INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

SATELLITE COMMUNICATIONS								
V Semester: ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AECD25	**Elective**	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Analog and Digital Communications								

I. COURSE OVERVIEW:

Satellites form an essential part of telecommunications worldwide. This course will cover the fundamentals of satellite communications, LEO satellites, MEO satellites, GEO satellites, and orbits. Transponders on communication satellites, link budget calculations, multiple access techniques and the propagation of radio waves through the earth's atmosphere. This course also covered the growth of VSAT systems and internet packet communications in satellite.

II. COURSES OBJECTIVES:

The students will try to learn

I. The basics of orbital mechanics, the types of satellite orbits, the location of ground stations, and the look angles from ground stations to the satellite.

II. Organization of communications between a satellite and a ground station (TTC and M, payload, data and channels), basic analysis of link budget and examples of calculations.

III. The application of the satellite communication in the fields of multi spectral remote sensing, resource management and mineral exploration.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1 Explain the fundamental concepts of satellite communication, including orbital parameters, types of satellite orbits (LEO, MEO, GEO), and orbital mechanics.

CO2 Describe various subsystems of a communication satellite, perform link budget calculations, and analyze propagation impairments such as rain attenuation and atmospheric absorption.

CO3 Compare and contrast multiple access techniques such as FDMA, TDMA, CDMA, and evaluate their suitability for different satellite communication scenarios.

CO4 Understand the components and functioning of earth stations and VSAT systems, including transmitter/receiver design, antenna systems, and NGSO constellation architecture.

CO5 Analyze satellite packet communication techniques like ALOHA and satellite switching methods, and assess their performance in data transmission applications.

CO6 Explore modern advancements in satellite communication, including laser communication, satellite mobile services, remote sensing systems, and satellite-based navigation (GPS) and their applications.

IV. COURSE CONTENT:

MODULE - I: COMMUNICATIONS SPACECRAFT AND ORBITS (10)
Definition, Basic Principles, Orbital parameters, overview of present and future trends of satellite communications introduction to satellite systems: Low earth orbit (LEO); Medium earth orbit (MEO); Geo synchronous earth orbit (GEO); Geostationary earth orbit (GEO); Orbital mechanics: Orbital elements; Orbital elements; Locating the satellite with respect to the earth; Coverage angle; Slant range; Inclined orbits; Orbital perturbations due to earth's oblateness and moon and sun; Eclipse of GEO satellite; Sun transit outage.

MODULE –II: SPACE SEGMENT (09)
Placement of a communication satellite in GEO satellite sub systems: Telemetry, tracking and command system, power system, satellite antenna equipment, communications subsystem and transponders, TWT amplifier operation, satellite frequency bands and allocations; Satellite link: Basic transmission theory, system noise temperature and G/T ratio, basic link analysis, design of satellite links for a specified C/N with and without frequency Re-use, link budget; Propagation effects: Introduction, atmospheric absorption, cloud attenuation,

troposphere and ionospheric scintillation and low angle fading; Effects of rain: Rain induced attenuation, rain induced cross polarization interference.

MODULE –III: COMMUNICATION SATTELLITE ACCESS SYSYTEMS (10)
Multiple Access: Frequency division multiple access (FDMA), Time division multiple access (TDMA), frame structure, burst structure, satellite switched TDMA, on-board processing, demand assignment multiple access (DAMA), types of demand assignment, characteristics.

Code Division Multiple Access (CDMA) / Spread Spectrum Multiple Access (SSMA): Direct sequence CDMA (DS-CDMA) or DS spread spectrum transmission and reception, adjacent channel interference, inter modulation, handover, satellite diversity.

MODULE –IV: EARTH STATION AND VSAT SYSTEMS TECHNOLOGY (09)
Earth Station: Transmitters, receivers, antennas, tracking systems, terrestrial interface, power test methods, lower orbit considerations; VSAT (Very Small Aperture Terminal) Systems: Overview of VSAT systems, VSAT network architecture, access control, multiple access selection. NGSO constellation design: Orbits, coverage, frequency bands, delay and throughput, no geostationary orbit NGSO) constellation design and problems.

MODULE –V: SATELLITE PACKET COMMUNICATION (10)
Message transmission by FDMA: M/G/1 queue, message transmission by TDMA, pure aloha, satellite packet switching, slotted aloha, packet reservation, tree algorithm; Over view of future satellite communication systems, introduction to satellite laser communication, data relay communication satellites, satellite mobile services, applications. Classification of remote sensing systems, orbits, Payloads, Types of images: Image Classification, Interpretation, Applications. Development of Satellite Navigation Systems, GPS system, Applications

V. TEXT BOOKS:

1. Dennis Roddy, "Satellite Communications", 2nd edition, 2004.
2. Pratt. Bostian, Allnutt, "Satellite Communications", Wiley India, 2nd edition, 2006.
3. Gérard Maral, "Satellite Communication Systems", 1993.

VI. REFERENCE BOOKS:

1. M. Richharia - Satellite Communications: Design Principles, 2nd edition, BS Publications, 2003.
2. D.C Agarwal - Satellite Communication, 5th edition, Khanna Publications,
3. K.N. Raja Rao - Fundamentals of Satellite Communications, PHI, 2004
4. Dennis Roddy - Satellite Communications, 4th edition, McGraw Hill, 2009.

I. ELECTRONICS RESOURCES:

1. NPTEL: Satellite Communications
2. NPTEL: SLC
3. https: //nptel.ac.in/courses/104104085
4. NPTE: https://archive.nptl.ac.in
5. NPTE: Fundamentals of Satellite Communications

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation