AE 240, AE 240M & AE 713

Slot No. 3

Monday – 1035 to 1130

Tuesday – 1135 to 1230

Thursday – 0830 to 0925

Venue

Virtual

Instructor

Ashok Joshi

Introduction to the Subject

Space Fundamentals

Space has always been of keen **interest** to mankind as it is believed to **contain** information relevant to formation, existence and **continued** sustenance of our planet.

In this regard, **astrophysics**, which is an important **space science**, employs the principles of **physics** and **chemistry** to provide information about **nature** of space & objects.

Similarly, **astronomy,** an old natural **science**, provides information about **origin & evolution** of celestial objects e.g. planets, stars, galaxies etc. using **observed** data**.**

Concept of Space Exploration

However, as **terrestrial** instruments e.g. telescopes, have a **limited** reach**,** there is a limitation on the **amount** and quality of information **accessed** through such means.

Further, many **Earth** related activities e.g. communication, etc. **also** are also found to be **better** performed with instruments positioned at higher **altitudes.**

These have **resulted** in the concept of space-based **objects** to address both the terrestrial as well as **exploration** needs.

Course Plan

Broad Course Objectives

To **understand** fundamental principles governing **ascent** mission design including **configuration** design of launch vehicles.

To provide **exposure** to basic concepts of spacecraft **orbital** mechanics and interplanetary **travel**.

To **highlight** issues concerning entry**/reentry** phase and strategies to address these.

Ascent Trajectory

Introduction: Space missions and role of launch vehicles and spacecraft.

Ascent Mission: Objectives, mathematical models, rectilinear motion, effect of gravity and aerodynamic drag on the mission performance, gravity turn concept.

Rocket Configuration

Multi-staging: Basic concept, series staging formulation and solution, optimal staging concept, strategy and benefits of parallel staging.

Special Topics: Air-breathing and photonic rocket concepts, Rocket attitude stability and jet damping effect.

Spacecraft Orbital Mechanics

Orbits: Two-body problem & Kepler's laws, orbits from initial conditions, types of orbits, orbits in geographical context.

Operations & Manoeuvres: Orbit raising, Hohmann and low thrust transfers, orbit inclination / perigee change, fast transfers and launch window concepts, rendezvous and docking manoeuvres.

Inter-planetary and Reentry Missions

Interplanetary Missions: Interplanetary motion basics, non-Keplerian formulation and restricted three-body problem, departure and arrival solutions, gravity assist trajectories.

Reentry Mission: Concept of re-entry, orbit decay solution, ballistic, lifting and other reentry concepts.

Texts / References

Thompson, 'Introduction to Space Dynamics', Dover Publications, New York, 1986.

Hale, 'Introduction to Space Flight', Prentice Hall, 1994.

Wiesel, 'Spaceflight Dynamics', McGraw-Hill, 1997.

Curtis, 'Orbital Mechanics for Engineering Students', 2nd Ed., Elsevier, 2010.

Walter, 'Astronautics: The Physics of Space Flight', Wiley-VCH, 2012.

Pre-requisites

Course does not have any formal pre-requisites.

However, good **familiarity** with basic Newtonian **mechanics** and mathematical **/** numerical **techniques** for solving differential equation, is **desirable.**

Further, some **understanding** of basic aerodynamics and **propulsion,** as applicable to space vehicles, will be **useful.**

Evaluation & Attendance Policies

1 Assignment	- 20% (**Written**, Viva, Upload on Moodle)
2 Quizzes	- 20% (**Written**, Upload on Moodle)
Mid-semester	- 20% (**Written**, Upload on Moodle)
Class Tests	- 20% (**MCQ**, Through Moodle)
End-semester	- 20% (**Written**, Upload on Moodle)

No DX grade

Audit based on minimum **passing** marks.

Compensation Policy

Missed class tests will **not** be compensated. However, only best **80%** of all class tests will be **counted** towards the 20% weightage.

Missed quizzes & mid-semester**,** for **medical** and other compelling **reasons** e.g. long duration internet **glitches**, power cuts etc., will be **compensated** as deemed fit**.**

Compensation for missed **end-semester** will be as per the institute **rule.**

Course Delivery Mechanism

Course will be **conducted** mainly through **Moodle**.

Lecture **slides** pertaining to each **week** will be uploaded on Moodle at the **start** of the week.

Class hours will be used for **discussion** on lectures, clarifications of **doubts**, problem solving and class tests.

Google Meet will be used as the **VC** platform for class **hours**, whose recordings would be **available** through link posted on **Moodle**.

All exams, including class **tests**, will be proctored.