction, Terminology, Bellman"s Principle of optimality, Applications of	

dynamic programming, shortest path problem, linear programming problem. Simulation: Introduction, Definition, types of simulation models, steps involved in the simulation process - Advantages and Disadvantages, Application of Simulation to queuing and inventory.
Text Books:
1. J. K. Sharma, "Operations Research", Macmillan, 5th Edition, 2012. 2. R. Pannerselvan, "Operations Research", 2nd Edition, PHI Publications, 2006.
Reference Books:
1. A. M. Natarajan, P. Balasubramani, A. Tamilarasi, "Operations Research", Pearson Education, 2013. 2. Maurice Saseini, Arhur Yaspan, Lawrence Friedman, "Operations Research: Methods & Problems", 1st Edition, 1959. 3. Hamdy A. Taha, "Introduction to O.R", PHI, 8th Edition, 2013. 1. Harvey M.Wagner, "Operations Research", PHI Publications, 2nd Edition, 1980.
Web References:
1. https://www.aicte-india.org/flipbook/p&ap/Vol.%20II%20UG/UG_2.html#p=8 2. https://www.britannica.com/topic/operations-research

XVI. COURSE PLAN:

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

Lecture No	Topic's to be covered	Course Learning Outcomes (CLOs)	Reference
1	Understand Introduction – Definition– Characteristics and Phases – Types of operation Research models	CLO 1	T1: 1.1- 1.5
2	Understand Modeling in operations research , principles and application	CLO 2	T1: 1.6 – 1.15
15	Remember Allocation - Linear Programming Problem formulation	CLO 3	T1: 2.7 – 2.86
5-6	Understand concepts of Graphical solution	CLO 3	T1: 3.1- 3.4.2
6-7	Remember concepts of Simplex method	CLO 4	T1: 4.1- 4.62
8-9	Understand Artificial variables techniques	CLO 4	T1: 4.4.1
10-11	Understand concepts of Two–phase method	CLO5	T1: 4.4.1
12-13	Remember concepts of Big-M method	CLO5	T1: 14.1- 14.2
14-16	Understand Transportation model Formulation-Optimal solution balanced model	CLO6	T1: 9.1 – 9.4
17-20	Understand Formulation-Optimal solution balanced and unbalanced and transportation models	CLO6	T1: 9.5 – 9.6.1
21-23	Analyze Degeneracy type transportation model	CLO7	T1: 9.6.2 – 9.7
24-25	Understand concepts of Assignment problem- Formulation – Optimal solution	CLO8	T1: 10.1 – 10.3.1
26-28	Understand concepts of variants of Assignment Problem, travelling salesman problem	CL09	T1:10.4 – 10.4.6
29-30	Remember the concepts of Introduction-Flow-Shop sequencing-n jobs through two machines-n jobs through three machines	CLO10	T1: 11..1-11.4
31-32	Understand concepts of Job shop sequencing – two jobs	CLO11	T1: 11.5 – 11.8

	through "m: machines		
33-34	Remember concepts of replacement of items that deteriorate with time-when money value is not counted	CLO12	T1: 17.1 – 17.2
35-36	Understand the concept of replacement of items that deteriorate with time-when money value is counted	CLO13	T1: 17.3
37-39	Remember the concept of replacement of items that fail completely, group replacement. Group replacement	CLO14	T1: 17.4
40	Understand the concepts of Game theory terminology , Solution of games with saddle points	CLO15	T1: 12.1 – 12.3
41	Understand the concepts of Rectangular games without saddle points-2 x 2 games conductivity gauges	CLO15	T1: 12.4 – 12.6
42-43	Remember the concept of Dominance principle for solving Transportation problem	CLO16	T1: 12.5
44-45	Remember concept of *2 & 2 * n games -graphical method	CLO17	T1: 12.6.4 – 2.6.5
46-47	Understand the concepts of Inventory: Introduction-Single item, Derive the formula for Inventory models	CLO18	T1: 14.1 – 14.7
48-49	Understand the concepts of Purchase inventory models with one price break and multiple price breaks	CLO18	T1: 14.10
50-51	Understand the concepts of Stochastic Models	CLO19	T1: 14.11 – 14.12.5
52-53	Understand the concepts of demand may be discrete variable or continuous variable – Single period model and no setup cost	CLO19	T1:15.2 – 15.3
54-55	Remember the concepts of Waiting Lines, Introduction-Single Channel- Poisson arrivals	CLO20	T1: 16.1 – 16.6
55-56	Understand the concept of Multichannel-Poisson arrivals	CLO20	T1: 16.7 – 16.9
57-59	Remember the concepts of e dynamic programming concepts and models		
60	Understand the concepts of Simulation, types of Simulation models-phases of simulation-applications of simulation	CLO21	T1: 19.1 – 19.4
61-62	Understand advantages and disadvantages and application of simulation to queuing and inventory.	CLO22	T1: 19.5 – 19.8

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

S NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PSOs
1	Advanced Simulation practices	Seminars and Laboratory Practice	PO2	PSO1
2	Advanced topics	Guest Lectures and Laboratory Practice	PO3	PSO2
3	Recommended practices in optimization processes	Seminars and Laboratory Practice	PO3	PSO2

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