Indian Institute of Technology, Kanpur

Proposal for a New Course for Undergraduate studies

1. Course No:

2. Course Title: Introduction to Space Science and Technology

3. Per Week Lectures: 3(L), Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours[0-2]:0 (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

6. Course Description:

   A. Objectives: The objective of this course is to introduce the students from interdisciplinary Engineering and science streams to the fundamentals of the science and Engineering topics related to manmade orbital satellites and its environment.

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

S No.	Broad Title	Topics	No. of lectures
1	Introduction to Space Environment	Orbital Spacecraft and the ambient space environment, interactions between the environment and a spacecraft, solar wind, the magnetosphere, geomagnetic substorms, the auroral region, the radiation belts, relevance of the space plasma environment on spacecraft charging; spacecraft charging, spacecraft potential, electron and ion fluxes, current and potential equilibrium, spacecraft charging in Maxwellian plasma.	7
2	Orbits and its dynamics	Keplerian orbits, Kepler's laws, Newton's law, relative movement of two-point bodies, orbital parameters, subsatellite path, apogee, perigee, the earth's orbit, earth–satellite geometry, eclipses of the sun, sun–satellite conjunction, useful orbits for satellite applications, elliptical orbits with non-zero inclination, geosynchronous elliptic orbits with zero inclination, geosynchronous circular orbits with non-zero inclination, sub-synchronous circular orbits with zero inclination, geostationary satellite orbits, sun-synchronous orbit, orbit perturbations.	8
3	Launch vehicles	Injection into orbit with a conventional launcher, transfer phase, Hohmann transfer orbit,	3

		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.	
4	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
5	Reliability of satellite systems and its application	introduction to reliability for satellite systems to operate in space environment. Application of satellites in Communication, Navigation, remote sensing, outer space exploration.	5

C. Pre-requisites: Not Applicable.

D. Short summary for including in the Courses of Study Booklet: The aim of this course is to introduce the students from interdisciplinary Engineering and science streams to the fundamentals of the science and Engineering topics related to man-made orbital satellites. The students will learn about the space environment and effects on the spacecrafts, different earth's orbits and the dynamics, plasma environment, orbital dynamics, satellite charging, launch vehicles, different segments of a satellite system, reliability of satellite systems, applications of different types of satellites. The course is targeted for all engineering and science disciplines.

7. Recommended books:

Textbooks:

- Pankaj Jain, 'An introduction to astronomy and astrophysics' CRC Press, Taylor and Francis Group, 2015
- Max Jammer, 'Concepts of Space The History of Theories of Space in Physics' Dover Publications, Inc. 1993
- Shu T. Lai, 'Fundamentals of Spacecraft Charging: Spacecraft Interactions with Space Plasmas' Princeton University Press, 2012.
- Gerard Maral, Michel Bousquet, 'Satellite Communications Systems, Systems, Techniques and Technology' John Wiley & Sons Ltd, 2009
- Dennis Roddy, 'Satellite Communications' McGraw-Hill, 2001

Reference Books:

- Shu T. Lai, 'Spacecraft Charging' American Institute of Aeronautics and Astronautics, Inc., 2011
- Travis S. Taylor, 'Introduction to Rocket Science and Engineering', CRC Press, 2017
- Patrick D. T. O'connor, Andre Kleyner, 'Practical Reliability Engineering', 2 John Wiley & Sons, Ltd, 2012.
- Iain H. Woodhouse, 'Introduction to Microwave Remote Sensing', CRC Press, Taylor & Francis Group, 2006.

8. Any other remarks:

Dated:25.12.2023 (Revised on July 29, 2024) Proposer: Soumyabrata Chakrabarty

Dated:_____ DUGC/DPGC Convener:_____

The course is approved / not approved

Chairman, SUGC/SPGC

Dated:_____