

SATELLITE COMMUNICATIONS

Education curriculum

October 2007



CSSTEAP
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Acronyms

AIR	All India Radio
AOCS	Attitude and Orbit Control System
APT	Asia Pacific Telecommunity
ATM	Asynchronous Transfer Mode
BER	Bit Error Ratio
BSS	Broadcast Satellite Service
CDMA	Code Division Multiple Access
CISC	Complex Instruction Set Computer
C/kT	Carrier power to Noise power spectral density ratio
C/N	Carrier power to Noise power ratio
DAMA	Demand Assigned Multiple Access
DBS	Direct Broadcasting Satellite
DCT	Discrete Cosine Transform
DECU	Developmental and Educational Communication Unit
DFT	Discrete Fourier Transform
DMA	Direct Memory Access
DOE	Department of Electronics
DOS	Disk Operating System
DOT	Department of Telecommunications
DSDB	Digital Sound and Data Broadcasting
DSP	Digital Signal Processing
DTH	Direct to Home
DVB	Digital Video Broadcasting
EIRP	Effective Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ETSI	European Telecommunications Standards Institute
FFT	Fast Fourier Transform
FIR	Finite Impulse Response
FM	Frequency Modulation
FMTV	Frequency Modulation Television
FSS	Fixed Satellite Service

GEO	Geosynchronous Earth Orbit
GPS	Global Positioning System
G/T	Antenna Gain to System Noise Temperature Ratio
HDTV	High Definition Television
HPA	High Power Amplifier
IIR	Infinite Impulse Response
IMD	India Meteorological Department
IMT	International Mobile Telecommunication
INSAT	Indian National Satellite
I/O	Input/Output
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JDCP	Jhabua Developmental Communications Project
KCP	Kheda Communication Project
LAN	Local Area Network
LEO	Low Earth Orbit
LNA	Low Noise Amplifier
MBS	Multimedia Broadcast Service
MCPC	Multiple Channels Per Carrier
MEO	Medium Earth Orbit
MIC	Microwave Integrated Circuit
MPEG	Moving Picture Experts Group
MSS	Mobile Satellite Service
NICNET	National Informatics Centre Network
NOAA	National Oceanic and Atmospheric Administration
OBP	On Board Processing
PTI	Press Trust of India
RFI	Radio Frequency Interference
RISC	Reduced Instruction Set Computer
SCPC	Single Channel Per Carrier
SITE	Satellite Instructional Television Experiment

S/N	Signal to Noise Ratio
SNG	Satellite News Gathering
SSMA	Spread Spectrum Multiple Access
TCP/IP	Transmission Control Protocol / Internet Protocol
TDCC	Training and Developmental Communication Channel
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
TT and C	Telemetry, Tracking and Command
TVRO	Television Receive Only System
UGS	University Grant Commission
VHRR	Very High Resolution Radiometer
VSAT	Very Small Aperture Terminal

SATELLITE COMMUNICATIONS

Education curriculum

1.0 Introduction

At the initiative of UN Office of Outer Space Affairs (UN-OOSA) Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) was set up in 1995 with the primary aim to develop human resource in the developing countries to enhance utilization of space technology for development. This centre provides post graduate education and research on remote sensing, satellite communications, satellite meteorology and space science based on model curricula formulated by the UN Experts. In 2001, UN-OOSA reviewed the activities of the Centre and updated the curricula. UN-OOSA gave freedom to the Centre to decide on the depth and content of the topics and fine tune the topics to address the issues related to Asia and the Pacific region. For this purpose a Board of Studies (BOS) on SATCOM was constituted by the Director of CSSTEAP. The BOS meets every year and based on the feedback received from the faculty and the student recommends necessary changes that are followed in the subsequent course. Till now five SATCOM courses were conducted and at present the sixth course is in progress.

As the curriculum development is a continuous process to take into account various technological developments and emerging applications a specialized committee is constituted by the Director of CSSTEAP, to review the current syllabus and make recommendations on the changes needed.

The committee was mandated to carry out the following.

- i. Review the syllabus followed till now.
- ii. Suggest changes / modifications in the existing curricula, based on the latest advances in the field / newer applications areas. Detailed sub-topics under each module to be identified.
- iii. Suggest new areas of applications themes to be added.
- iv. Suggest time allotment for each topic.

- v. Suggest mark allotment for each module.
- vi. Review the existing practical and recommend addition / deletion as deemed necessary.
- vii. Suggest text books to be followed. Internet links also to be suggested for self study.
- viii. Any other suggestions that make the course more effective to enhance the knowledge and skills of the students.

The review procedure is described in section 2 and the recommendations are shown in section 3. The details of the changes from the previous curriculum are shown in Section 4. The revised curriculum with topics and their time distributions is shown in section 5. The recommended teaching materials including books, journals and websites are also listed in section 5. The course curriculum as recommended by BOS in April 2006 that is being followed for the sixth postgraduate course in satellite communications is shown in Annexure-I. Annexure-II shows the list of M.Tech. Theses submitted and Annexure-III shows country wise participation in SATCOM courses till now.

2.0 Review

Committee noted the objectives and guidelines provided by the UN expert working group held in Frascati, Italy in 2001 [Ref: Satellite communications Education curriculum, Office of Outer Space Affairs ST/SPACE/16]. The specific objectives for this course identified by the working group are,

- (a) To develop the skills of university educators, researchers, telecommunications professionals, government personnel and others in the field of satellite communications and its applications to broadcasting, telecommunications, health care, education, disaster management etc.;
- (b) To provide assistance in preparing satellite-based communications projects, defining policy and establishing communications systems;
- (c) To develop expertise in the use operational systems and integrate advances in communications technology in day to day activities;

- (d) To provide assistance in promoting intra and inter regional cooperation in utilizing and expanding the scope of communication technology;
- (e) To promote the development and enhancement of public awareness of the benefits of satellite based communication technologies in improving the quality of life.

The committee considered the recommendations of the BOS held after the fifth SATCOM course and reviewed the curriculum for the sixth postgraduate course in satellite communications being held at the Centre for Space Science and Technology Education in Asia and the Pacific from August 1, 2007.

3.0 Recommendations

Based on the above the committee has proposed a revised curriculum. No major addition or deletion of the topics prescribed in the previous course is made in the revised curriculum as the topics remains relevant as on date. Only restructuring of the modules is done to maintain uniformity in time duration. A few topics are revamped considering the new developments with emphasis on digital mode of transmission as analogue transmission applications are steadily decreasing.

To provide academic flavor the word “Module” is replaced with “Paper”. Revised SATCOM course will consist of twenty one Papers. The duration of the course is divided into two semesters in nine months to be held at CSSTEAP in India, followed by two semesters of project work in twelve months in participants’ own organization/country. Pilot project topic selected during Semester-II will be oriented towards the twelve months project work.

The topics and the sub topics to be covered in the Papers are prepared. Important changes from the content of the previous course are,

- Practical for each theory Paper is identified as a separate Paper.
- Common education module on space technology as suggested by UN OOSA will be part of Orientation course Paper.

