

Indian Institute of Technology, Kanpur

Proposal for a New Course for Undergraduate studies

1. Course No: 4XX
2. Course Title: **Introduction to Space Technology**
3. Per Week Lectures: 3(L), Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours[0-2]:2 (A), Credits ($3*L+2*T+P+A$): 9, Duration of Course: Full Semester

4. Proposing Department/IDP : Space, Planetary & Astronomical Sciences & Engineering (SPASE)

Other Departments/IDPs which may be interested in the proposed course:

Other faculty members interested in teaching the proposed course:

5. Proposing Instructor(s): Soumyabrata Chakrabarty and Pankaj Jain

6. Course Description:

A. Objectives: The objective of this course is to introduce the students from interdisciplinary Engineering streams to various topics of Space Technology which are imperative for the design, development, operation, and application of a spacecraft system.

- B. Contents (*preferably in the form of 5 to 10 broad titles*):

S No.	Broad Title	Topics	No. of lectures
1	Introduction	Recapitulation of the basic concepts related to Earth's atmosphere, ionosphere, spacecraft orbits, earth's radiation belts etc.	2
2	Basics of launch vehicle design & Missiles	Injection into orbit with a conventional launcher, transfer phase, Hohmann transfer orbit, geosynchronous transfer orbit, positioning phase, different types of launchers: basic principles, specific impulse, rocket equation, Indian launch vehicles; elements of SLV, ASLV, PSLV, GSLV, SSLV, RLV.	5
3	Guidance, Navigation & Control (GNC)	The fundamental concepts of GNC systems for spacecraft, Analysis of spacecraft trajectories and attitude, design and evaluation of control laws for stability and performance, familiarization with sensors and actuators used in GNC systems, practical aspects of implementation in space missions	4
4	Fundamentals of mission trajectory design	Coordinate reference frames, space flight mechanics and attitude dynamics, Attitude parameterization (direction cosine matrix, Euler axis and angles, quaternions, Euler angles), attitude rates, attitude determination, Euler equation and attitude dynamics	3
5	Different segments of an artificial satellite	Space segments, power system, attitude and orbit control system, station keeping, thermal control, TT&C subsystem, payloads, propulsion system; earth segments; receive-only home TV systems, transmit-receive earth stations, large earth stations.	4

	Materials for Spacecrafts	Overview of the space environment, Effects of vacuum, microgravity, radiation, and thermal cycling, atomic oxygen and micrometeoroid impacts, Launch and re-entry stresses; key material properties: Mechanical: strength, stiffness, toughness, Thermal: conductivity, expansion, resistance, Electrical: conductivity, dielectric strength, Radiation resistance; Criteria for material selection in spacecraft design, mass minimization and structural efficiency, Space qualification of spacecraft material and tests matrices	6
6	Navigational Satellite System	Introduction to Satellite Navigation, Basic Concepts of Satellite Navigation, Global Navigation Satellite Systems (GNSS), IRNSS/NavIC, GPS, GLONASS, Galileo, BeiDou	3
7	Satellite Data and Image Processing	Fundamentals of satellite digital image processing, fundamentals photogrammetry, cartography, microwave radar imaging system	4
8	Basics of remote sensing Satellites, Data acquisition and applications	Definition and overview of satellite based remote sensing systems: Electromagnetic radiations, laws of radiation, EM spectrum, sources of EM Radiation, interaction between EM radiation and matter, reflection, absorption and transmission, Interaction between EM radiation and atmosphere, atmospheric windows. Different platforms types: Airborne and spaceborne: satellites for earth observations. Different types of sensors and its applications.	4
9	Space Laws and Policy	Introduction to the need and overview of all aspects of space laws and its interface with international conventions and treaties, introduction and basic principles of international law, Indian space bill and space policy 2022, Space-enabled Communication and services regulation, space tourism,	4

C. Pre-requisites: Not Applicable.

D. Short summary for including in the Courses of Study Booklet: Basics of satellite Space environment and its orbit, Basics of launch vehicles, Rocket equation, remote sensing satellite systems, Fundamental concepts of Guidance, Navigation & Control (GNC), Spacecraft trajectories and attitude, Fundamentals of mission trajectory design, different segments of a satellite system, Materials for Spacecrafts, Navigational Satellite System, Satellite Data and Image Processing, satellite data products, space laws and policies.

7. Recommended books:

Textbooks:

- Pratap Misra & Per Enge, Global Positioning System: Signals, Measurements, and Performance, Ganga-Jamuna Press.
- Edberg, D., and Costa, W., Design of Rockets and Space Launch Vehicles, AIAA Education Series, 2020

- Kadam, N. V., Practical Design of Flight Control Systems for Launch Vehicles and Missiles, Allied Publishers, 2009
- Wiesel, W. E., Spacecraft Dynamics, 2nd ed, McGraw-Hill 1997
- Noton, M., Spacecraft Navigation and Guidance, Springer 1998
- Charles Elachi, Jakob van Zyl, 'Introduction to the Physics and Techniques of Remote Sensing' John Wiley & Sons, Inc., Hoboken, New Jersey, 2006.
- Fawwaz t. Ulaby Richard K. Moore Adrian k. Fung 'Microwave Remote Sensing: Active and passive', Vol. 1, Artech House, 1981
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Reference Books:

- Iain H. Woodhouse, 'Introduction to Microwave Remote Sensing', CRC Press, Taylor & Francis Group, 2006.
- Alan C. Tribble, 'The Space Environment: Implications for Spacecraft Design', Princeton University Press, Princeton New Jersey, 2003.
- Gerard Maral, Michel Bousquet, 'Satellite Communications Systems, Systems, Techniques and Technology' John Wiley & Sons Ltd, 2009

8. Any other remarks:

S. B. Chakrabarty

Pankaj Jain

Dated: 05.08.2025 Proposer: Soumyabrata Chakrabarty and Pankaj Jain

Dated: 30-09-2025 DUGC/DPGC Convener: *Robert*

The course is approved / not approved

Chairman, SUGC/SPGC

Dated: _____