Indian Institute of Technology, Kanpur

Proposal for a New Course for Undergraduate studies

1. Course No: SPA 402

2. Course Title: Introduction to Manmade Satellite System and its Environment

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 Astronomy and Space Physics	The concept of space in modern science, a tour of the universe, planets, stars, galaxies, scales and dimensions, constellations, earth, sun, and solar system, retrograde motion of planets, sidereal time.	5
2	Space Environment	Spacecraft orbits 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.	5

3	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
4	Launch vehicles	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.	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
6	Reliability of satellite systems	introduction of reliability, failure rate, the probability of survival or reliability, failure probability or unreliability, mean time to failure, mean satellite lifetime, reliability during the wear-out period, satellite system availability, subsystem reliability.	3
7	Application of artificial satellites	Communication satellite, uplink, downlink and overall link performance, Intersatellite links, frequency allocations, different types of transponders; bent pipe payloads, regenerative payloads, navigation satellite; space segment, control segment, user segment; remote sensing satellite; different types of remote sensing satellites, microwave payloads; optical payloads Interplanetary satellites.	6

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 manmade orbital satellites. The students will learn about solar system with emphasis of earth in space and its orbits, 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 Proposer: Soumyabrata Chakrabarty

Dated:_____ DUGC/DPGC Convener:_____

The course is approved / not approved

Chairman, SUGC/SPGC

Dated:_____