GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150101
Semester –V
Subject Name:Flight Mechanics

Type of course: Professional Course

Prerequisite: Engineering Mechanics**,** Fundamentals of Aerodynamics

Rationale: Flight Mechanics characterizes the motion of a flight vehicle in the atmosphere**.** This course imparts basic knowledge related to aircraft performance, stability and control. This will help to design the propeller and jet airplane.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	1	0	5	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs	Weightage%
1	**Standard Atmosphere:** Definition of altitude, Geometric Altitude, Geo-potential Altitude, Absolute Altitude, The hydrostatic equation, Relation between geopotential and geometric altitudes, Definition of standard atmosphere, Pressure, Density & temperature altitudes	**06**	**10**
2	**Airplane Performance for Steady Flight**: Introduction, Equation of motion, Thrust required, Thrust available and maximum velocity, Power required, Power available and maximum velocity for jet engine and reciprocating engine-propeller combination, Altitude effect on power required and available, Stall and High lift devices, Climbing Flight, Gliding flight, Absolute and service ceilings, Time to Climb, Range & endurance for propeller driven airplane and jet engine driven airplane	**12**	**20**
3	**Airplane Performance for Accelerated Flight**: Level turn, Pull-up and Pull-down maneuvers, V-n diagram, Accelerated rate of climb: Energy method, Take-off Performance, Landing Performance.	**08**	**15**
4	**Basics of Stability and Control:** Definition of stability and control,importance of flight dynamics; forces acting on an airplane; degrees of freedom for a rigid airplane; subdivisions of flight dynamics	**06**	**5**
5	**Longitudinal Stick-fixed static stability and control::** Criteria for longitudinal static stability and control; contributions of wing, horizontal tail, fuselage and power to pitching moment coefficient (Cm_{cg}) and its derivative with respect to angle of attack ($C_{m\alpha}$) stick-fixed neutral point and static margin ; elevator angle for trim; limitations on forward and rearward movements of c.g. ; determination of neutral point from flight tests.	**12**	**20**
6	**Longitudinal stick-free static stability and control:**	**12**	**20**

	Hinge moment and its variation with tail angle, elevator deflection andtab deflection ; floating angle of elevator ; stick-free static stability andstick-free neutral point; stick force and stick force gradient and theirvariations with flight speed ; determination of stick-free neutral pointfrom flight tests. Elevator required in pull-up; stick-fixed maneuverpoint; stick force gradient in pull-up; maneuver point stick-free; overall limits on c.g. travel.		
7	**Static directional and lateral stability and control:** Directional stability, Directional control, Lateral stability, Roll Control	**04**	**10**

Suggested Specification table with Marks (Theory):

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

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. Stengel, R. F., Flight Dynamics, Princeton University Press, 2004.
2. Roskam, J., Airplane Flight Dynamics and Automatic Flight Controls, DAR Corporation, 1995.
3. Nelson, R. C., Flight Stability and Automatic Control, McGrawHill International, 1990.
4. Etkin, B. and Duffy, L. D., Dynamics of Flight: stability and control, John Wiley, NY 1995.
5. Perkins, C. D. and Hage, R. E., Airplane Performance Stability and Control, Wiley, New York, 1949.
6. Introduction to Flight by J D Anderson Jr., McGraw Hill, Inc
7. Aircraft Performance and Design by J D Anderson Jr., McGraw Hill, Inc

Course Outcomes:

Upon completion of this course students should be able to:

Sr. No.	CO statement	Marks % weightage
CO1	Define different types of altitudes and standard atmosphere.	10%
CO2	Apply engineering mechanics theory to evaluate airplane performance in steady and accelerated flight.	35%
CO3	Define different types of stability and control	05%
CO4	Analyze static longitudinal stability and control derivatives, and criteria for a stable airplane.	40%
CO5	Understand basic concepts of static lateral and directional stability and control.	10%

List of Tutorials:

1. Calculation of Pressure, Density and Temperature altitudes.
2. Estimation of Thrust required for steady level flight.
3. Estimation of Power required for steady level flight.
4. To study climbing flight.
5. To study gliding flight
6. Determination of Range and Endurance for propeller driven airplane.
7. Determination of Range and Endurance for Jet airplane.
8. To study Turning Flight.
9. Estimate takeoff & landing distance.
10. To study longitudinal stability and control.
11. To study directional stability and control.
12. To study lateral stability and control.

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