INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: **Centre for Space Science and Technology**

1. Subject Code: **SSC-501** Course Title: **Introduction to Space Science**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory 3** **Practical 0**

4. Relative Weightage**: CWS:10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: PCC**

8. Prerequisite**: NIL**

9. Objective: **To familiarize students with the basics of terrestrial and planetary atmosphere & geology**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Planetary Atmosphere and Ionosphere:** Physics of the atmosphere - classification of atmosphere based on temperature and pressure, hydrostatic equation, hypsometric equation. Atmospheric constituents – major and minor, role of ozone and other trace constituents, evolution of the atmosphere. Variation of temperature, density, ionization and pressure with altitude – defining regions of an atmosphere, Atmospheres of different planets, Ionosphere as plasma, Concept of Plasma, Chapman theory of layer production, formation of ionosphere, airglow and auroral emissions, measurements of ion and electron densities using ground based and space borne techniques.	**16**
2.	**Solar Radiation & Space Weather:** Components of solar radiation, solar wind, Parker solar wind theory, frozen-in magnetic field, interaction of solar wind with Earth's magnetic field and formation of magnetosphere, interplanetary magnetic field (IMF), geomagnetic storms, Van-Allen radiation belts, plasmasphere, coronal holes, CMEs, solar flares, satellite observations of various components of space weather and plasma instabilities, Role of the Indian Aditya-L1 mission	**12**
3.	**Planetary Processes in the Solar System:** Origin of the Solar System, Origin of the elements, Condensation and accretion in the solar nebula, Classification of planetary bodies, Formation models, Evidence of early solar system evolution from meteorites, asteroids and comets, Planetary processes, Tectonics and structures, Heat sources and heat transfer, Volcanism in the solar system, Melting and magmatism, Mechanics of eruption of Lava flows, and resulting planetary volcanic	**14**

	features, Impact Cratering, cratering mechanics, Ejecta deposits, Relative cratering rates and crater retention, Dating planetary surfaces with impact craters, Regolith, weathering, and surface texture, Geophysics of the Terrestrial Planets, Structure, mineralogy and thermochemical evolution of planetary interiors, Comparative Planetology, Space based observations and laboratory analysis, Role of the Indian Chandrayaan missions	
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	Mark Hans, "Space Science and Technology", John Wiley and Sons.	**2003**
2.	Emilio Chuvieco (Editor), Alfredo Huete (Editor), "Fundamentals of Satellite Remote Sensing, Taylor & Francis	**2009**
3.	K. N. Raja Rao, "Fundamentals of Satellite communications", Prentice-Hall of India Pvt. Ltd.	**2006**
4.	Verger E T, "The Cambridge Enclyopedia of Space, Missions, Applications and Exploration", Cambridge University Press	**2003**
5.	Uberoi C. and Chaicravorty S.C., "Space Environment and it's Interaction With Spacecraft", USc-ISRO Educational Program.	**2000**
6.	Hans Marl., Silveira, Yarymovych Michael I Milton., '"Encyclopedia of Space Science and Technology", Hoboken, Wiley-Interscience.	**2003**
7.	Garner, John T., Gones, Macolam, "Satellite Operations, Systems Approach to Design and Control", Ellis Horwood.	**1990**
8.	Kaula, William M, "Theory of Satellite Geodesy Applications of Satellite Geodesy", Mineola Dover Publications.	**2000**
9.	Chen F F, "Introduction to Plasma Physics**"**, Plenum Press New York.	**1990**
10.	Rossi, A. P., & Van Gasselt, S. (Eds.). (2018). Planetary geology (pp. 1-414). Cham, Switzerland: Springer International Publishing	**2018**
11.	Faure, Gunter, and Teresa Mensing. Introduction to planetary science. Berlin/Heidelberg, Germany: Springer, 2007.	**2007**
12.	Melosh, H.J., 2011. Planetary surface processes (Vol. 13). Cambridge University Press	**2013**

List of practicals:

