



# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

## MECHANICAL ENGINEERING

### COURSE DESCRIPTOR

<b>Course Title</b>	<b>COMPUTATIONAL TECHNIQUES LABORATORY</b>				
<b>Course Code</b>	BCCB25				
<b>Programme</b>	M. Tech				
<b>Semester</b>	I	M.Tech			
<b>Course Type</b>	Core				
<b>Regulation</b>	IARE - R18				
<b>Course Structure</b>	<b>Theory</b>			<b>Practical</b>	
	<b>Lectures</b>	<b>Tutorials</b>	<b>Credits</b>	<b>Laboratory</b>	<b>Credits</b>
	-	-	-	3	2
<b>Chief Coordinator</b>	Dr. K. Viswanath Allamraju, Professor				
<b>Course Faculty</b>	Dr. K. Viswanath Allamraju, 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
<b>PO1</b>	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	Presentation on real-world problems
<b>PO2</b>	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	3	Seminar
<b>PO3</b>	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	3	Seminar
<b>PO4</b>	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	3	Term Paper
<b>PO5</b>	Write and present a substantial technical report / document.	3	Seminar
<b>PO6</b>	Independently carry out research / investigation and development work to solve practical problems.	3	Seminar
<b>PO7</b>	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	3	Term Paper

**3 = High; 2 = Medium; 1 = Low**

## VII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Develop MATLAB 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.

## VIII. 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
BCCB25.01	CLO1	Write simple program modules to implement single numerical methods and algorithms.	PO 1	3
BCCB25.02	CLO2	Calculate solutions to mechanical engineering problems using standard numerical methods.	PO 1, PO 3	3
BCCB25.03	CLO3	Explore the vectors and scalars for writing MATLAB codes.	PO 1, PO 3	3
BCCB25.04	CLO4	Test program output for accuracy using hand calculations and debugging techniques.	PO 1, PO 2, PO 4	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCCB25.05	CLO5	Analyze the applicability and accuracy of numerical solutions to do thermal stress analysis.	PO 1, PO 3	2
BCCB25.06	CLO6	Able to use MATLAB for interactive computations.	PO 1, PO 2, PO 4	2
BCCB25.07	CLO7	Able to generate plots for ideal gas equations.	PO 1, PO 2, PO 3	1
BCCB25.08	CLO8	Able to generate plots and export this for use in reports and presentations.	PO 1, PO 2, PO 3	1
BCCB25.09	CLO9	Able to program scripts and functions using the MATLAB development environment.	PO 1, PO 2	2
BCCB25.10	CLO10	Understand the subplots	PO 1, PO 3	2
BCCB25.11	CLO11	Able to use basic flow controls (if-else, for, while).	PO 1, PO 3	3
BCCB25.12	CLO12	Familiar with strings and matrices and their use.	PO 1, PO 2	3
BCCB25.13	CLO13	Determine the thermal stresses developed in a shaft.	PO 1, PO 3	3
BCCB25.14	CLO14	Determine the thermal stresses developed in a pipe.	PO 1, PO 2	2
BCCB25.15	CLO15	Able to plot the displacement versus time of a single degree of freedom system	PO 1, PO 3, PO 4	2
BCCB25.16	CLO16	Able to plot the velocity versus time of a single degree of freedom system	PO 1, PO 2	2
BCCB25.17	CLO17	Able to write MATLAB programme for least square curve fitting.	PO 1, PO 2	3
BCCB25.18	CLO18	Determine the frequency developed in a continuous system	PO 1, PO 2	2
BCCB25.19	CLO19	Able to plot the Acceleration versus time of a single degree of freedom system	PO 1, PO 3, PO 4	1
BCCB25.20	CLO20	Able to plot resultant acceleration verses variation of acceleration in MATLAB	PO 1, PO 2	1

3= High; 2 = Medium; 1 = Low

#### IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(COs)	Course Outcomes						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3						
CO 2	3		2	3		3	
CO 3	3	3	2	3		3	

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	3						
CLO 2	3						
CLO 3	3	3					
CLO 4	3	2					
CLO 5		2					
CLO 6	2	2	2				
CLO 7		1					
CLO 8		1	1				
CLO 9		2					
CLO 10	2	2					
CLO 12			3			3	
CLO 13		3				3	
CLO 14		3	3				
CLO 15			1			1	

**XI. ASSESSMENT METHODOLOGIES – DIRECT**

CIE Exams	PO1, PO2, PO3	SEE Exams	PO1, PO4	Assignments	-	Seminars	PO2, PO3, PO5, PO6
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO4, PO7						