- Module 6 and module 9 are merged into one Paper of theory and one Paper of practical.
- Module 7 and module 8 are merged into one Paper of theory and one Paper of practical.
- Depth and content of the topics for lectures and tutorials are left to the discretion of the Course Director.
- Educational visits are recommended as part of practical and students should write report on the visits which will be assessed.

4.0 Changes from previous curriculum to new curriculum

Details of changes from previous curriculum to the revised curriculum are listed below.

1. Word “Module” is replaced with word ”Paper”.
2. Module numbers has been changed to Paper numbers with MSAT (representing M. Tech. in Satellite Communications) as prefix followed by Semester number and Paper number. In previous Curriculum Modules are numbered from ‘0’ onward, in the new curriculum Papers are numbered from ‘1’ onward. (Example: Module-0 is replaced by MSAT.I.01)
3. In the previous curriculum Theory and Practical are listed within same module. In the new curriculum Theory Paper and Practical Paper are identified as separate Papers. (Example: Previous Module-2 Theory part is now MSAT.I.03 and previous Module-2 Practical part is now MSAT.I.04).
4. Technical visits that are listed in different modules of previous curriculum are not shown in the new curriculum. These will be part of Practical.
5. Previous curriculum Module-0 “Orientation course” topics “communication skill, introduction to local environment, Hindi language” is replaced in the new curriculum MSAT.I.01 by topics “CSSTEAP common education module, introduction to SATCOM common terminologies”.

6. Previous curriculum Module-4 “Modulation, Multiplexing and Multiple Access”, sub topics 4.2 “measurement of Video S/N vs C/N and video threshold, measurement of S/N vs FM Deviation“ is omitted due to obsolete analogue technologies.
7. Previous curriculum Module-5 “Broadcasting Using Communication Satellites” sub topic 5.1 “ TV coverage of sports” will be covered in the new curriculum MSAT.II.03 under “SNG / Outdoor Broadcasting van”.
8. Previous curriculum Module-5 “Broadcasting Using Communication Satellites” sub topic 5.2 “Setting up of a TV Direct Reception System and Digital Audio and Data Broadcasting (DSDB System)” is replaced in new curriculum MSAT.II.04 by “Setting up of a DTH TV System and Satellite Services through DVB-S Network”.
9. Previous curriculum Module-6 “Applications and Trends in Satellite Communications” sub topic 6.1 “News and Meteorological Data Dissemination System” and “Meteorological Data Reception System for LEO & GEO and Data Collection System” will be covered in new curriculum MSAT.II.05 under “VSAT Network for Voice, Data and Fax” and “Automatic Weather Station” respectively.
10. Previous curriculum Module-6 and Module-9 are merged in new curriculum into one theory paper of MSAT.II.05. The topics in previous curriculum Module-9 will be covered in MSAT.II.05 under “Rural / Remote Area Communication, Telemedicine, Tele-Education Systems and VSAT Network for Voice, Data and Fax”.
11. Laboratory experiments in previous curriculum Module-6 “Applications and Trends in Satellite Communications” sub topic 6.2 “Data and Sound Broadcasting System” is omitted and “NOAA / VHRR Data Reception and INSAT Reporting System” is replaced in new curriculum MSAT.II.06 by

“VHRR Data Reception and INSAT MSS Systems” respectively. A new experiment “Distress Alert Terminal” is included the same paper.

12. Previous curriculum Module-7 “Operational communication satellite systems” and Module-8 “Network planning / management / operational issues of Satellite communications systems” are merged in the new curriculum as one paper MSAT.II.07. “Operational Communication Satellite Systems, Network Planning, Management and Operational Issues” having the same topics.
13. Previous curriculum Module-10 “Pilot projects” more topics are suggested in the new curriculum paper MSAT.II.09.

5.0 Revised course curriculum on Satellite Communications

A. Course Duration in India	9 months (39 weeks)
Course work at Ahmedabad, including Pilot Project (Duration of Semester-I is approximately 18 weeks, Duration of Semester-II is approximately 17 weeks)	35 Weeks
Visit of different SATCOM establishment, Indian Industries and Andhra University	4 Weeks
Total	39 Weeks

B. Duration of Project Work in Participant’s own Country: 1 year (52 Weeks)
(Semester-III and Semester-IV)

SEMESTER-I 20 weeks (19 weeks + 1 week of examination)

Paper No.	Topics	Lecture hours			
		Lecture	Tutorial	Practical	Total
MSAT.I.01	Orientation course	38	0	0	38
MSAT.I.02	Introduction to Communication Systems	57	19	0	76
MSAT.I.03	Communication Systems Lab	0	0	57	57
MSAT.I.04	Satellite Communication Systems	57	19	0	76
MSAT.I.05	Satellite Communication Systems Lab	0	0	57	57

MSAT.I.06	Earth Station Technology	38	19	0	57
MSAT.I.07	Earth Station Technology Lab	0	0	57	57
MSAT.I.08	Modulation, Multiplexing and Multiple Access	57	19	0	76
MSAT.I.09	Modulation, Multiplexing and Multiple Access Lab	0	0	57	57
MSAT.I.10	Seminar	38	0	0	38
Semester-I Total Lecture hours		285	76	228	589

SEMESTER-II 19 weeks (18 weeks + 1 week of examination)

Paper No.	Topics	Lecture hours			
		Lecture	Tutorial	Practical	Total
MSAT.II.01	Digital Signal Processing	54	18	0	72
MSAT.II.02	Digital Signal Processing Lab	0	0	54	54
MSAT.II.03	Broadcasting Using Communication Satellites	36	0	0	36
MSAT.II.04	Broadcasting Using Communication Satellites Lab	0	0	54	54
MSAT.II.05	Applications and Trends in Satellite Communications	54	0	0	54
MSAT.II.06	Applications and Trends in Satellite Communications Lab	0	0	54	54
MSAT.II.07	Operational Communication Satellite Systems, Network Planning, Management and Operational Issues.	36	0	0	36
MSAT.II.08	Operational Communication Satellite Systems, Network Planning, Management and Operational Issues Lab.	0	0	54	54
MSAT.II.09	Pilot Project	0	0	162	162
Semester-II Total Lecture hours		180	18	378	576

Details of syllabus

SEMESTER-I

		Lecture Hours
Paper No. MSAT.I.01	Orientation Course	38
	<ul style="list-style-type: none"> • Introduction to the course 2 • Introduction to Activities of CSSTEAP and SAC 2 • CSSTEAP common education module 9 • Introduction to Satellite Communication and common terminologies 25 	
Paper No. MSAT.I.02	Introduction to Communication System	76
	Principle of Communications and Networking	
	<ul style="list-style-type: none"> • Communication Over view 12 <ul style="list-style-type: none"> - Signals & Systems - Spectrum & Bandwidth - Digital Communications fundamentals - Long Distance Communications • Principle of Information Theory and Mathematical Tools 20 <ul style="list-style-type: none"> - Probability Theory and Basic Statistics - Information Theory - Spherical Geometry - Linear Algebra - MATLAB Mathematical Tools • Principle of Modulation and Coding 3 <ul style="list-style-type: none"> - Analog and Digital Communications System - Modulation and Coding • Microwave Theory and Techniques 9 <ul style="list-style-type: none"> - Transmission Line Parameters (Z, Y, ABCD, S) - Wave-guide and Coaxial Components - Applications of Microwave Technology - Wave propagation - Antennas • Optical communications 1 • Principles of Networking and Protocols 9 <ul style="list-style-type: none"> Data Networking <ul style="list-style-type: none"> Local Area Network (LAN) Wide Area Network (WAN) Metropolitan Area Network (MAN) Protocols <ul style="list-style-type: none"> OSI Reference Model TCP/IP Internet <ul style="list-style-type: none"> Asynchronous Transfer Mode (ATM) ISDN Packet Switching Fundamental Broadband An Overview 	

