FLIGHT VEHICLE DESIGN

VII Semester: AERO

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAE017	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the basic skills involved in weight estimation for aircraft conceptual design process.
II. Illustrate relevant theoretical knowledge, applicable for initial sizing and configuration layout of aircraft
III. Evaluate basic techniques in literature retrieval and query, also creative and have systematic scientific research methods and working abilities
IV. Observe different designing processes and how an aircraft production company works on it.
V. Explore the new concepts of aerodynamics propulsion and fuel system integration.

COURSE OUTCOMES (COs):

CO 1: Describe different phases of aircraft design , weight estimation and few basics of aerodynamics.

CO 2: Differentiating size estimation fuel system and understanding the installation of engine systems

CO 3: Estimation of lift curve slopes maximum lift coefficient and different material selection can be found

CO 4: Understanding the concepts of stability for different control surfaces and also understanding the methods of structural analysis.

CO 5: Acquiring knowledge on cost estimation research, Development, Test, and Evaluation and product cost for designing an aircraft

COURSE LEARNING OUTCOMES (CLOs):

1. Understanding the different designing concepts like preliminary design conceptual design and detail design.
2. Interpret the weight estimation of propulsion system structural weight empty weight
3. Calculating the dimensioning of engine inlet location and capture
4. Estimation of wing geometry and wing vertical location, wing tip shapes, tail geometry and arrangements, thrust to weight ratio-statistical estimation
5. Apply a theories and to predict the maximum lift coefficient, and complete drag build up, installed performance of an engine
6. Development of configuration lay out from conceptual sketch.
7. Calculating the velocity, angle of Attack, angle of attack rate, pitch rate, elevator angle.
8. Constructing v-n diagram, air load distribution on lifting surfaces
9. Developing the concept of Propulsion selection fuel selection.
10. Plotting the mission segment with different weight fractions
11. Understanding the concepts of different landing gear system
12. Estimation of design-stability and control.
13. Analysis of performance under constrained conditions constraint.
14. Acquire Basic knowledge to solve real time problems in Aircraft propulsion and structure with different loading conditions.
15. Apply the fundamental concepts in competitive examinations.

SYLLABUS

UNIT-1	OVERVIEW OF THE DESIGN PROCESS	Classes: 10

Phases of aircraft design, aircraft conceptual design process, project brief / request for proposal, problem definition, information retrieval, integrated product development and aircraft design. initial conceptual sketches, takeoff gross weight estimation, airfoil selection, airfoil design, airfoil design considerations, wing geometry and wing vertical location, wing tip shapes, tail geometry and arrangements, thrust to weight ratio, thrust matching, wing loading performance, constraint analysis

UNIT -II	INITIAL SIZING & CONFIGURATION LAYOUT	Classes: 10

Sizing with fixed engine and with rubber engine. Geometry sizing of fuselage, wing, tail, control surfaces, and development of configuration lay out from conceptual sketch. the inboard profile drawing, lofting definition, significance and methods, flat wrap lofting, special consideration in configuration lay out, Isobar tailoring, Sears-Hack volume distribution, structural load paths, radar, IR, visual detectability, aural signature, considerations of vulnerability, crashworthiness, producibility, maintainability, fuselage design, crew station, passengers and payload

UNIT-III	PROPULSION, FUEL SYSTEM INTEGRATION, LANDING GEAR AND BASELINE DESIGN ANALYSIS - I	Classes: 10

Propulsion selection, jet engine integration, propeller engine integration, engine design considerations, engine size estimation, fuel system design and integration, landing gear and sub systems arrangements, guidelines and significance of design layout, report of initial specifications. Estimation of lift curve slope, maximum lift coefficient, complete drag build up, installed performance of an engine, installed thrust methodology, net propulsive force, part power operation, aircraft structures and loads categories, air load distribution on lifting surfaces, review of methods of structural analysis, material selection, weights and moments statistical group estimation method, center of gravity excursion control

UNIT-IV	BASELINE DESIGN ANALYSIS - II	Classes: 10

Estimation of static pitch stability, velocity stability and trim, estimation of stability and control derivatives, static lateral, directional stability and trim. estimation of aircraft dynamical characteristics, handling qualities, Cooper – Harper scale, relation to aircraft dynamic characteristics, performance analysis and constraint analysis– steady level flight, minimum thrust required for level flight, range and loiter endurance, steady climbing and descending flight, best angle and rate of climb, time to climb, fuel to climb, level turning flight, gliding flight, energy maneuverability methods of optimal climb trajectories and turns, the aircraft operating envelope, take off analysis, balanced field length, landing analysis, fighter performance measures of merit, effects of wind on aircraft performance, initial technical report of baseline design analysis and evaluation, refined baseline design and report of specifications.

UNIT-V	COST ESTIMATION, PARAMETRIC ANALYSIS, OPTIMISATION, REFINED SIZING AND TRADE STUDIES	Classes: 10

Elements of life cycle cost, cost estimating method, RDT&E and production costs, operation and maintenance costs, cost measures of merit, aircraft and airline economics, DOC and IOC, airline revenue, breakeven analysis, investment cost analysis, parametric analysis and optimization, improved conceptual sizing methods, sizing matrix plot and carpet plot, trade studies, design trades, requirement trades, growth sensitivities, multivariable design optimization methods, measures of merit, determination of final baseline design configuration, preparation of type specification report. Case studies on design of DC-3 and Boeing B-707&747; General dynamics F-16, SR-71 Blackbird, Northrop-Grumman B-2 Stealth Bomber.

Text Books:

1. Raymer, D.P., Aircraft Design: A Conceptual Approach, 3rdedn., AIAA Education Series, AIAA, 1999, ISBN: 1-56347-281-0.
2. Howe, D., Aircraft Conceptual Design Synthesis, Professional Engineering Publishing, London, 2000, ISBN: 1-86058-301-6.
3. Fielding, J.P., Introduction to Aircraft Design, Cambridge University Press, 2005, ISBN: 0-521- 657222-9.

Reference Books:

1. E. Torenbeek, Synthesis of Subsonic Airplane Design, Delft University Press, New York, 1986.
2. E. H Bruhn, Analysis and Design of Flight Vehicles Structures, Jacobs Publishing House, USA, New Edition, 1973.
3. E. E Scheler, L.G Dunn, Airplane Structural Analysis and Design, John Wiley & Sons, USA, 1963.
4. D. Howe, Aircraft conceptual Design Synthesis‖, John Wiley and Sons Publishers, USA, 2005.

Web References:
1. http://www.arabiceng.com/?page=articles_file_download&id=80 2. http://a.moirier.free.fr/Conception/Bouquins/Torenbeek%20~%20Synthesis%20Of%20Subsonic%20Airplane%20Design.pdf
E-Text Books:
1. http://jntuaerobooks.blogspot.in/p/aero-3-2-books.html 2. https://uta-ir.tdl.org/uta-ir/bitstream/handle/.../WALKER_uta_2502M_12539.pdf 3. https://www.scribd.com/doc/220947115/Analysis-and-Design-of-Flight-Vehicle-Structures-by-E-FBruhn-pdf