**XII. ASSESSMENT METHODOLOGIES – INDIRECT**

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

### XIII. SYLLABUS:

<b>Week-I</b>	<b>INTRODUCTION TO MATLAB PROGRAM</b>
Applications to MATLAB in Mechanical Engineering.	
<b>Week -2</b>	<b>MATLAB PROGRAM TO PLOT THE INTERNAL FORCES, AND BENDING MOMENT.</b>
The radius of the semicircular member is 25 mm and supported with roller and hinged supports. The load 300N acting vertically downward at the center and 200 N acting horizontally at the roller support toward left direction .Write a MATLAB program to plot the internal forces, namely, the axial forces, shearing force and bending moment as functions of $\alpha$ for $0 < \alpha < 90^\circ$ .	
<b>Week-3</b>	<b>THERMAL STRESS ANALYSIS OF PISTON USING MATLAB PROGRAM</b>
Temperature distribution around the given piston dimensions.	
<b>Week-4</b>	<b>FORMULATION OF IDEAL AND REAL GAS EQUATIONS.</b>
Gas phase thermodynamic equations of state relate the three state variables of temperature, pressure, and volume for a gas. One of the three state variables can be calculated through the equation of state if values for the other two variables are known. For example, the ideal gas law states $PV = RT$ ~ where P : pressure, Pa: V : specific or molar gas volume, m <sup>3</sup> mol R : ideal gas constant, (= 8.314 J/(mol K)) T : absolute temperature, K.	
<b>Week-5</b>	<b>USING MATLAB PROGRAM PLOT THE FUNCTION OF ONE VARIABLE AND TWO VARIABLE</b>
Graphing-functions of one variable and two variables	
<b>Week-6</b>	<b>MULTI BODY DYNAMIC ANALYSIS THROUGH MATLAB PROGRAM</b>
Use of MATLAB to solve simple problems in vibration, Mechanism Simulation using multi body dynamic software	
<b>Week-7</b>	<b>MATLAB PROGRAM FOR EULERS EQUATION OF MOTION</b>
Solution of Difference Equations using Euler Method.	
<b>Week-8</b>	<b>MATLAB PROGRAM FOR CURVE FITTING.</b>
Determination of polynomial using method of Least Square Curve Fitting.	
<b>Week-9</b>	<b>DYNAMIC ANALYSIS USING MATLAB PROGRAM</b>
Dynamics and vibration analysis	
<b>Week-10</b>	<b>MATLAB PROGRAM TO PLOT THE RESULTANT ACCELERATION AND THE VARIATION OF ACCELERATION</b>
A jet plane is going in a parabolic path described by $y=0.05x^2$ . At a point in the path, it has a velocity of 200 m/s, which is increasing at the rate of $0.8 \text{ m/s}^2$ . Find the resultant acceleration and plot the variation of acceleration as a function of its horizontal position $x$ .	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. Delores M. Etter, David C. Kuncicky , Holly Moore, “Introduction to MATLAB 7”, Pearson Education Inc, 1st Edition,, 2009.</li> <li>2. Rao. V. Dukkupati , “MATLAB for ME Engineers” , New age Science, 1st Edition, 2008.</li> <li>3. Agam Kumar Tyagi, “MATLAB and Simulink for Engineers”, Oxford University Press 1st Edition, 2012.</li> </ol>	
<b>Web References:</b>	
<ol style="list-style-type: none"> <li>1. <a href="http://www.tutorialspoint.com/matlab/">http://www.tutorialspoint.com/matlab/</a></li> <li>2. <a href="http://in.mathworks.com/products/matlab/?requestedDomain=www.mathworks.com">http://in.mathworks.com/products/matlab/?requestedDomain=www.mathworks.com</a></li> </ol>	

#### XIV. COURSE PLAN:

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

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	Types of windows, Variables, logical operations, Assignment statements, Matrices. Applications.	CLO1	T1-1.1 , R1- 1.31.4 ,R2.1.7
4-6	Vectors, Scalars, Transpose matrix, Product, summation and inverse matrices.	CLO1	T1- 1.2, R1-1.8,
7-9	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, Thermal analysis.	CLO1,CLO19	T1- 1.15, R1- 1.16
10-12	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
13-15	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
16-18	The constant of the spring is $k = 3 \text{ kN/m}$ 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 $x_m$ and the maximum speed $v_m$ , (c) plot the speed.	CLO2,CLO15	T1-2.6, R3-2.10
19-21	Plots interpretation of 2D and 3D	CLO3	T1-3.2, R2-3.3,
22-24	Thermal stress analysis of piston	CLO3	T1-3.5
25-27	Degree of freedom, Equations of motion	CLO4,CLO11	T1-2.13, 2.14,R1- 2.16
28-30	Kinematics, four bar mechanism, slider crank mechanism, analysis	CLO4,CLO16	T1-2.15, R1-2.15
31-33	Velocity analysis, acceleration analysis	CLO4,CLO11	T1-3.9, R1-3.9
34-36	Curve fitting by least square technique	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
1	Parametric program of design of shaft	Seminars	PO 1, PO 4
2	SIMULINK concepts	Seminars / NPTEL	PO 4, PO3

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