COMPUTATIONAL AEROSPACE ENGINEERING LABORATORY

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAEB10	**Core**	-	-	4	2	30	70	100

Contact Classes: Nil	Tutorials: Nil	Practical Classes: 36	Total Classes: 36

I. COURSE OVERVIEW:

This course aims to enhance the skills through a detailed introduction to the state-of-the-art computational methods and their applications for digital age aerospace engineering applications. It provides a unique opportunity for cross-disciplinary education and knowledge transfer in the computational engineering of fluid and solid mechanics for aerospace industrial applications. Focusing on fully integrated digital design for aerospace applications, you will be able to understand and implement numerical methods on various computing platforms for aerospace applications.

II .COURSE OBJECTIVES:

The course should enable the students to:

I. Learn basic MATLAB software and use them to solve structural aerodynamic and flight control system problems.
II. Understand the basics of plotting in MATLAB both in two dimensional and three dimensional.
III. Develop codes for solving structural response problems, aerodynamic simulation problems and flight control system analysis and design.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1	**Make use of** MATLAB and Simulink tools for solving aerospace engineering problems in designing.	**Apply**
CO2	**Examine** the thin-walled beams and shells using finite element method for analyzing the bending stiffness of aircraft structure.	**Analyze**
CO3	**Solve** the Burger's equation using explicit Mac Cormack method for analyzing fluid flows.	**Analyze**
CO4	**Develop** the numerical code for solving laminar flow over a flat plate.	**Analyze**
CO5	**Make use of** MATLAB and Simu-link for simulating the motion of aircraft and re-entry vehicles.	**Analyze**
CO6	**Build** the mathematical model by using different techniques for simulating satellite attitude dynamics.	**Analyze**

LIST OF EXPERIMENTS	

Week-1	**MATLAB/SIMULINK FUNDAMENTALS FOR AEROSPACE APPLICATIONS**

	MATLAB introduction, Plotting and graphics: Plot, log and semi-log plots, polar plots; Subplots, axis, mesh, contour diagrams, flow diagrams, movies, MATLAB tool boxes: continuous transfer functions, root locus, Nichols chart, Nyquist chart, linear quadratic regulator, state space design, digital design, aerospace toolbox; M cells, structures and M-files, MEX files; Standard simulink libraries, simulink aerospace blockset, Building simulink linear models: transfer function modelling in simulink, zero pole model, state-space model; simulink LTI viewer and usage of it, equivalent simulink LTI models, single input single output design tool, building Multi-input, multi output models, building simulink S-functions; State flow introduction: Opening, executing, and saving state flow models, constructing a simple state flow model, using a state flow truthtable.
Week-2	**THIN-WALLED BEAMS**
	Software development for thin-walled beams using finite element method.
Week-3	**PLATE BENDING**
	Software development for Plate bending using finite element method.
Week-4	**BEAMS ANALYSIS**
	Software development for Beams analysis using finite element method.
Week-5	**TRUSSES ANALYSIS**
	Software development for Trusses analysis using finite element method.
Week-6	**THIN SHELLS ANALYSIS**
	Software development for Thin shells analysis using finite element method.
Week-7	**GENERATION OF STRUCTURES AND UNSTRUCTURED**
	Software development for simulation in generation of structures and unstructured grids in two and Three dimensions of fluid flows.
Week-8	**SOLUTION OF BURGERS EQUATION**
	Software development for simulation in solution of burgers equation using explicit McCormack method of fluid flows.
Week-9	**BLASIUS SOLUTION FOR LAMINAR BOUNDARY LAYER OVER A FLAT PLATE**
	Software development for simulation in Blasius solution for laminar boundary layer over a flat plate of fluid flows.
Week-10	**RIEMANN SOLVER FOR SHOCK TUBE PROBLEM**
	Software development for simulation in Riemann solver for shock tube problem of fluid flows.
Week-11	**SIMULATION OF AIRCRAFT MOTION**
	Simulation experiment in dynamics and control using MATLAB and Simulink to Simulate aircraft motion such as longitudinal dynamics, lateral dynamics.
Week-12	**SIMULATION OF AIRCRAFT MOTION WITH ILLUSTRATION OF F-16 MODEL**
	Six-degrees-of-freedom simulation of aircraft motion with illustration of F-16 model using MATLAB and Simulink.
Week-13	**SIMULATION OF RE-ENTRY VEHICLE DYNAMICS**
	Simulation of re-entry vehicle dynamics for ballistic re-entry and maneuvering re-entry.

Week-14	SIMULATION OF NON-LINEAR CONTROL SYSTEM

Simulation of non-linear control system for controlling roll dynamics of a fighter aircraft.

Week-15	SIMULATION OF SATELLITE ATTITUDE DYNAMICS

Simulation of the following relating to satellite attitude dynamics:
 a. Torque free rotation of axisymmetric and asymmetric spacecraft.
 b. Attitude maneuvers of spin- stabilized spacecraft.

Reference Books:

1. Richard Colgren, "Basic MATLAB, Simulink, and State Flow", AIAA Education Series, 1st Edition, 2007.
2. Steven T. Karris, "Introduction to Simulink with Engineering Application", Orchard Publication, 3rd Edition, 2006.
3. Ashish Tewari, "Atmospheric and Space Flight Dynamics", Birkhauser Publication, 1st Edition, 2007
4. A. Tewari, "Modern Control Design with MATLAB and Simulink", Wiley, 1st Edition, 2002.

Web References:

1. http://www.springer.com/us/book/9780817644376
2. https://www.scribd.com/doc/53680598/Modern-Control-Design-With-MATLAB-and-SIMULINK