INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad -500 043

DEPARTMENT OF AERONAUTICAL ENGINEERING

COURSE DESCRIPTION

Course Title	**INTRODUCTION TO SPACE TECHNOLOGY**			
Course Code	A42106			
Academic Year	2016-2017			
Course Structure	**Lectures**	**Tutorials**	**Practical's**	**Credits**
	5	-	-	4
Course Coordinators	C.Satya Sandeep : Assistant professor			
Team of Instructor	C.Satya Sandeep : Assistant professor			
Branch	II Year-II Semester Aeronautical Engineering			

I. COURSE OVERVIEW:

The Introduction to Space Technology Course will improvise their knowledge in space technology, space propulsion, space dynamics and space mission operations. Space craft and its components are exposed from the beginning as raw materials to the end of its operating life. This includes the assembling and test environment on earth, transportation from point to point on the earth, launch environment, the space environment and possibly an atmospheric entry and continued operations to the destination of another planet having different environment.To study about basic operations of both liquid and solid rocket engines and examining the technical issues pertaining to both liquid and solid rocket engines. This course helps in understanding the basics of rocket motion in 2D and 3D trajectories in space. Consequently study of single stage rocket and multistage rocket systems. Orbital maneuvering is based on the fundamental principle that an orbit is uniquely determined by the position and the velocity at any point. This course provides ability to know spacecraft attitude and ability to command a desired attitude. To study about descriptions of various activities performed by members of a space mission operation team over the course of a mission. Finally proven operations techniques frequently used in successful space operations are summarized.

II. PREREQUISITE(S):

Level	**Credits**	**Periods/Week**	**Prerequisites**
UG	**4**	**5**	Basics of space Technology

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam Marks	Total Marks
Mid Semester Test There shall be 2 mid-term examinations. Each mid-term examination consists of one objective paper, one subjective paper and two assignments. The objective paper is for 10 marks and subjective paper is for 10 marks, with duration of 1 hour 20 minutes (20 minutes for objective and 60 minutes for subjective paper). Objective paper is set for 20 bits of – multiple choice questions, fill-in the blanks, 10 marks. Subjective paper contains of 4 full questions (one from each unit) of which, the student has to answer 2 questions, each question carrying 5 marks. First mid-term examination shall be conducted for 1-2.5 units of syllabus. Second mid-term examination shall be conducted for 2.6-5 units. 5 marks are allocated for Assignments (as specified by the concerned subject teacher) – first two assignments should be submitted before the conduct of the first mid, and the second two assignments should be submitted before the conduct of the second mid. The total marks secured by the student in each mid-term examination are evaluated for 25 marks, and the better of the two mid-term examinations shall be taken as the final marks secured by each candidate	**75**	**100**

IV. EVALUATION SCHEME:

S.No	Component	Duration	Marks
1	I Mid examination	90 minutes	20
2	I Assignment	--	05
3	II Mid examination	90 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES:

1. To List and explain the characteristics and performance of aerospace propulsion systems.
2. To understand newly-conceived rocket or air breathing propulsion systems and estimate their performance and behavior.
3. To study basic Orbital elements, Attitude Control of Spacecraft and types of orbits.
4. To study Supporting Ground system architecture, Mission phases and core operations.
5. To explain the importance of launch vehicles, its performance and re-entry dynamics.

VI. COURSE OUTCOMES:

The student will be able to

1. Explain the different aspects of space technology.
2. Recognize different space mission types and the selection of launch vehicle required.
3. Understand the fundamentals of rocket propulsion.
4. Analyze different trajectories of rockets and missiles, their sizing and staging.
5. What is atmospheric re-entry? Explain different types of re-entry.
6. Explain the fundamentals of orbital mechanics of two body motion.
7. Write about basic orbital elements of circular, elliptic, hyperbolic orbits.
8. Describe various orbit changes, plane changes and orbital transfers.
9. Relate different satellite attitude control mechanisms for spinning, non-spinning, dual-spinning spacecraft's.
10. Explain the different space mission operations, ground system architecture and mission phases required.