- Study of atmospheric attenuation
- Determination of aerosol size distribution in the air
- Determination of metallic content in liquid using flame photometer
- Investigation of planetary materials using a range of analytical techniques
- Investigation of planetary materials- hand specimens

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Centre for Space Science and Technology

1. Subject Code: SSC 503 **Course Title**: Experimental techniques for space exploration

2. Contact Hours: L: 3 T: 0 P: 2

3. Examination Duration (Hrs): Theory: 0 | 3 **Practical**: 0 | 0

4. Relative Weightage: CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 00

5. Credits: 0 | 4 **6 Semester:** Autumn

7. Pre-requisite: Nil 8. Subject Area: PCC

9. Objective: To provide an understanding of different experimental techniques used in space science

10. Details of the Course:

S. No.	Contents	Contact Hours
1.	**Fundamentals of Spectroscopy:** Interaction of radiations with matter, Absorption, Emission, Absorbance and reflectance, Atomic and molecular spectra, Allowed and forbidden transitions, Factors affecting the transitions	4
2.	**Principles and Applications of Different Spectroscopic Methods:** Microwave spectroscopy, Infrared spectroscopy, Raman spectroscopy, Electronic spectroscopy, Photo-electron spectroscopy, Mass spectroscopy, Laser-induced breakdown spectroscopy, laser ablation ionization mass spectrometer.	14
3.	**Advanced Spectroscopic Techniques for Space Exploration**: Review of Spectrometer used in earlier missions, Design strategies, Spectral database, Data acquisition, Analysis, Applications and limitations.	10
4.	**Nuclear Radiation and Instrumentation in space**: Nuclear radiation in space exploration, sources of nuclear radiation in space, interaction of radiation with matter, basic properties of detectors, gas detectors, scintillation detectors, semiconductor detectors, response of detectors for space radiation, pulse processing modules for radiation detection, radiation risks, radiation-induced effects in materials, space radiation shielding	14
	Total	42

11. Suggested Books:

Sl. No.	Name of Books / Authors	Year of Publication
1.	Banwell, C.N., McCash, E.L.M.,"Fundamentals of Molecular Spectroscopy", 4th Ed. McGraw-Hill N. Y.	2017
2.	Pavia, D. L., Lampman, G. L., G. S. Kriz, Introduction to Spectroscopy, 5th Ed. Cengage India Pvt. Ltd.	2015
3.	Hollas, J. M. Modern Spectroscopy, 4th Ed. John Wiley & Sons. Ltd.	2004
4.	Miziolek, A. W. Palleschi, V., Schechter, I. Laser-Induced Breakdown Spectroscopy-Fundamentals and Applications, Cambridge University Press.	2009
5.	Demaison, J., Sarka, K., Cohen, E. A., Spectroscopy from Space, NATO Science Series, Springer-Science-Business Media	2001
5.	National Research Council, *Managing Space Radiation Risk in the New Era of Space Exploration*. Washington, DC: The National Academies Press.	2008
6.	Knoll G. F., Radiation Detection and Measurements, 4th Edition, John Wiley & Sons.	2010

Experiments (Some of the experiments need several turns)

1. Plateau characteristics of G. M. Counter
2. Statistical nature of nuclear radiation using G. M. Counter
3. Absorption coefficient of materials for beta and gamma rays using G. M. Counter
4. Energy calibration of scintillation detector for gamma rays using SCA & MCA
5. Analysis of molecules using different spectroscopic methods
6. Data acquisition of interstellar molecules from different databases
7. Simulation and analysis of spectral data in different environments

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Centre for Space Science and Technology

