INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTATIONAL MECHANICAL ENGINEERING LABORATORY**				
Course Code	AME106				
Programme	B. Tech				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	-	-	-	3	2
Chief Coordinator	Dr. K. Viswanath Allamraju, Professor,				
Course Faculty	Dr. K. Viswanath Allamraju, Professor Mr. G. Aravind Reddy, Assistant Professor.				

I. COURSE OVERVIEW:

The aim of this course is to write programme for analysis of mechanical structures through mathematical modeling. It is a high-level language for numerical computation, visualization and application development. It also provides an interactive environment for iterative exploration, design and problem solving. It provides vast library of mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration and solving ordinary differential equations. It provides built-in graphics for visualizing data and tools for creating custom plots. MATLAB's programming interface gives development tools for improving code quality maintainability and maximizing performance.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
-	-	-	Basics of Mathematics	-

III. MARKSDISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Computational Mechanical Engineering Laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

√	Marker & talk	√	Quiz	√	Assignments	✘	Moocs
√	Lcd / ppt	√	Seminars	✘	Mini project	✘	Videos
✘	Open ended experiments						

V. EVALUATION METHODOLOGY:

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 are 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 evaluate the preparedness for the programme.
20 %	To write the programme with input and computational variables.
20 %	To study the calculations and graphs related to the concern programme.
20 %	To interpret the results and the error analysis of the programme.
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 day performance	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 hours duration.

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

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	Engineering Knowledge: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on real-world problems
PO2	Problem Analysis: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	3	Seminar
PO3	Design/ development of solutions: Competence to design a system, component or process to meet societal needs within realistic constraints.	3	Seminar
PO4	Conduct investigations of complex problems: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	3	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Lecture, Assignments.
PSO2	**Problem solving skills**: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	3	Projects
PSO3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	3	Projects

3= High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Develop MAT LAB programs for simple and complex engineering problems.
II	Interpret the output graphical plots for the given governing equation.
III	Apply the MATLAB programming to real time applications.

IX. 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
AME106.01	CLO1	Write simple program modules to implement single numerical methods and algorithms.	PO 1	3
AME106.02	CLO2	Calculate solutions to mechanical engineering problems using standard numerical methods.	PO 1, PO 3	3
AME106.03	CLO3	Explore the vectors and scalars for writing MATLAB codes.	PO 1, PO 3	3
AME106.04	CLO4	Test program output for accuracy using hand	PO 1, PO 2,	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		calculations and debugging techniques.	PO 4	
AME106.05	CLO5	Analyze the applicability and accuracy of numerical solutions to diverse mechanical engineering problems.	PO 1, PO 3	2
AME106.06	CLO6	Able to use MATLAB for interactive computations.	PO 1, PO 2, PO 4	2
AME106.07	CLO7	Familiar with memory and file management in MATLAB.	PO 1, PO 2, PO 3	1
AME106.08	CLO8	Able to generate plots and export this for use in reports and presentations.	PO 1, PO 2, PO 3	1
AME106.09	CLO9	Able to program scripts and functions using the MATLAB development environment.	PO 1, PO 2	2
AME106.10	CLO10	Understand the subplots	PO 1, PO 3	2
AME106.11	CLO11	Able to use basic flow controls (if-else, for, while).	PO 1, PO 3	3
AME106.12	CLO12	Familiar with strings and matrices and their use.	PO 1, PO 2	3
AME106.13	CLO13	Determine the thermal stresses developed in a shaft.	PO 1, PO 3	3
AME106.14	CLO14	Determine the thermal stresses developed in a pipe.	PO 1, PO 2	2
AME106.15	CLO15	Able to plot the displacement versus time of a single degree of freedom system	PO 1, PO 3, PO 4	2
AME106.16	CLO16	Able to plot the velocity versus time of a single degree of freedom system	PO 1, PO 2	2
AME106.17	CLO17	Able to plot the displacement versus time of a two degree of freedom system by Runga Kutta method	PO 1, PO 2	3
AME106.18	CLO18	Determine the frequency developed in a continuous system	PO 1, PO 2	2
AME106.19	CLO19	Able to plot the Acceleration versus time of a single degree of freedom system	PO 1, PO 3, PO 4	1
AME106.20	CLO20	Study the variation of stress along the cross section of the beam under uniformly distributed load.	PO 1, PO 2	1

3= High; 2 = Medium; 1 = Low

X. 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	2	
CLO 2	3		3										1		
CLO 3	3		3										1	2	
CLO 4	2	2		2									1	2	

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 5	2		2										1	2	
CLO 6	2	2		2										2	
CLO 7	1	1	1										1		
CLO 8	1	1	1											2	
CLO 9	2	2												2	
CLO 10	2		2										1		
CLO 11	3		3											2	
CLO 12	3	3											1		
CLO 13	3		3										1	2	
CLO 14	2	2											1		
CLO 15	2		2	2									1	2	
CLO 16	2	2											1		
CLO 17	3	3											1		
CLO 18	2	2											1	2	
CLO 19	1		1	1										2	
CLO 20	1	1												2	

3= High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2,PO3	SEE Exams	PO1,PO4	Assignments	-	Seminars	PO4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO4						

XII. ASSESSMENT METHODOLOGIES–INDIRECT

√	Assessment of course Outcomes (by feedback, once)	√	Student feedback on faculty (twice)
✘	Assessment of mini projects by experts		

