GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170101
Semester –VII
Subject Name: Aircraft Design

Type of course: Professional Core

Prerequisite: Fundamentals of Aeronautical Engineering, Aerodynamics, Flight Mechanics, Aircraft Structure etc.

Rationale: Aircraft Design is one of the core areas in the field of aviation. The concepts of Aircraft Design are very important in core industry. As aeronautical industries are growing fast across the world because of needs of military and civil aviation applications. A student should be proficient enough to design aircraft and aircraft's components with structural and aerodynamic considerations.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No	Content	Total Hrs
1.	**Introduction of conceptual design of a flight vehicle design and Weight Estimation Process.** Aircraft purposes, Payload, cruise & Maximum Speed, Range, Endurance, take off and landing distance, design process, conceptual design. Determination of Fuel Fraction, Maximum Take Off Weight, Basic Empty Weight.	5
2.	**Wing loading, Thrust/ Weight selection, Wing and Fuselage Design** Wing loading effect on takeoff, landing, climb, acceleration, range, combat, flight ceiling & glide rate, Airfoil Selection, Wing Geometry, Biplane Wings, Tail geometry, Volume considerations of fuselage, Aerodynamic considerations of fuselage, and drag estimation.	6
3.	**Initial Sizing and Tail plane Sizing** Introduction, Rubber Engine Sizing, Fix Engine Sizing, Geometry Sizing, Control Surface Sizing, Airfoil selection Tail arrangement, horizontal and vertical tail sizing, tail plan form shape, Airfoil section type, tail placement.	7
4.	**Engine selection, Propulsion and Fuel System integration:** Propulsion selection, No's of engines, Engine ratings, turbojet engine sizing, propulsion system. Jet engine integration, Propeller engine integration, Fuel system.	6
5.	**Configuration Layout and Loft:** End products of configuration layout, Conic lofting, Conic fuselage development, Flat wrap fuselage lofting, Circle-To-Square adapter, Fuselage loft verification, Wing/tail layout and loft, Aircraft Layout Procedure, Wetted Area Determination, Volume Determination.	6

6.	**Special Considerations in Configuration Layout and Unique Aircraft Concept-** Aerodynamic considerations, Structural considerations, Radar detectability, Infrared detectability, Visual detectability, Aural signature, Vulnerability Considerations, Crashworthiness and Passenger compartment design considerations, Producibility considerations, Crew station/Cockpit design, Weapons carriage, Gun installation Cargo provision, Maintainability considerations. Various Jet VTOL and Prop VTOL configurations.	**7**
7.	**Landing Gears and Subsystems:** Landing Gear Arrangement, Tire Sizing, Shock absorbers, Castoring wheel geometry, Gear retraction geometry, Sea planes, Sub systems (Hydraulics, Electrical systems, Pneumatic System, Auxiliary/Emergency power, Avionics).	**6**
8.	**Weights: Introduction:** Approximate Group Weight Method, Statistical Group weight Method,	**2**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20%	**30%**	**20%**	**10%**	**--**	**20%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Aircraft design – A conceptual approach. Author: D.P. Raymer
2. Aircraft conceptual design analysis. Author: Denis Howe
3. Aircraft Performance and Design Author: John D. Anderson, Jr.
4. Synthesis of subsonic airplane design Author: E. Torenbeck Publisher: Delft Univ. Press 1977

Course Outcomes:

Upon completion of this course students should be able to:

Sr. No.	CO statement	Marks % Weightage
CO1	Make a layout and lofting of fuselage, wing and tail plane configuration after getting dimensions.	30%
CO2	Choose an engine of particular aircraft design and locate them in the aircraft designs.	30%
CO3	Design landing gear/ undercarriage and locate them with retraction geometry.	20%
CO4	Design Crew station, Passenger compartment, Cargo provisions, Weapons carriage bay, Gun installation etc.	20%

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List of Practical:

Important guidelines for practicals:

- **Student will choose any one of below mentioned aircrafts to design**.

A faculty will give different figure of Payload (in terms of lbs or number of passengers and cabin/cockpit crews), Cruising Altitude or Service Ceiling (in Ft), Cruise and Maximum speed (in Knots or Mach no.), Take off and Landing distance (In Feet or Meters), Elevation of airfield (In Feet), Range (in Nautical Miles), Endurance (in Hours and Minutes) etc. as per aviation terminology only. Keep drawing/ drafting as soon as you get dimensions.

1. Public Transport jet plane (Medium range or Long Range Jet Airliner)
2. Single engine – Home built. (Metal/Wood/Composite)
3. Twin engine – Home built.
4. Single engine piston prop-personal utility aircraft
5. Twin engine piston prop-personal utility aircraft
6. Twin engine turbo prop-personal utility/ Public/Cargo Transport aircraft
7. Powered Sailplane
8. Unpowered Sailplane (Glider)
9. Jet trainer
10. Jet fighter (Multirole, Interceptor, Dog fighter, Patrolling, Ground attack, Deep Penetration Strike etc)
11. Sea Plane
12. Unmanned Ariel Vehicle
13. Aerobatic Sports Plane (Single Engine Piston Prop,)
14. Utility/Aerobatic Biplane (Single Engine Piston Prop)
15. Ultra light / Micro light Aircraft
16. Radio Control (RC) Plane. (Single Engine, Piston Prop)
17. Radio Control (RC) Plane. (Single Engine, Jet)
18. Radio Control (RC) Sail Plane (Powered and Unpowered)
19. Or any other type of fix or variable sweep wing aircraft

List of practicals:

1. As per given data draw a flight envelope of aircraft and make a weight estimation. Estimate payload weight, empty weight, fuel weight, maximum take-off weight, maximum zero fuel weight.
2. Determine wing loading and thrust to weight ratio.
3. Determine wing geometry and airfoil selection. Determine Wing area, wing span, sweep back angle, root chord, tip chord, mean aerodynamic chord, wing twist and dihedral or anhedral angle. Draw in wing geometry in drawing sheet. Mention Geometric aerodynamic centre, neutral point and centre of gravity range.
4. Prepare Fuselage geometry. Determine fuselage length, fuselage width, empennage length, location of centre of gravity. Prepare cockpit geometry.
5. Configure tail plane and design horizontal and vertical stabilizers.
6. Select type and numbers of engine. Determine engine sizing and plot in the drawing sheet. Locate with reference to aircraft geometry.
7. Landing gear and Undercarriage sizing. Determine track and base distance. Draw retraction geometry.

8. Control surface sizing. Determine % of chord and % of span of all primary and secondary control surfaces.
9. Discuss your design with respect to Aerodynamic considerations, Structural considerations, Radar detectability, Infrared detectability, Visual detectability, Aural signature, Vulnerability Considerations, Crashworthiness considerations, Producibility considerations, Maintainability considerations.

List of Open Source Software/learning website:
https://nptel.ac.in/