	• Computer Organisation	3	
	- Computer Architecture		
	CISC		
	RISC		
	Parallel Processor		
	- I/O Devices		
	I/O Programming/ Controlling		
	Interrupt		
	DMA		
	- Standard Operating Systems		
	• Tutorial	19	
Paper No. MSAT.I.03	Introduction to Communication System Lab		57
	• MATLAB	20	
	• Microwave Measurements	20	
	• Analog and Digital Modems	10	
	• Fiber Optics	7	
Paper No. MSAT.I.04	Satellite Communication Systems		76
	• Introduction to Satellite Communications	6	
	- Evolution of Satellite Communications		
	- Elements of Satellite Communications		
	- Geo-Synchronous Satellite Communications		
	- Satellite Communications Services		
	• Satellite Orbits	2	
	• Launch Vehicles and Launching of Satellites	2	
	• Satellite Communications Links	6	
	• Frequency Bands for Satellite Communications	2	
	• Propagation Effects on Satellite Communication Links	4	
	• Satellite Configurations	1	
	• Satellite Bus Sub-Systems	9	
	- Mechanical Structure		
	- AOCS		
	- Propulsion Sub-System		
	- Electrical Power Sub-System		
	- TT & C		
	- Thermal Sub-System		
	- Integration & Testing		
	- Life considerations		
	• Communication Transponder	3	
	• Communication Transponder Sub-Systems	9	
	- Antenna and Feed		
	- Receiver and Transmitter		
	- Input / Output Multiplexer		
	• Communication Transponder On-Board Processing	3	
	• Integration and Testing of Communication Transponder	2	
	• In-Orbit Check-Out of Communication Satellite	1	

•	Reliability and Space Qualification	1
•	Reliability of Satellite Communication Payload	1
•	Electrostatic Discharge Hazards in Satcom Electronics	1
•	EMI, EMC and RFI	2
•	Radiation effects	1
•	Space Environment	1
•	Tutorial	19

Paper No. MSAT.I.05 **Satellite Communication Systems Lab** **57**

•	Familiarisation of Measuring Instruments	9
•	Determination of Satellite Look Angles and Optimisation of Earth Station Antenna	6
-	Azimuth and Elevation Angles	
-	X-Y Angles	
-	Optimisation of Sense of Polarisation	
•	Measurement of Satellite Link Parameters	15
-	Total C/kT and Downlink C/kT	
-	G/T and EIRP	
-	BER Vs C/kT	
•	Familiarisation and Measurement of Satellite Transponder Characteristics (Communication Simulator)	12
•	Testing of Communication Transponder Subsystems	15
-	Multiplexer	
-	Receiver	
-	Power Amplifier	
-	Antenna and Feed	

•	Satellite Communications Earth Station – An Overview	3
•	Technology of Earth Station Sub-Systems	15
-	Antenna Reflector and Mount for Large, Medium and Small Earth Station	
-	Feed System for Large, Medium and Small Earth Station	
-	Antenna Tracking System	
-	Low Noise Amplifier	
-	Solid State Power Amplifier	
-	High Power Amplifier	
-	Frequency Converter	
-	Modulator and Demodulator	
-	Encoder and Decoder	
-	Test Loop Translator	
-	Electrical Power Supply System	
-	Boresight and Rearward Link	
•	Earth Station Design Considerations	6
-	EIRP and G/T	
-	Antenna Size and Gain	
-	Radiation Pattern and Antenna Coverage	
-	Reliability and Redundancy	
-	Environmental Specifications	
-	VSAT / Mobile / Brief Case / Hand-Held Terminals	
-	Frequency Coordination	
•	Earth Station Standards	1
•	Checkout of Earth Station	9
-	Antenna Measurements (Far Field, Near Field, Anechoic Chamber)	
-	LNA and G/T	
-	HPA and EIRP	
-	Frequency Converter	
-	Test Loop Translator	
•	Operations & Maintenance of Fixed and Transportable Earth Station	3
•	Fabrication Techniques	1
-	Mechanical Fabrication Techniques	
-	Electronics Fabrication Techniques	
-	Microwave Integrated Circuits	
•	Tutorial	19

Paper No. MSAT.I.07	Earth Station Technology Lab	57
	<ul style="list-style-type: none"> • Familiarisation of Earth Station Subsystem 8 • Testing of Earth Station Subsystems 49 <ul style="list-style-type: none"> - Testing of Feed System - Testing of HPA - Testing of LNA - Testing of Frequency Converter - Testing of Antenna Tracking System (Manual and Auto Mode) 	
Paper No. MSAT.I.08	Modulation, Multiplexing and Multiple Access	76
	<ul style="list-style-type: none"> • Analog and Digital Modulation and Demodulation Techniques (AM / FM / PM / M-PSK / MSK / Hybrid) 9 • Transmission Impairments 6 • Source Coding of Video & Audio signals 9 • Channel coding (Block / Convolutional) 9 • Multiplexing /De-multiplexing 6 <ul style="list-style-type: none"> - Frequency and Time division Techniques • Spread Spectrum Techniques 9 <ul style="list-style-type: none"> - Basic concepts and Features - Direct Sequence/ Frequency Hopping - SS Codes, Synchronisation and Selection Criteria etc. • Multiple Access Techniques 9 <ul style="list-style-type: none"> - FDMA - TDMA - CDMA - Random Access (ALOHA / Slotted ALOHA) - SCPC / DAMA • Tutorials 19 	
Paper No. MSAT.I.09	Modulation, Multiplexing and Multiple Access Lab	57
	<ul style="list-style-type: none"> • Familiarisation and Operation of SCPC, SSMA and TDMA Equipment 14 • Measurement of BER Vs C/N for data channel 13 • Determination of Transponder Operating Points for Single Carrier per Transponder 12 Multiple Carrier per Transponder • MATLAB Simulations 18 	
Paper No. MSAT.I.10	Seminar	38
	Topics on societal applications based on Satellite ommunications	

