FLIGHT VEHICLE DESIGN

VII Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB24	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

This course is designed to provide students an understanding of procedure followed in conceptual design of an aircraft, meeting the user-specified design requirements and safety considerations specified by the aircraft certification agencies. The course introduces theoretical basics of methods and models that are used in the conceptual airplane design and discusses the theoretical problem-solving skills related to analysis and design of flight vehicle structures. This course explains re-sizing and of a baseline civil transport aircraft to meet a specified market requirement.

II. OBJECTIVES:

The course should enable the students to:

I	The fundamental concepts of various aerofoil characteristics and blend the best suitable requirements for various applications designing in various applications.
II	Initial sizing of fuselage and tail plane design; static stability; structural loading; cost analysis; takeoff and landing; and specification of (T/W) ratio and wing loading (W/S).
III	The characteristics of stability and performance of an aircraft and the role of primary and secondary controls in longitudinal and lateral stability.
IV	The Conceptual designs of aerospace vehicles, components, missions, or systems that incorporate realistic constraints/applicable engineering standards.

III. COURSE OUTCOMES:

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

CO 1	**Choose** data collection for conceptual sketch from existing air craft for understanding aerodynamic & performance requirements.	Apply
CO 2	**Classify** rubber engine sizing of a given fighter aircraft for calculating the take -off weights in order so that the aircraft meets all set requirements.	Analyze
CO 3	**Make** use of airfoil geometry and co-ordinates for obtaining the required 3D model by using designer tools like catiaV5.	Apply
CO 4	**Simplify** the performance estimations involving design layout for calculating the variation of C L and CD at angle of attack.	Analyze
CO 5	**Estimate** take-off gross weight of simple cruise mission profile for calculating the empty weight fraction.	Evaluate
CO 6	**Identify** the total drags on an aircraft and calculate the total weight, thrust and drag for exit pressure and Mach number for the given nozzle configurations	Apply

IV. SYLLABUS:

MODULE-I	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.

MODULE-II	INITIAL SIZING AND CONFIGURATION LAYOUT	Classes: 09
Sizing with fixed engine and with rubber engine. geometry sizing of fuselage, wing, tail, control surfaces, 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-Haack volume distribution, structural load paths,radar, IR, visual detectability, aural signature, considerations of vulnerability, crashworthiness, producibility, maintainability, fuselage design, crew station, passengersand payload		
MODULE-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, centre of gravity excursion control.		
MODULE-IV	**BASELINE DESIGN ANALYSIS - II**	**Classes: 09**
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 and 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.		
MODULE-V	**COST ESTIMATION, PARAMETRIC ANALYSIS, OPTIMISATION, REFINED SIZING AND TRADE STUDIES**	**Classes: 07**
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. Daniel P. Raymer, “Aircraft Design: A Conceptual Approach”, AIAA Educational Series, USA, 4th Edition, 2006.
2. J. F. Marchman, L. R. Jenkinson, “Aircraft Design Projects for Engineering students”, AIAA Publishers, USA, 2003.
3. Ajoy Kumar Kunda, “Aircraft Design”, Cambridge University Press, UK, 2010.

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-F-Bruhn-pdf