GUJARAT TECHNOLOGICAL UNIVERSITY

AERONAUTICAL ENGINEERING
SPACE DYNAMICS
SUBJECT CODE: 2180103
B.E. 8thSEMESTER

Type of course: Engineering Science

Prerequisite: Mechanics

Rationale: Exposure to basic aspects of Space Flight would be an advantage to the students of aeronautical engineering who want to pursue their further studies or career in the field of aerospace.

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)	
					PA	ALA	ESE	OEP		
3	0	0	3	70	20	10	0	0	0	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction** Definition of Space, Types of Space Vehicles, Newton's law of Gravitation, Gravitational potential energy,	3	10
2	**Particle Dynamics** Force and Momentum, Work and Energy, The Two-body problem, Central Force motion,Mechanics of Circular Orbits, Orbit equation, Geometry of Conic Sections, Kepler's laws, Energy balance in orbits, The Hohmann Transfer	9	30
3	**Attitude Dynamics** Introduction, Rigid body dynamics, Dual Spin Satellite, Attitude Control	12	30
4	**Reentry Dynamics** Introduction, Types of Entry Paths, Equation of Motion for Atmospheric entry, Application to Ballistic entry, Entry Heating, Lifting reentry with application to Space shuttle	12	30

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
35%	**25%**	**20%**	**15%**	**5%**	**0%**

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. Wiesel, William E., Spaceflight Dynamics, Tata McGraw Hill Publishing Company Limited, New Delhi.
2. Thomson, William T., Introduction to Space Dynamics, Dover Publication,Inc. New York.
3. J.D Anderson, Introduction to Flight

Course Outcome:

After learning the course the students should be able to:

1. Understand the basics of Orbital Mechanics
2. Full understanding of conic sections and fundamental orbit equations of motion
3. Understanding of the fundamentals of spacecraft attitude dynamics

List of Practicals:

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. Ultralight / Microlight 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.

Design based Problems (DP)/Open Ended Problem:

1. Make a model of a semimonocoque empennage structure of a jet transport aircraft with dorsal fin. Consider spin recovery.
2. Make a model of a taper-sweep back wing showing spar, trailing edge spar, kick spar, wing rib, stringers, skin, and man hole.

Major Equipments:

A0 Size of drawing sheet, Drawing Sheet Container, Ergonomic Drawing table, Set Square, Mini Drafter, A set of four drawing board clip, A set of French curves, 6B pencil (For better visibility only) (Clutch pencil is not preferable), Compass box, Circle Master, Rounder, Tailor's curve, 1/1.5/2 feet scales, 1'Roller Scale, Scientific Calculator, any other instruments required for engineering drawing.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be submitted to GTU.

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