SEMESTER-II

Paper No.
MSAT.II.01

Digital Signal Processing

72

- Discrete Time Signals and Systems 4
 - Discrete Time Signals: Sequences
 - Discrete Time Systems
 - Linear Time-In Variant Systems
 - Frequency Domain representation of sampling
 - Discrete Time Signals and Systems
 - Representation of Sequences by Fourier Transform
 - Fourier Transform Theorems
 - Discrete Time Random Signals
- Sampling of Continuous Time Signals 6
 - Periodic Sampling
 - Frequency Domain Representation of Sampling
 - Reconstruction of a Band limited signal from its signals
 - Continuous time processing of Continuous/ Discrete Time signals
 - Changing the sampling rate using discrete time processing
 - Practical Considerations
- Z-Transform 6
 - Properties of region of convergence for Z-Transform
 - Inverse Z-Transform
 - Z-Transform Properties
 - Inverse Z-Transform using contour integration
 - Complex Convolution Theorem
 - Parseval's Relation
 - Unilateral Z-Transform
- Discrete Fourier Transform 6
 - Representation of Periodic sequences
 - Discrete Fourier Series
 - Properties of Discrete Fourier Series
 - Fourier Transform of Periodic Signals
 - Sampling of Fourier Transform
 - Fourier Representation of Finite Duration Sequences
 - Discrete Fourier Transform
 - Linear Convolution using Discrete Fourier Transform
- Computation of Discrete Fourier Transform 6
 - Efficient Computation of Discrete Fourier Transforms
 - Goertzel Algorithm
 - Decimation-in-Time FFT Algorithms
 - Decimation-in-Frequency FFT Algorithms
 - Implementation of FFT Algorithms
 - FFT algorithms for Composite-N
 - Implementation of DFT using Convolution

	- Effects of Finite Register length in Discrete Fourier Transform Computations	
	• Structure for Discrete Time Systems	6
	- Block Diagram Representation of Linear Constant Coefficient differential equation	
	- Basic Structure for Infinite Impulse Response (IIR) Systems	
	- Basic Network Structures for FIR Systems	
	- Overview of Finite-Precision Numerical Effects	
	- Effects of Co-efficient quantization	
	- Effects of Round-Off Noise in Digital Filters	
	- Zero input cycles in Fixed Point realizations of IIR digital filters	
	• Filter Design Techniques	9
	- Basic Issues in Digital Filter Design	
	- IIR Filter Design	
	- Frequency Transformation of Low Pass IIR Filters	
	- Design of Filters by Windowing	
	- Optimum Approximation of FIR Filters	
	- FIR Equi-Ripple Approximation	
	• Wavelet Transforms	1
	• Signal Compression	
	- Lossless compression	8
	- Lossy compression	
	• Examples of DSP based subsystems for Satellite Communications	2
	• Tutorials	18
Paper No. MSAT.II.02	Digital Signal Processing Lab	54
	• MATLAB Based Exercise	36
	- Design of FIR and IIR Filter	
	- Implementation of DFT / FFT	
	- Examples of DSP Based Communication Systems	
	• Familiarization and Implementation on Evaluation Board	18
	- FIR and IIR Filters	
	- Demodulator Algorithm	
	- Viterbi Coding	
	- FFT and DCT	
Paper No. MSAT.II.03	Broadcasting Using Communication Satellites	36
	• Analog & Digital Broadcasting Systems & Standards	9
	- Colour Television	
	- Digital Television	
	- High Definition Television (HDTV)	
	- Digital Video Broadcasting (DVB)	
	- Moving Picture Experts Group (MPEG)	
	• Satellite TV and Access Systems	6
	- Cable TV	
	- DBS	
	- DTH	

	- Network Management	
•	Internet Protocol (IP) over Satellite	
	- Unicast	6
	- Broadcast	
	- Multicast	
	Selected Applications	
•	Satellite News Gathering (SNG) for Radio and TV	2
•	Radio Networking	2
•	Digital Audio Broadcasting	2
•	TV Studio and its Operations/ Outdoor Broadcasting Van	2
•	Video Conferencing via Satellite	2
•	Multimedia & IP TV	3
•	Video On Demand	2
Paper No. MSAT.II.04	Broadcasting Using Communication Satellites Lab	54
•	Measurement of TV Signal Parameters using Waveform Monitor, Vectorscope and Automated Test Equipment	8
•	Familiarisation of Radio Networking Terminal	7
•	Demonstration of Operation of SNG Terminal	7
•	Setting up of a DTH TV System	8
•	Satellite Services through DVB-S Network	8
•	Satellite Services through DVB-RCS Network	8
•	Multimedia Broadcasting / Multicasting	8
Paper No. MSAT.II.05	Applications and Trends in Satellite Communications	54
	Satellite Communications Services and Applications	2
•	Rural / Remote Area Communication	12
•	VSAT Network for Voice, Data and Fax	
	- TDM / TDMA	
	- SCPC / DAMA	
	Elements for VSAT Network	
	- Remote Terminals	
	- Hub	
	- Network Management	
•	Automatic Weather Station	2
•	Disaster Management using Satellite Communications	2
•	Search and Rescue System	2
	- International	
	- Regional (INSAT)	
•	Warning Dissemination System	2
•	Telemedicine	2
•	Time and Frequency Transmission System	2
•	Tele-Education Systems	2
•	Mobile and Personal communications Services	8
•	Strategic Satellite Communication System	4
•	Satellite Navigation System	8
•	Satellite-based Internet System	2
•	Multimedia Broadband Satellite Systems	2
•	Future Trends in Satellite Communications	2

- Telecom
- Broadcasting
- Mobile and Personal Communications

Paper No. MSAT.II.06 Applications and Trends in Satellite Communications Lab 54

- VHRR Data Reception 9
- Meteorological Data Dissemination System 9
- Search and Rescue Beacon / Distress Alert terminal 9
- Operations of GPS Receiver 9
- VSAT Terminal and Network 9
- INSAT MSS Systems 9

Paper No. MSAT.II.07 Operational Communication Satellite Systems, Network Planning, Management and Operational Issues 36

- Overview of Operational Satellite Communications Systems 6
 - Fixed Satellite Services (FSS)
 - Mobile Satellite Services (MSS)
 - Broadcast Satellite Services (BSS)
 - Broadband Multimedia Broadcast Services (B-MBS)
- Operational Communication Satellite Systems 6
 - International Satellite Communication Systems:
 - Regional and Domestic Satellite Communications Systems:
- International Telecommunications Union (ITU) & Other Standardisation Organisations (ISO, APT, ETSI) 2
- International Regulations 2
- Technical Considerations for Network Planning 2
- Planning for Space Segment 2
 - Traffic Requirements
 - Options for Satellite Transponder (Coverage, Power Bandwidth, Frequency Bands, Bent-Pipe/Regenerative)
 - Cross Pol. Isolation and Collocated Satellites
 - Choice of Orbits (GEO, MEO, LEO)
- Planning for Ground Segment 2
 - Trade-Off between Space Segment and Ground Segment
 - HPA Power and Transmit Antenna Size
 - Off-Axis Radiation Pattern
 - LNA Noise Temperature and Receive G/T
 - Antenna Size
 - Cost
- Network Operations and Control 2
- Management of Communication Satellite Operations 3
 - Normal Operations
 - Operations of Satellite Control Earth Station (Tele-Command, Telemetry, Tracking and Ranging)
 - Orbit determinations, Station Keeping and Fuel Management

