

EE-452 Satellite Communication Systems(3-0)

Course Information

Course Number and Title:	EE-452 Satellite Communication Systems
Credits:	3+0
Instructor(s)-in-charge:	
Course type:	Lecture
Required or Elective:	Elective
Course pre-requisites	EE-351 Communication Systems -1
Degree and Semester	
Month and Year	

Course Schedule

Lecture:	3 hrs/week, Meets twice weekly
Discussion:	1 hrs/week
Office Hours :	3 hrs/week by the instructor

Course Assessment

Exam:	1 Mid Term and 1 Final Examination	
Homework:	3 Assignments	
Quizzes:	3 Quizzes	
Grading	Quizzes:	10%
	Assignments:	10%
	Mid Term	30%
	Final Exam:	50%

Course book and Related Course Material

Textbooks:	<p>Satellite Communications Systems: Systems, Techniques and Technology, 6th Edition, Gerard Maral, Michel Bousquet, Zhili Sun (Contributing Editor), Wiley Publications. (avail in lib)</p> <p>Satellite Communications Systems Engineering Atmospheric Effects, Satellite Link Design and System Performance by Louis J. Ippolito, Jr., 2nd edition, Wiley publications. (ebook 2008 avail in lib)</p>
Reference Books:	<ol style="list-style-type: none"> 1. Satellite Communications, 4th Edition by Dennis Roddy, McGraw Hill Publications (ebook). 2. The Satellite Communication Applications Handbook by Bruce R. Elbert, 2nd Edition, Artech House Publications.

Course Descriptions

The satellite communication system course aims to teach students regarding the engineering and commercial aspects of a satellite. Fundamentals concepts like orbital mechanics, look angles determination, orbital effects in system performance, spacecraft subsystems, transponders, antennas, satellite link design, modulation, multiple access and multiplexing techniques used in satellite communication systems will be described in detail by this course.

Course Objectives

This is an elective course for students in a senior year.

- The goal of the course is to introduce students to the fundamentals of satellite communication.
- To provide them with a sound understanding of how a satellite communication system successfully transfers information from one earth station to another.
- To expose them to examples of applications and tradeoffs that typically occur in engineering system design, and to ask them to apply the knowledge in design problems.
- This course contributes to the educational objectives of fundamental knowledge, specialization, design skills and self-learning.

Topics covered in the Course and Level of Coverage

Topics	Chap	CLO	Week
Introduction to Satellite Communication Systems <ul style="list-style-type: none"> • Historical Background • Satellite architecture and components 	(1) Satellite Communications Systems, Techniques and Technology	1	1 Week (1)
<ul style="list-style-type: none"> • Regulatory aspects <ul style="list-style-type: none"> ○ ITU-R regulations ○ Space radio communication services • Frequency management: Frequency allocation regions • Orbits in Common Use <ul style="list-style-type: none"> ○ Geostationary Orbit ○ Low Earth Orbit ○ Medium Earth Orbit ○ Highly Elliptical Orbit ○ Polar Orbit 	(2) Satellite Communications Systems, Techniques and Technology, (2) Satellite Communications Systems Engineering	1	1 Week (2)
Link Budget Analysis <ul style="list-style-type: none"> • Concept of EIRP/ antenna gain computation, Free space loss • Flux density limitations • Thermalnoise aspects 	(5) Satellite Communications Systems, Techniques and Technology	2	1 Week (3)
<ul style="list-style-type: none"> • Signal to noise and carrier to noise ratios 	(5) Satellite	2	1 Week

<ul style="list-style-type: none"> • Gain to temperature ratio • Related examples 	Communications Systems: Systems, Techniques and Technology		(4)
<ul style="list-style-type: none"> • Radiowave Frequency and Space Communications • Propagation Below About 3 GHz <ul style="list-style-type: none"> ○ Ionospheric Scintillation ○ Polarization Rotation ○ Dispersion • Propagation Above About 3 GHz <ul style="list-style-type: none"> ○ Rain Attenuation ○ Gaseous Attenuation ○ Cloud and Fog Attenuation ○ Depolarization ○ Tropospheric Scintillation • Radio Noise <ul style="list-style-type: none"> ○ Noise from Atmospheric Gases ○ Sky Noise due to Rain ○ Sky Noise due to Clouds ○ Noise from Extra-Terrestrial Sources 	(6) Satellite Communications Systems Engineering	2	1 Week (5)
<p>Multiple Access Techniques</p> <ul style="list-style-type: none"> • Traffic routine • Access to a particular satellite channel (or transponder) • Multiple access to the satellite repeater • Performance evaluation – efficiency • Access techniques 	(6) Satellite Communications Systems Engineering	3	1 Week (6)
<ul style="list-style-type: none"> • FDMA <ul style="list-style-type: none"> ○ TDM/PSK/FDMA ○ SCPC/FDMA ○ adjacent channel interference ○ FDMA efficiency • TDMA <ul style="list-style-type: none"> ○ Burst generation ○ frame structure 	(6) Satellite Communications Systems: Systems, Techniques and Technology	3	1 Week (7)
<ul style="list-style-type: none"> • TDMA cont <ul style="list-style-type: none"> ○ factors necessitating synchronization ○ types of synchronization: closed-loop and open-loop ○ throughput TDMA • CDMA (Concept and bandwidth aspects,) <ul style="list-style-type: none"> ○ DSSSS ○ Realization of CDMA 	(6) Satellite Communications Systems: Systems, Techniques and Technology	3	1 Week (8)
<ul style="list-style-type: none"> • FHCDMA <ul style="list-style-type: none"> ○ code generation ○ synchronization ○ throughput of CDMA • Fixed and on demand assignment 	(6) Satellite Communications Systems: Systems, Techniques and	3	1 Week (9)

<ul style="list-style-type: none"> • Random access, • Synchronous and asynchronous protocols. 	Technology		
MID TERM			
Satellite networks <ul style="list-style-type: none"> • Satellite link types • On-board connectivity with transponder hopping • On-board connectivity with transparent processing <ul style="list-style-type: none"> ○ Analog transparent switching ○ Digital transparent switching 	(7) Satellite Communications Systems: Systems, Techniques and Technology	3	1 Week (11)
<ul style="list-style-type: none"> • On-board connectivity with regenerative processing <ul style="list-style-type: none"> ○ Baseband switching ○ Rate conversion • Scanning beams with transparent payload • Scanning beams with regenerative payload • Links between geostationary and low earth orbit satellites (GEO–LEO) • Links between geostationary satellites (GEO–GEO) • Satellite Clusters 	(7) Satellite Communications Systems: Systems, Techniques and Technology	3	1 Week (12)
Satellite Platform <ul style="list-style-type: none"> • Subsystems • Altitude control • Antenna coverage, • Power subsystem 	(9) Satellite Communications Systems: Systems, Techniques and Technology, (3) Satellite Communications Systems Engineering	3	1 Week (13)
<ul style="list-style-type: none"> • Orbital control system • Thermal control system • Telemetry, tracking, command and Monitoring (TTC& M). • Communication Payload 	(9) Satellite Communications Systems: Systems, Techniques and Technology, (3) Satellite Communications Systems Engineering	3	1 Week (14)
<ul style="list-style-type: none"> • Functions of the payload • Characterisation of the payload • Frequency Translation Transponder • On-board Processing Transponder 	(9) Satellite Communications Systems: Systems, Techniques and Technology, (3) Satellite Communications Systems	3	1 Week (15)

	Engineering		
Configuration of Earth Station <ul style="list-style-type: none"> • Station organization, • Antenna subsystem <ul style="list-style-type: none"> ○ Radiation characteristics ○ Antenna with symmetrical parabolic reflector ○ Antenna Pointing angles • Radio frequency subsystem: <ul style="list-style-type: none"> ○ Receiving equipment ○ Transmission equipment ○ Redundancy 	(8) Satellite Communications Systems: Systems, Techniques and Technology	3	1 Week (16)
Modern Trends <ul style="list-style-type: none"> • Iridium (LEO internet service for land/marine/aviation, positioning, cell phone) • Oneweb (LEO internet service for enterprise) • Starlink (Starlink Mini, Direct-to-Cell Satellite Service) 	Open	3	1 Week (17)

Course Outcomes and their Relation to Program Outcomes (Mapping CLO to PLO)

Course Learning Outcome (CLOs)		PLOs	Learning Level
CLO 1	Explain the satellite communication architecture and orbital mechanics	1	C2
CLO 2	Carry out link budget analysis / link feasibility/ design	2	C2
CLO 3	Describe the multiple access techniques used in satellite communication and explain the design and implementation of ground and payload segments.	3	C2

Mapping of CLOs to Program Learning Outcomes

PLOs / CLOs	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
PLO:1 (Engineering Knowledge)	C2				
PLO:2 (Problem Analysis)		C2			
PLO:3 (Design/ Development of Solutions)			C2		
PLO:4 (Investigation)					
PLO:5 (Modern Tool Usage)					
PLO:6 (The Engineer and Society)					
PLO:7 (Environment and Sustainability)					

PLO:8 (Professional Ethics)					
PLO:9 (Individual and Team Work)					
PLO:10 (Communication)					
PLO:11 (Project Management)					
PLO:12 (Lifelong Learning)					

EED-MCS-Sep 2025