VII. HOW COURSE OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO 1	Knowledge in fundamentals of mathematics, science and engineering.	H	Assignments
PO 2	An ability to identify, formulate and solve problems in key areas of Aerodynamics, Structures, Propulsion, Flight Dynamics and Control, Design, Testing, Space and Missile Technologies and Aviation of Aeronautical Engineering discipline	H	Assignments
PO 3	An ability to design and conduct experiments, analyze and interpret data related to various areas of Aeronautical Engineering.	H	Discussions
PO 4	An ability in conducting investigations to solve problems using research based knowledge and methods to provide logical conclusions.	H	Discussions
PO 5	Skills to use modern engineering and IT tools, software and equipment to analyze the problems in Aeronautical Engineering.	S	Assignments
PO 6	Understanding of impact of engineering solutions on the society to assess health, safety, legal, and social issues in Aeronautical Engineering.	S	Derivations
PO 7	The impact of professional engineering solutions in environmental context and to be able to respond effectively to the needs of sustainable development.	H	Discussions
PO 8	The knowledge of Professional and ethical responsibilities.	H	Discussions
PO 9	An ability to work effectively as an individual and as a team member/leader in multidisciplinary areas.	H	Derivations

PO 10	An ability to critique writing samples (abstract, executive summary, project report), and oral presentations.	S	Assignments
PO 11	Knowledge of management principles and apply these to manage projects in multidisciplinary environments.	H	Derivations
PO 12	The need of self-education and ability to engage in life - long learning.	S	Discussions

N-None **S-Supportive** **H-Highly Related**

VII. HOW PROGRAMME SPECIFIC OUTCOMES ARE ASSESSED

Program Outcomes		**Level**	**Proficiency assessed by**
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	H	Discussions
PSO 2	**Problem solving skills:** imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles	N	Discussions Assignments
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	S	Project
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats	H	

N-None **S-Supportive** **H-Highly Related**

IX. SYLLABUS:

INTRODUCTION TO SPACE TECHNOLOGY

UNIT-I FUNDAMENTALS OF ROCKET PROPULSION

Space Mission Types, Space Environment, Launch Vehicles Selection, Introduction to Rocket Propulsion, Fundamentals of Solid propellant Rockets. Fundamentals of liquid propellant rockets, Rocket equation, two dimensional trajectories of rockets and missiles, Vehicle Sizing, Multistage Rockets and Two Stage Rockets, trade of ratios- single stage to orbits, Sounding Rocket, Aerospace Plane, Gravity Turn Trajectories, Impact Point Calculation, Injection Conditions, and Flight Dispersions.

UNIT-II ATMOSPHERIC RE-ENTRY

Introduction to atmospheric re-entry vehicles, Steep Ballistic re-entry, Ballistic Orbital Re-entry, Skip Re-entry, Double Dip Re-entry, Aero Braking, Lifting Body Re-entry.

UNIT-III FUNDAMENTALS OF ORBITAL MECHANICS, ORBITAL MANUEVERS

Two-body motion- circular, Elliptical, Hyperbolic, Parabolic Orbits, Basic Orbital elements, Ground Trace, In plane Orbit Changes, Hohman Transfer, Bi Elliptical Transfer, Plane changes, Combined Maneuvers, Propulsion For Maneuvers.

UNIT-IV SATELLITE ATTITUDE DYNAMICS

Torque free axis symmetric rigid Body, Attitude Control for Spinning Spacecraft's, Attitude control for Non-Spinning spacecraft's, Yo-Yo Mechanism, Gravity Gradient satellite, Dual spin Spacecraft-attitude determination.

UNIT-V SPACE MISSION OPERATIONS

Supporting Ground system architecture and team interfaces, Mission phases and core operations, Team responsibilities, Mission diversity, Standard operations and practices.

TEXT BOOKS

1. "Spaceflight Dynamics", W.E. Wiesel, McGraw Hill, 1997.

REFERENCES

1. "Rocket Propulsion and Space flight dynamics", Cornelisse, Schoyer HFR and Wakker KF, Pitman, 1984.
2. Vincet L. Pisacane, "Fundamentals of Space Systems", Oxford University Press, 2005.
3. "Understanding Space: An Introduction to Astronautics", J.Sellers, McGraw Hill, 2000.
4. "Introduction to Space Flight", Francis J Hale, Prentice-Hall, 1994.
5. "Spacecraft Mission Design", Charies D.Brown, AIAA education Series, 1998.
6. "Elements of Space Technology for aerospace Engineers", Meyer Rudolph X, Academic Press, 1999.

Outcome The students shall be a quant himself with space technology

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1-2	**What** is space technology?	**UNIT-I FUNDAMENTALS OF ROCKET PROPULSION**	
3-4	**Describe** various mission types and the types of launch vehicle selected for each mission.	Space Mission Types, Space Environment, Launch Vehicles Selection,	T1
5-7	**Explain** different types of rocket propellants	Introduction to Rocket Propulsion, Fundamentals of Solid propellant Rockets. Fundamentals of liquid propellant rockets,	T1
8-10	**Derive** rocket equation and explain trajectories of rocket	Rocket equation, two dimensional trajectories of rockets and missiles,	T2
11-13	**Explain** rocket staging and its importance	Vehicle Sizing, Multistage Rockets and Two Stage Rockets,	T1
14-16	**Explain** launch vehicle types and their trajectories	trade of ratios- single stage to orbits, Sounding Rocket, Aerospace Plane, Gravity Turn Trajectories,	T1
17-20	**Explain** the injection condition of a rocket and flight dispersion	Impact Point Calculation, Injection Conditions, and Flight Dispersions.	T1
21	**Explain** atmospheric re-entry	**UNIT-II ATMOSPHERIC RE-ENTRY**	
22	**Describe** atmospheric re-entry vehicles in detail.	Introduction to atmospheric re-entry vehicles,	T1
23	**Explain** Steep Ballistic re-entry	Steep Ballistic re-entry	T2
24-25	**Discuss** Ballistic Orbital Re-entry	Ballistic Orbital Re-entry	T3
26-27	**Explain** Skip Re-entry, Double Dip Re-entry.	Skip Re-entry, Double Dip Re-entry,	T1
28-29	**Discuss** Aero Braking, Lifting Body Re-entrance	Aero Braking, Lifting Body Re-entry.	T1
30	**Discuss** fundamentals of orbital mechanics	**UNIT-III FUNDAMENTALS OF ORBITAL MECHANICS, ORBITAL MANUEVERS**	
31	**Explain** Two-body motion- circular in detail.	Two-body motion- circular,	T1
32	**Discuss** Two-body motion- Elliptical, Hyperbolic in detail	Elliptical, Hyperbolic	T1
33	**Describe** Two-body motion- Parabolic Orbits in detail	Parabolic Orbits	T2
34	**Explain** Basic Orbital elements	Basic Orbital elements	T1
33-34	**Explain** Ground Trace and In plane Orbit Changes	Ground Trace, In plane Orbit Changes	T1
35-37	**Discuss** Hohman Transfer, Bi Elliptical Transfer,	Hohman Transfer, Bi Elliptical Transfer,	T1

38-40	**Explain**Plane changes, Combined Maneuvers and Propulsion For Maneuvers	Plane changes, Combined Maneuvers, Propulsion For Maneuvers.	T1
41	**Explain**satellite attitude dynamics	**UNIT-IV SATELLITE ATTITUDE DYNAMICS**	
42-43	**Explain** Torque free axis symmetric rigid Body	Torque free axis symmetric rigid Body	T1
44-45	**Explain** Attitude Control for Spinning Spacecraft's	Attitude Control for Spinning Spacecraft's	T1
46-47	**Explain** Attitude Control for Non-Spinning Spacecraft's	Attitude control for Non-Spinning spacecraft's	T2
48-50	**Discuss** Yo-Yo Mechanism, Gravity Gradient satellite	Yo-Yo Mechanism, Gravity Gradient satellite	T1
51-53	**Determine** Dual spin Spacecraft-attitude	Dual spin Spacecraft-attitude determination	T1
54-55	**Discuss** space mission operations	**UNIT-V SPACE MISSION OPERATIONS**	
56-58	**Explain** Supporting Ground system architecture and team interfaces	Supporting Ground system architecture and team interfaces	T1
58-60	**Discuss** Mission phases and core operations	Mission phases and core operations	T1
61-63	**Explain** Team responsibilities, Mission diversity	Team responsibilities, Mission diversity	T2
64-66	**Discuss** space mission Standard operations	Standard operations and practices.	T1

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAMOUTCOMES:

Course	Program Outcomes												Program Specific			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
I	S	N	H	H	H	S	S	H	H	H	H	S	H	S	S	H
II	S	N	H	S	S	H	N	H	H	S	H	H	H	S	S	H
III	S	S	S	H	H	S	N	H	H	H	H	H	S	H	H	H
IV	S	N	S	H	H	H	H	S	H	H	S	H	H	S	H	H
V	S	H	H	S	H	S	H	H	S	H	H	H	H	H	S	H

S = Supportive **H = Highly Related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAMOUTCOMES:

COURSE OUT COMES	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	S	H	H	S	S	S	S	H	H	H	S	S	H	S	H	H
2	S	S	H	S	H	H	H	H	H	H	S	S	H	S	H	H
3	S	H	H	S	H	H	H	H	S	S	S	S	H	H	S	H
4	S	S	H	H	H	S	H	H	H	S	S	H	H	H	S	H
5	S	H	H	H	H	H	H	S	S	S	H	H	H	H	S	H
6	S	H	S	S	H	S	H	S	H	S	H	H	H	S	H	H
7	S	H	H	S	S	H	H	H	S	H	H	H	H	H	S	H
8	S	S	H	H	H	H	H	H	H	H	H	H	H	S	H	H
9	S	H	H	H	S	H	H	H	H	H	H	H	H	H	S	H
10	S	H	S	S	H	H	S	H	S	H	S	H	H	S	H	H

S = Supportive **H = Highly Related**

Prepared by:

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