XIII. SYLLABUS:

Week-1	**FEATURES OF MATLAB**
Types of windows, Variables, logical operations, Assignment statements, Matrices, Vectors, Scalars, Transpose matrix, Product, summation and inverse matrices.	
Week –2	**USES OF MATLAB.**
Algorithm development, Scientific and engineering graphics, Modeling, simulation, and prototyping, Application development, including Graphical User Interface building, Math and computation,Data analysis, exploration, and visualization	
Week -3	**MATHEMATICAL PROBLEMS IN MATLAB**
Plotting the graph for sin(x), cos(x), tan(x), csc (x), Hold on command application in drawing the multiple plots	
Week -4	**FORMULATION OF IDEAL AND REAL GAS PROBLEMS IN MATLAB PROGRAM**
The gas law, for example, P = f(n,T,V) [= nRT/V], plotting between P and T, P and V, analysis, interpretation of graphs.	
Week -5	**DYNAMICS AND VIBRATION ANALYSIS-I IN MATLAB PROGRAM**
The constant of the spring is k = 3 kN/m and the tension in the cable is 30 N. When the cable is cut, (a) derive an expression for the velocity of the block as a function of its displacement x, (b) determine the maximum displacement xm and the maximum speed vm, (c) plot the speed.	
Week-6	**DYNAMICS AND VIBRATION ANALYSIS-II IN MATLAB PROGRAM**
The constant of the spring is k = 5 kN/m and the tension in the cable is 50 N. When the cable is cut, (a) derive an expression for the velocity of the block as a function of its displacement x, (b) determine the maximum displacement xm and the maximum speed vm, (c) plot the speed.	
Week -7	**THERMAL STRESS ANALYSIS OF PISTON-I IN MATLAB PROGRAM**
The data is taken for the design of piston through which various geometries of the piston can be found out which are mentioned below. The material of the piston is Aluminum alloy 6061. Design of the Piston can be done by general programme in MATLAB Software.	
Week -8	**THERMAL STRESS ANALYSIS OF PISTON-II IN MATLAB PROGRAM**
The data is taken for the design of piston through which various geometries of the piston can be found out which are mentioned below. The material of the piston is Aluminum alloy 3003. Design of the Piston can be done by general programme in MATLAB Software.	
Week-9	**ANALYSIS OF KINEMATICS IN FOUR BAR MECHANISM IN MATLAB PROGRAM**
For a given geometry of four bar mechanism, drawing the plots of velocity, acceleration of the links at various angles.	
Week –10	**ANALYSIS OF KINEMATICS IN FOUR BAR MECHANISM IN MATLAB PROGRAM**
For a given geometry of slider crank mechanism, drawing the plots of velocity, acceleration of the links at various angles.	
Week -11	**REVISION TO ALL MATLAB PROBLEMS**
IF else, While else commands, 2D plots, frequency calculation of vibration systems.	
Week -12	**REVISION TO ALL MATLAB PROBLEMS**
Thermal analysis, Vibration analysis, preparation for semester end exam.	
Text Books:	
1. Agam Kumar Tyagi, "MATLAB and Simulink for Engineers", Oxford University Press 1st Edition, 2012. 2. S.S.Rao, Vibration Problems, CRC press, 4 th Edition, 2014.	
Reference Books:	
1. Delores M. Etter, David C. Kuncicky , Holly Moore, "Introduction to MATLAB 7", Pearson Education Inc, 1st Edition,, 2009. 2. Rao. V. Dukkipati , "MATLAB for ME Engineers" , New age Science, 1st Edition, 2008.	

Web References:
1. http://www.tutorialspoint.com/matlab/ 2. http://in.mathworks.com/products/matlab/?requestedDomain=www.mathworks.com

XIV. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Week N	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1	Types of windows, Variables, logical operations, Assignment statements, Matrices,	CLO1	T1-1.1 , R1- 1.31.4 ,R2.1.7
2	Vectors, Scalars, Transpose matrix, Product, summation and inverse matrices.	CLO1	T1- 1.2, R1-1.8,
3	Algorithm development, Scientific and engineering graphics, Modeling, simulation, and prototyping, Application development, including Graphical User Interface building, Math and computation,Data analysis, exploration, and visualization	CLO1,CLO19	T1- 1.15, R1- 1.16
4	Plotting the graph for sin(x), cos(x), tan(x), csc (x), Hold on command application in drawing the multiple plots.	CLO2,CLO17	T1- 1.6
5	The gas law, for example, P = f(n,T,V) [= nRT/V], plotting between P and T, P and V, analysis, interpretation of graphs.	CLO2	T1- 2.2, R2-2.6
6	The constant of the spring is k = 3 kN/m and the tension in the cable is 30 N. When the cable is cut, (a) derive an expression for the velocity of the block as a function of its displacement x, (b) determine the maximum displacement xm and the maximum speed vm, (c) plot the speed.	CLO2,CLO15	T1-2.6, R3-2.10
7	Plots interpretation of 2D and 3D	CLO3	T1-3.2, R2-3.3,
8	Thermal stress analysis of piston	CLO3	T1-3.5
9	Degree of freedom, Equations of motion	CLO4,CLO11	T1-2.13, 2.14,R1- 2.16
10	Kinematics, four bar mechanism, slider crank mechanism, analysis	CLO4,CLO16	T1-2.15, R1-2.15
11	Velocity analysis, acceleration analysis	CLO4,CLO11	T1-3.9, R1-3.9
12	Applications of matlab in 2 dof and 3 dof	CLO5	T1-6.1, R2-6.3

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Parametric program of design of shaft	Seminars	PO 1, PO 4	PSO 1
2	SIMULINK concepts	Seminars / NPTEL	PO 4, PO3	PSO 1
3	Encourage students to design beams by writing MATLAB code to solve the mode shapes	NPTEL	PO 2	PSO 1

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