	- Sun Outage and Eclipse Operations	
	- Loss of Lock	
	• Intra-system/ Inter-system Interference Coordination	3
	• Satellite Communication Policy, Regulations and licensing	2
	• Space Law	2
	• Financial Aspects of Satellite Communication	2
Paper No. MSAT.II.08	Operational Communication Satellite Systems, Network Planning, Management and Operational Issues Lab	54
	• Visit to NOCC, MCF, ISTRAC, VSAT Network Hub	
Paper No. MSAT.II.09	PILOT PROJECT	162
	• Project Definition	
	- Needs of the Participant's Country	
	- Topic of Interest of the Participant	
	- The work leading towards the one year Project	
	• Suggested Topics for the Project	
	- Earth Station Subsystems	
	- Systems Analysis for Communication Satellite	
	- Spacecraft Payload Design	
	- Antenna Design	
	- Communication Systems Design	
	- Satellite Communications protocols	
	- Radio wave propagation studies / Fade Mitigation Techniques	
	- Interference source identification and mitigation technique	
	- New satellite communications applications	
	- Network Planning and Relevant Software Development	
	- Applications of TV and Radio for Development Communications	
	- Economics of Satellite Communications	
	- Domestic SATCOM System Definition	
	- Policy Research	

6.0 Recommended teaching materials

Books

Chakrabarti N.B. and Datta A.K., An Introduction to the Principles of Digital Communications, New Age International (P) Limited, Publishers (formerly Wiley Eastern Limited)

Elbert, B., Introduction to satellite communications, Archtech House Publishers

Elbert, B.R., Satellite communications Applications Handbook, Artech House

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Maral, G, Bousquet, M., Satellite Communications Systems : systems, techniques and technology, John Willy and sons

Pratt, T and C.W. Bostian, Satellite communications, John Willey and sons

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Richharia, M., Satellite communications systems: design principles, MacMillan Publishers

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Zhili Sun, Satellite Networking Principles and Protocols, John Wiley & sons

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IEEE Communications magazine, www.comsoc.org

International Journal of satellite communications and networking, www.interscience.wiley.com

Journal on Space Communications by Asia Pacific Satellite Communications Council (APSCC), <http://www.apsc.org.kr/>

Microwave and RF, www.mwrf.com

Pacific Telecommunications Review, <http://web.ptc.org/library/ptr/>

Space communications an international journal, www.iospress.nl

Via satellite, www.viasatellite.com

SatMagazine an on-line magazine on communications satellites. http://www.satmagazine.com/cgi-bin/display_edition.cgi

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Beyond The Ionosphere: Fifty Years of Satellite Communication (NASA SP-4217, 1997)
<http://history.nasa.gov/SP-4217/sp4217.htm>

Communications satellites short history by David J. halen
<http://www.hq.nasa.gov/office/pao/History/satcomhistory.html>

satcoms UK
<http://www.satcoms.org.uk/satcoms.asp>

Communications satellite
http://en.wikipedia.org/wiki/Satellite_communications

Lloyd's Satellite Constellations
<http://personal.ee.surrey.ac.uk/Personal/L.Wood/constellations/index.html>

ANNEXURE-I

COURSE CURRICULUM

ON

SATELLITE COMMUNICATIONS

April 2006

**Centre for Space Science and Technology Education
In Asia and the Pacific
(CSSTE-AP)
SPACE APPLICATIONS CENTRE (AHMEDABAD)**

CSSTEAP Course on Satellite Communications

August 2007 – April 2008

A. Details of Course Duration in India (August 2007 – April 2008)

➤	Course Work at Ahmedabad, including Pilot Project	35 Weeks
➤	Visit of different SATCOM establishment Indian Industries And Andhra University	4 Weeks
TOTAL		39 Weeks

B. Duration of Project Work in Participant's Country (May 2008– April 2009)

1 Year (52 Weeks)

5.0 Course Modules

Module No.	Topics	Duration in Weeks
0	Orientation Course	1
1	Communication System Review and Digital Signal Processing Part-1-Communication System and Part-II- Digital Signal Processing	6
2	Satellite Communication Systems	5
3	Earth Station Technology	3
4	Modulation, Multiplexing and Multiple Access	2
5	Broadcasting Using Communication Satellites	2
6	Applications and Trends in Satellite Communications	3
7	Operational Communication Satellite Systems	1
8	Network Planning, Management and Operational Issues of Satellite Communication Systems	1
9	Satellite Communications for Development, Education and Training	1
10	Pilot Projects	10
TOTAL DURATION		35

D. Break-Up of Number of Classes in Course Modules

Course Module No.	0	1	2	3	4	5	6	7	8	9
Lectures	40	66+76=142	100	46	40	32	62	30	26	32
Practical		24+32=56	36	28	20	20	28			
Visits			36	24	8	12	16	08	6	16
Tutorial & Library		26	14	12	4	8	8		4	
Class Tests & Exams		16	14	10	8	8	6	2	4	8
TOTAL	40	240	200	120	80	80	120	40	40	56

E. Timings of Classes

➤ Eight Lectures per Day/ Five Days a Week

- Morning Session 0945 – 1300 Hrs
(4 Classes of 45 minutes each and Tea / Coffee Break of 15 minutes)
- Lunch Break 1300 – 1400 Hrs
- Afternoon Session 1400 – 1715 Hrs
(4 Classes of 45 minutes each and Tea / Coffee Break of 15 minutes)

MODULE-0

Orientation Course

Duration: 1 Week

	No. of Classes
0.1 Introduction to the course	2
0.2 Introduction to Activities of CSSTEAP and SAC	2
0.3 Communication Skills (Oral, Written, Presentation, Group Discussion etc)	24
0.4 Introduction to the Local environment	6
• Geographic Perspectives of India with Special Reference to Gujarat and Ahmedabad	
• Social Systems and Customs	
• Festivals of India	
0.5 Hindi Language	6
• Common Hindi Words	
• Simple Spoken Hindi	
TOTAL	40

MODULE-1
Communication System Review and Digital Signal Processing

Part-I – Communication System
Duration: 3 Weeks

1.1	Class Room Lectures	No. of Classes
	Principle of Communications and Networking	
•	Communication Over view	12
	- Signals & Systems	4
	- Spectrum & Bandwidth	2
	- Digital Communications fundamentals	4
	- Long Distance Communications	2
•	Principle of Information Theory and Mathematical Tools	20
	- Probability Theory and Basic Statistics	8
	- Information Theory	6
	- Spherical Geometry	1
	- Linear Algebra	3
	- MATLAB Mathematical Tools	2
•	Principle of Modulation and Coding	4
	- Analog and Digital Communications System	2
	- Modulation and Coding	2
•	Microwave Theory and Techniques	10
	- Transmission Line Parameters (Z, Y, ABCD, S)	
	- Wave-guide and Coaxial Components	
	- Applications of Microwave Technology	
	- Wave propagation	
	- Antennas	
•	Optical communications	4
•	Principles of Networking and Protocols	12
	Data Networking	6
	- Local Area Network (LAN)	
	- Wide Area Network (WAN)	
	- Metropolitan Area Network (MAN)	
	- Protocols	
	• OSI Reference Model	
	• TCP/IP	
	- Internet	
	- Asynchronous Transfer Mode (ATM)	
	ISDN	2
	Packet Switching Fundamental	2
	Broadband An Overview	2

		No. of Classes
Class Room Lectures		
•	Computer Organisation	4
	Computer Architecture	
	CISC	
	RISC	
	Parallel Processor	
	I/O Devices	
	I/O Programming/ Controlling	
	Interrupt	
	DMA	
	Standard Operating Systems	
	Sub-Total	66
1.2	Laboratory Sessions	
-	MATLAB	8
-	Microwave Measurements	8
-	Analog and Digital Modems	4
-	Fiber Optics	4
	Sub-Total	24
	Tutorial and Library	10
	Total	100

MODULE-1
Communication System Review and Digital Signal Processing

Part-II – Digital Signal Processing
Duration: 3 Weeks

1.3 Class Room Lectures	No. of Classes
<ul style="list-style-type: none"> • Discrete Time Signals and Systems <ul style="list-style-type: none"> - Discrete Time Signals: Sequences - Discrete Time Systems - Linear Time-In Variant Systems - Frequency Domain representation of sampling - Discrete Time Signals and Systems - Representation of Sequences by Fourier Transform - Fourier Transform Theorems - Discrete Time Random Signals 	4
<ul style="list-style-type: none"> • Sampling of Continuous Time Signals <ul style="list-style-type: none"> - Periodic Sampling - Frequency Domain Representation of Sampling - Reconstruction of a Band limited signal from its signals - Continuous time processing of Continuous/ Discrete Time signals - Changing the sampling rate using discrete time processing - Practical Considerations 	6
<ul style="list-style-type: none"> • Z-Transform <ul style="list-style-type: none"> - Properties of region of convergence for Z-Transform - Inverse Z-Transform - Z-Transform Properties - Inverse Z-Transform using contour integration - Complex Convolution Theorem - Parseval's Relation - Unilateral Z-Transform 	8
<ul style="list-style-type: none"> • Discrete Fourier Transform <ul style="list-style-type: none"> - Representation of Periodic sequences - Discrete Fourier Series - Properties of Discrete Fourier Series - Fourier Transform of Periodic Signals - Sampling of Fourier Transform - Fourier Representation of Finite Duration Sequences - Discrete Fourier Transform - Linear Convolution using Discrete Fourier Transform 	6

Class Room Lectures		No. of Classes
•	Computation of Discrete Fourier Transform	8
-	Efficient Computation of Discrete Fourier Transforms	
-	Goertzel Algorithm	
-	Decimation-in-Time FFT Algorithms	
-	Decimation-in-Frequency FFT Algorithms	
-	Implementation of FFT Algorithms	
-	FFT algorithms for Composite-N	
-	Implementation of DFT using Convolution	
-	Effects of Finite Register length in Discrete Fourier Transform Computations	
•	Structure for Discrete Time Systems	6
-	Block Diagram Representation of Linear Constant Coefficient differential equation	
-	Basic Structure for Infinite Impulse Response (IIR) Systems	
-	Basic Network Structures for FIR Systems	
-	Overview of Finite-Precision Numerical Effects	
-	Effects of Co-efficient quantization	
-	Effects of Round-Off Noise in Digital Filters	
-	Zero input cycles in Fixed Point realizations of IIR digital filters	
•	Filter Design Techniques	12
-	Basic Issues in Digital Filter Design	
-	IIR Filter Design	
-	Frequency Transformation of Low Pass IIR Filters	
-	Design of Filters by Windowing	
-	Optimum Approximation of FIR Filters	
-	FIR Equi-Ripple Approximation	
•	Wavelet Transforms	2
•	Signal Compression	20
-	Lossless compression	
-	Lossy compression	
•	Examples of DSP based subsystems for Satellite Communications	4
	Sub-Total	76
1.4	Laboratory Exercises / Tutorial	48
•	MATLAB Based Exercise	20
-	Design of FIR and IIR Filter	
-	Implementation of DFT / FFT	
-	Examples of DSP Based Communication Systems	
•	Familiarization and Implementation on Evaluation Board	12
-	FIR and IIR Filters	
-	Demodulator Algorithm	
-	Viterbi Coding	
-	FFT and DCT	
	Total	124

MODULE –2

SATELLITE COMMUNICATION SYSTEMS

Duration: 5 Weeks

2.1	Class Room Lectures	No. of Classes
•	Introduction to Satellite Communications	4
	- Evolution of Satellite Communications	
	- Elements of Satellite Communications	
	- Geo-Synchronous Satellite Communications	
	- Satellite Communications Services	
	Satellite Orbits	4
	Launch Vehicles and Launching of Satellites	4
	Satellite Communications Links	4
	Frequency Bands for Satellite Communications	2
	Propagation Effects on Satellite Communication Links	2
	Satellite Configurations	2
	Satellite Bus Sub-Systems	24
	- Mechanical Structure	2
	- AOCS	4
	- Propulsion Sub-System	2
	- Electrical Power Sub-System	4
	- TT & C	4
	- Thermal Sub-System	4
	- Integration & Testing	2
	- Life considerations	2
	Communication Transponder	4
•	Communication Transponder Sub-Systems	12
	- Antenna and Feed	4
	- Receiver and Transmitter	6
	- Input / Output Multiplexer	2
	Communication Transponder On-Board Processing	4
	Integration and Testing of Communication Transponder	2
	In-Orbit Check-Out of Communication Satellite	2
	Reliability and Space Qualification	2
	Reliability of Satellite Communication Payload	2
	Electrostatic Discharge Hazards in SatCom Electronics	2

Class Room Lectures		No. of Classes
	EMI, EMC and RFI	4
	Radiation effects	4
	Space Environment	2
	Satellite Communications (Tutorials and Learning kits)	14
	Sub-Total	100
2.2	Experiments / Demonstrations	
	Familiarisation of Measuring Instruments	4
	Determination of Satellite Look Angles and Optimisation of Earth Station Antenna	4
	- Azimuth and Elevation Angles	
	- X-Y Angles	
	- Optimisation of Sense of Polarisation	
	Measurement of Satellite Link Parameters	8
	- Total C/kT and Downlink C/kT	
	- G/T and EIRP	
	- BER Vs C/kT	
•	Familiarisation and Measurement of Satellite Transponder Characteristics (Comm. Simulator)	4
•	Testing of Communication Transponder Subsystems	16
	- Multiplexer	
	- Receiver	
	- Power Amplifier	
	- Antenna and Feed	
	Sub-Total	36
2.3	Visit of Laboratories and Other Facilities of SAC/ISAC	
•	Communication Payload R & D Labs	
•	Communications Techniques Labs	
•	Payload Fabrication Facility	
•	Environmental Test Facility	
•	Communication Systems Lab	
•	Remote Sensing Laboratories	
	Sub-Total	36
2.4	Tutorial & Library	14
	Total	186