1. Subject Code: SSC-505 **Course Title**: Launch Vehicle Technology

2. Contact Hours: L: 3 T: 1 P: 0

3. Examination Duration (Hrs): Theory: 0 3 **Practical**: 0 0

4. Relative Weightage: CWS: 20-35 PRS: 00 MTE: 20-30 ETE: 40-50 PRE: 00

5. Credits: 0 4 **6 Semester:** Autumn

7. Pre-requisite: Nil **8. Subject Area:** PCC

9. Objective: To provide an understanding of various launch vehicle technologies

10. Details of the Course:

S. No.	Contents	Contact Hours
1.	Introduction to Space Technology – Basics of rocketry, propulsion, aerodynamics, pyro systems, control and guidance, inertial and navigation, telemetry and telecommand, ground based support systems, emerging trends including atmospheric reentry and human space flights	6
2.	Materials and Manufacturing – selection criteria for materials for space applications, structural materials, high temperature materials, functional materials, additive and near net manufacturing, testing for space worthiness, emerging trends	12
3.	Mechanical Structures and Systems –Stage and interstage structures, auxiliary system, ground based systems, precision and advanced fabrication techniques, emerging trends	12
4.	SATCOM concept and basics, Beacons, Communication between ground station (GS) and LV, antenna for GS, telecommand, tracking and control (TTC), Radiometers.	12
	Total	42

11. Suggested Books:

Sl. No.	Name of Books / Authors	Year of Publication
1.	A. Sivathanu Pillai, "Introduction to Rocket Science and Space Exploration, CRC Press,	2022
2.	Adrian P. Mauritz, "Introduction to aerospace materials", Woodhead Publishing Limited,	2012
3.	Charles D Brown, "Spacecraft Propulsion", AIAA Education Series	1996
4.	Book: Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Sons.	

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Centre for Space Science and Technology

1. Subject Code: SSC-507 **Course Title**: Satellite System Technology

2. Contact Hours: L: 3 T: 0 P: 2

3. Examination Duration (Hrs): Theory: 0 | 3 **Practical**: 0 | 0

4. Relative Weightage: CWS: 10-25 PRS: 25 MTE: 15-25 ETE: 30-40 PRE: 00

5. Credits: 0 | 4 **6 Semester:** Autumn

7. Pre-requisite: Nil 8. Subject Area: PCC

9. Objective: To provide an understanding of satellite system technology

10. Details of the Course:

S. No.	Contents	Contact Hours
1.	Elements of satellite system architectures: Different classes of satellite systems: communication satellites, navigational satellites, remote sensing satellites; Satellite subsystems; Attitude and Orbit control system; Tracking, telemetry, Power system; Communication Transceiver system; Transponder; Satellite Antennas	**10**
2.	Orbits and Launchers: Orbital Mechanics; Equation of the Orbit; Kepler's Three laws; Look angle determination, Orbital Elements; Apogee and Perigee Heights; Orbital perturbation, Orbit Determination; Launch vehicles, Orbital effects in Communication system performance	**10**
3.	Satellite Link Design: Basic transmission theory; system noise temperature and G/T ratio, Design of Downlinks; Link budget; Uplink design; effects of rain	**10**
4.	Modulation, Multiplexing and Multiple Access Techniques: Analog transmission and Analog modulation techniques; Digital transmission and digital modulation technique; Multiple access techniques: FDMA, TDMA, and CDMA	**9**
5.	Satellite Services: Direct broadcast TV and Radio; Satellite Navigation and Global positioning system; Satellite based mobile communication	**3**
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books / Authors	Year of Publication
1.	Timothy Pratt, Charles Bostian, and Jeremy Allnutt, "Satellite Communication" John Wiley & Sons, 2nd Edition	2003
2.	W. A. Imbriale, S. Gao, and L. Boccia, "Space Antenna Handbook," John Wiley & Sons., 1st Edition.	2012
3.	D. Roddy, "Satellite Communications," McGraw-Hill, Third Edition	2006

4.	L. Ippolito Jr., "Satellite Communications System Engineering – Atmospheric Effects, Satellite Link Design and System Performance," John Wiley & Sons.	2008
5.	Wilbur L. Pritchard, Henri G. Suyderhoud, and Robert A. Nelson"Satellite Communications System Engineering" Pearson, Second Edition	2016