MODULE –3

EARTH STATION TECHNOLOGY

Duration: 3 Weeks

3.1 Class Room Lectures	No. of Classes
• Satellite Communications Earth Station – An Overview	2
• Technology of Earth Station Sub-Systems	22
- Antenna Reflector and Mount for Large, Medium and Small Earth Station	
- Feed System for Large, Medium and Small Earth Station	
- Antenna Tracking System	
- Low Noise Amplifier	
- Solid State Power Amplifier	
- High Power Amplifier	
- Frequency Converter	
- Modulator and Demodulator	
- Encoder and Decoder	
- Test Loop Translator	
- Electrical Power Supply System	
- Boresight and Rearward Link	
• Earth Station Design Considerations	6
- EIRP and G/T	
- Antenna Size and Gain	
- Radiation Pattern and Antenna Coverage	
- Reliability and Redundancy	
- Environmental Specifications	
- VSAT / Mobile / Brief Case / Hand-Held Terminals	
- Frequency Coordination	
• Earth Station Standards	2
• Checkout of Earth Station	6
- Antenna Measurements (Far Field, Near Field, Anechoic Chamber)	
- LNA and G/T	
- HPA and EIRP	
- Frequency Converter	
- Test Loop Translator	
• Operations & Maintenance of Fixed and Transportable Earth Station	2
• Fabrication Techniques	6
- Mechanical Fabrication Techniques	
- Electronics Fabrication Techniques	
- Microwave Integrated Circuits	
Sub-Total	46

		No. of Classes
3.2	Experiments / Demonstrations	
	• Familiarisation of Earth Station Subsystem	4
	• Testing of Earth Station Subsystems	24
	- Testing of Feed System	
	- Testing of HPA	
	- Testing of LNA	
	- Testing of Frequency Converter	
	- Testing of Antenna Tracking System (Manual and Auto Mode)	
	Sub-Total	28
3.3	Visits	24
	• DOT Earth Station	
	• Software Technology Park (DOE)	
	• Antenna Test Facility (SAC)	
	• MIC Facility (SAC)	
	• Electronics Fabrication Facility (SAC)	
	• Mechanical Fabrication Facility (SAC)	
3.4	Tutorials and Library	12
	Total	110

MODULE –4

MODULATION, MULTIPLEXING AND MULTIPLE-ACCESS

Duration: 2 Weeks

4.1 Class Room Lectures		No. of Classes
	Analog and Digital Modulation and Demodulation Techniques (AM/ FM/ PM/ M-PSK/ MSK/ Hybrid)	08
	Transmission Impairments	02
•	Source Coding of Video & Audio signals	04
•	Channel coding (Block/ Convolutional)	06
	Multiplexing /De-multiplexing	04
-	Frequency and Time division Techniques	
	Spread Spectrum Techniques	08
-	Basic concepts and Features	
-	Direct Sequence/ Frequency Hopping	
-	SS Codes, Synchronisation and Selection Criteria etc.	
	Multiple Access Techniques	08
-	FDMA	
-	TDMA	
-	CDMA	
-	Random Access (ALOHA/ Slotted ALOHA)	
-	SCPC/ DAMA	
	Sub Total	40
4.2 Experiments / Demonstrations		
•	Familiarisation and of Operation of SCPC, SSMA and TDMA Equipment	
	Measurement of Video S/N Vs C/N and Video Threshold	
•	Measurement of S/N Vs FM Deviation	
•	Measurement of BER Vs C/N for data channel	
	Determination of Transponder Operating Points for Single Carrier per Transponder Multi Carrier per Transponder	
	MATLAB Simulations	
	Sub Total	20
4.3	Visits	8
4.3	Library and Tutorials	4
	Total	72

MODULE –5

BROADCASTING USING COMMUNICATION SATELLITES

Duration: 2 Weeks

5.1	Class Room Lectures	No. of Classes
•	Analog & Digital Broadcasting Systems & Standards	8
-	Colour Television	
-	Digital Television	
-	High Definition Television (HDTV)	
-	Digital Video Broadcasting (DVB)	
-	Moving Picture Experts Group (MPEG)	
•	Satellite TV and Access Systems	4
-	Cable TV	
-	DBS	
-	DTH	
-	Network Management	
	Internet Protocol (IP) over Satellite	4
-	Unicast	
-	Broadcast	
-	Multicast	
	Selected Applications	
•	Satellite News Gathering (SNG) for Radio and TV	2
•	Radio Networking	2
•	Digital Audio Broadcasting	2
•	TV Studio and its Operations/ Outdoor Broadcasting Van	2
•	TV Coverage of Sports	2
•	Video Conferencing via Satellite	2
•	Multimedia & IP TV	2
•	Video On-Demand, IP TV	2
	Sub-Total	32
5.2	Laboratory Experiments / Demonstrations	
•	Measurement of TV Signal Parameters using Waveform Monitor, Vectorscope and Automated Test Equipment	
•	Familiarisation of Radio Networking Terminal	
•	Demonstration of Operation of SNG Terminal	
•	Setting up of a TV Direct Reception System	
•	Digital Audio and Data Broadcasting (DSDB System)	
•	Satellite Services through DVB-RS Network	
•	Multimedia Broadcasting / Multicasting	
	Sub-Total	20

		No. of Classes
5.3	Visits	
	• TV Broadcasting Station of Doordarshan	
	• Radio Networking System of AIR	
	• TV Studio (DECU)	
	Sub-Total	12
5.4	Tutorials and Library	8
	Total	72

MODULE –6

APPLICATIONS AND TRENDS IN SATELLITE COMMUNICATIONS

Duration: 3 Weeks

6.1 Class Room Lectures	No. of Classes
Satellite Communications Services and Applications	
Rural/ Remote Area Communication	2
VSAT Network for Voice, Data and Fax	8
TDM/TDMA	
SCPC / DAMA	
Elements for VSAT Network	
- Remote Terminals	
- Hub	
- Network Management	
• Meteorological Data Reception System for LEO & GEO	2
• News and Meteorological Data Dissemination System	2
• Data Collection System	2
• Disaster Management Using Satellite Communications	2
• Search and Rescue System	2
- International	
- Regional (INSAT)	
• Warning Dissemination System	2
• Telemedicine	2
• Time and Frequency Transmission System	2
• Tele-Education Systems	4
• Mobile and Personal communications Services (IMT-2000,4G etc.)	8
• Strategic Satellite Communication System	4
• Satellite Navigation System	6

Class Room Lectures	No. of Classes
• Satellite-based Internet System	2
• Multimedia Broadband Satellite Systems	2
• Future Trends in Satellite Communications	2
- Telecom	
- Broadcasting	
- Mobile and Personal Communications	
Tutorials	08
Sub-Total	62
6.2 Laboratory Experiments / Demonstrations	
• NOAA / VHRR Data Reception	
• News and Meteorological Data Dissemination System	
• Search and Rescue Beacon	
• Operations of GPS Receiver and INSAT Reporting System	
• VSAT Terminal and Network	
• Data and Sound Broadcasting System	
Sub-Total	28
6.3 Visits to Application Sites e.g. Airport, IMD, etc	16
6.4 Library	8
Total	114

MODULE –7

OPERATIONAL COMMUNICATION SATELLITE SYSTEMS

Duration: 1 Week

7.1	Class Room Lectures	No. of Classes
	Overview of Operational Satellite Communications Systems	8
	<ul style="list-style-type: none">- Fixed Satellite Services (FSS)- Mobile Satellite Services (MSS)- Broadcast Satellite Services (BSS)- Broadband Multimedia Broadcast Services (B-MBS)	
	<ul style="list-style-type: none">• Operational Communication Satellite Systems	18
	<ul style="list-style-type: none">- International Satellite Communication Systems: INTELSAT INMARSATIRIDIUM, GLOBALSTAR ICO WORLDSPACE Irridium SMALL LEO SYSTEMS- Regional and Domestic Satellite Communications Systems: INSAT ARABSAT PALAPA THAICOM ASIASAT	
	<ul style="list-style-type: none">• International Telecommunications Union (ITU) & Other Standardisation Organisations (ISO, APT, ETSI)	2
	<ul style="list-style-type: none">• International Regulations	2
	Sub Total	30
7.2	Visits	8
	Total	38

MODULE –8

NETWORK PLANNING / MANAGEMENT / OPERATIONAL ISSUES OF SATELLITE COMMUNICATIONS SYSTEMS

Duration: 1 Week

8.1	Class Room Lectures	No. of Classes
•	Technical Considerations for Network Planning	2
•	Planning for Space Segment	2
-	Traffic Requirements	
-	Options for Satellite Transponder (Coverage, Power Bandwidth, Frequency Bands, Bent-Pipe/ Regenerative)	
-	Cross Pol. Isolation and Collocated Satellites	
-	Choice of Orbits (GEO, MEO, LEO)	
•	Planning for Ground Segment	2
-	Trade-Off between Space Segment and Ground Segment	
-	HPA Power and Transmit Antenna Size	
-	Off-Axis Radiation Pattern	
-	LNA Noise Temperature and Receive G/T	
-	Antenna Size	
-	Cost	
•	Network Operations and Control	4
•	Management of Communication Satellite Operations	4
-	Normal Operations	
-	Operations of Satellite Control Earth Station (Tele-Command, Telemetry, Tracking and Ranging)	
-	Orbit determinations, Station Keeping and Fuel Management	
-	Sun Outage and Eclipse Operations	
-	Loss of Lock	
•	Intra-system/ Inter-system Interference Coordination	4
•	Satellite Communication Policy, Regulations and licensing,	4
•	Space Law	2
•	Financial Aspects of Satellite Communication	2
	Sub Total	26
8.2	Library and Earth Station Visits	10
	Total	36

MODULE –9

SATELLITE COMMUNICATIONS FOR DEVELOPMENT, EDUCATION AND TRAINING

Duration: 1 Week

9.1	Class Room Lectures	No. of Classes
	<ul style="list-style-type: none">• Satellite Communications for Development Education and Training – An Overview	2
	<ul style="list-style-type: none">• Hardware & Software Options for Development Broadcasting and Interactive Training Programs	4
	<ul style="list-style-type: none">• Interactive TV for Training, Education and Development	4
	<ul style="list-style-type: none">• Local Broadcasting: Kheda Com Project & JDCP	2
	<ul style="list-style-type: none">• Designing Satcom Educational System for Developing Countries	4
	<ul style="list-style-type: none">• Reach V/s Access to Communication in Countries and Role of Researchers	4
	<ul style="list-style-type: none">• Introduction to Gramsat Concept and New Technologies	4
	<ul style="list-style-type: none">• Role of Foreign Channels in Developing Countries	4
	<ul style="list-style-type: none">• Operational, Technological and Legal Issues in Trans-border Channels for Development	4
	Sub-Total	32
	Library and Visits	16
	Interactive Session Country paper Presentation	08
	TOTAL	56

MODULE –10

PILOT PROJECT

Duration: 10 Weeks

- **Project Definition**
 - Needs of the Participant's Country
 - Topic of Interest of the Participant
 - The Work Leading Towards the One Year Project

- **Suggested Topics for the Project**
 - Earth Station Subsystems
 - Systems Analysis for Communication Satellite
 - Spacecraft Payload Design
 - Antenna Design
 - Communication Systems Design
 - Network Planning and Relevant Software Development
 - Applications of TV and Radio for Development Communications
 - Economics of Satellite Communications
 - Domestic System Definition
 - Policy Research

ANNEXURE-II

M. Tech. Theses Submitted List

SATCOM-1

1. "Protocol Design of CDMA Based Mobile Satellite Network for Voice and Data"
Mr. Rajesh Kumar Uppal, India
2. "Study on Earth Station Reliability"
Mr. Mostafa Torabian, Islamic Republic of Iran.
3. "Study of Ku-Band VSAT Network for Nepal"
Mr. Dinesh Dev Pant, Nepal
4. "Study of Rain Attenuation on Earth-Space Downlink Operating at 12 GHz in Korea"
Mr. Min, Kyung Hyun, Republic of Korea
5. "Voice Coding & Decoding System Design & Software Development"
Mr. Lassana Weeratunge, Sri Lanka
6. "Study & Simulation of Video & Data Compression Techniques for Satellite Based Multimedia Applications"
Mr. Muthuthanthrige Saman Hemantha Cooray, Sri Lanka
7. "Design and Analysis of 3 m Dia. Earth Station Antenna-CAD Approach"
Mr. Botir Shucurillaevich Usmonov, Uzbekistan

SATCOM-2

8. "Study of Mobile Satellite Communication System"
Parimal Majithiya, India
9. "Study of Satellite System for Military Applications"
Mr. Ajay Malik, India
10. "Study and Simulation of Multi-Carrier Demodulator for On board Processing Communication Payload"
Mr. Himanshu M. Shah, India
11. "Development of CBT on Satellite Communication"
Ms. Erkhembaatar Narantuya, Mongolia
12. "Design of a Satellite Based Emergency Communications System"
Mr. Lok Raj Paneru, Nepal

SATCOM-3

13. “Study & Selection of suitable encryption schemes for Satellite Based Data Communication”
Mr. Deval Chitranjan Mehta, India

SATCOM-4

14. “Study of propagation Effects in Ka-band in India (study & Design)”
Mr. Damodar Mahipati Magdum, India
15. “Satellite based Communication system for Ship-borne Applications using INSAT”
Mr. Kumble Narendra Bhat, India
16. “Design & Development of Portable Communication System for Disaster Applications in Iran”
Mr. Hassan Rezazadeh, Islamic Republic of Iran

ANNEXURE-III

Country wise participation in SATCOM Courses (SATCOM-1 to SATCOM-6)

Country Name	No. of participants
Azerbaijan	1
Bangladesh	8
Bhutan	1
India	14
Indonesia	6
Iran	3
Korea DPR	6
Korea Rep.	1
Kyrgyz Rep.	6
Mongolia	16
Myanmar	1
Nepal	18
Philippines	1
Sri Lanka	4
Uzbekistan	5
Vietnam	1