**Course Profile**

**Course Title:** Digital and Satellite Communication **Course Code:** ETE 452

**Credit:** 3.0 **Total Marks:** 100 **Contact hour:** 1.5 hr

**Rationale:** Digital and Satellite Communication is one of the hottest areas in Telecommunication, Information Technology, Electrical and Electronic Branches. Digital and Satellite Communication is a regular course for ETE, CSE, IT and EEE students, both in Undergraduate and in Post Graduate Level. Digital and satellite Communication has also found applications in all engineering disciplines. However, critical understanding of the concepts from both theoretical and practical dimension is still lacking. This program will help the faculty and students to bridge this gap and enable them to better concepts for real life applications. In this region, there is a certain scope to enrich the research activities as well as industrialization. This course will be effective for the students, engineer, and industry personnel for enhancing the quality assessment of satellite communication system.

**Objective:** At the end of the course, the students will be able to:

* Build an understanding of the basic ideas of Digital and Satellite Communication system.
* Familiarize the student with the fundamental classification and terminology of the computer networking area.
* Introduce the student to understand the advanced satellite communication system.
* Prepare the student for entry advanced courses in Digital and Satellite Communication.
* Allow the student to gain expertise in some specific areas of networking such as the design, broadcast and maintenance of individual broadcast network.

|  |  |  |  |
| --- | --- | --- | --- |
| **Learning Outcomes** | **Course Content** | **Teaching Learning Strategy** | **Assessment Strategy** |
| 1. Know the historical background & development of Satellite communication.  2. Understand the different kind of communication system.  3. Understand the satellite transmission processes.  4. Understand the applications of satellite communication.  5. Know the future the satellite communication. | **Chapter 1.** **Introduction**  **1.1** Introduction.  Development of satellite communication.  **1.2** Different kind of communication system.  How satellite works.  **1.3** Communication Satellites.  **1.4** Satellite Applications.  The future of satellite communication. | Lecture, Discussion, Problem based learning, Exercise. | Assignment, Q/A, MCQ |
| 1. Understand the satellites orbit and orbit mechanics.  2. Understand the orbital velocity, Height and period of satellite systems.  3. Understand the Kepler’s Three laws of planetary motion.  4. Definitions of Terms for Earth-Orbiting Satellite.  5. Understand Orbital Elements.  6. Understand the Satellite frequency bands and LEO,MEO,GEO. | **Chapter 2. Orbiting Satellites, Satellite Frequency Bands and LEO, MEO, GEO.**  2.1 Introduction, Orbit mechanics: Developing the equations of orbit.  Orbital velocity, Height and period of satellite systems.  2.2 Kepler’s Three laws of planetary motion:  Describing the orbit of a satellite.  2.3 Definitions of Terms for Earth-Orbiting Satellite.  Orbital Elements.  2.4 Satellite frequency bands.  LEO,MEO,GEO | Lecture, Discussion, Problem based learning, Exercise | Assignment, Q/A, MCQ |
| 1. Understand Attitude and Orbit Control System. 2. Determine the orbit control systems. 3. The architecture and design of the AOCS subsystem | **Chapter 3**. **Satellite Subsystems: Attitude and Orbit Control System.**  3.1 Attitude and Orbit Control  Subsystem  AOCS Control Modes  3.2 AOCS Functional Block Diagram,  Attitude and Orbit Control Electronics.  3.3 Forces on a Satellite.  Relationship between axes of a satellite. | Lecture, Discussion, Problem based learning, Exercise | Assignment, Q/A, MCQ |
| 1. Understand the Satellite subsystems: Two principal subsystems- the platform and the payload.  2. The platform of satellite subsystem.  3. Understand the function and capabilities of the payload are the reasons a satellite is placed in orbit. The payload provides space­ based capabilities to the users.  4. Understand the control segment. The control segment is responsible for the operation of the overall system which includes platform control, payload control and network control. The control segment consists of ground satellite control facilities and systems on the satellites. | **Chapter 3. Satellite Subsystems: Telemetry, Tracking, Command and Monitoring**.  **3.4** Introduction Satellite subsystems- All satellites have two principal subsystems: The Platform and the payload.  **3.5** The platform consist of the following components and describe the components.  **3.6** Types of energy sources: Solar Energy, Chemical Energy, Nuclear Energy.  **3.7** Reliability of satellite systems  Failures | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Determine the Satellite Antennas. 2. Classify Satellite Antennas. 3. Determine the relations of Antennas with orbits. | **Chapter 4. Satellite Antennas**  4.1 Introduction. To Satellite Antennas  Basic Antenna Types and Relationships  **4.2** Typical satellite antenna patterns and coverage zones.  Satellite antennas in Practice  **4.3** Example. Global Beam antenna  Example. Regional Coverage Antenna | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand the Basic Transmission theory for satellite communication system. 2. Understand System Noise Temperature and G/T Ratio. 3. Find out the Calculation of system Noise Temperature with example. 4. Draw noise figure and Noise Temperature. | **Chapter 5. Satellite Link Design- Basic Transmission Theory, System Noise Temperature and G/T Ratio.**  5.1 Introduction all over the lesson  Basic Transmission Theory  Example  5.2 System Noise Temperature and G/T Ratio  Noise Temperature  5.3 Calculation of system Noise Temperature  Example  5.4 Noise Figure and Noise Temperature  Example  G/T Ratio for Earth Stations  Example | Lecture, Discussion, Problem based learning, Exercise | Do  [ |
| 1. Understand the basic concepts for design of Downlinks. . 2. Understand the Link Budgets 3. Link Budget Example: C-Band Downlink for Earth Coverage Beam .   Calculations of Downlinks/. | **Chapter 5. Satellite Link Design- Design of Downlinks.**  **5.5** Introduction the basic objectives of Downlinks and Uplinks Design.  Design of Downlinks  **5.6** Link Budgets  C-Band GEO satellite Link Budget in Clear Air  C-Band Downlink Budget in Rain  **5.7** Link Budget Example : C-Band Downlink for Earth Coverage Beam  Satellite Systems using small earth Satiations | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand the basic concepts for uplink design. 2. Understand the Link Budgets. 3. Link Budget Example: C-Band Downlink for Earth Coverage Beam .   Calculate the uplink design. | **Chapter 5. Satellite Link Design- Uplink Design.**  **5.8** Introduction the basic objectives of Uplinks Design.  Design of Uplink  **5.9** Link Budgets  C-Band GEO satellite Link Budget in Clear Air  C-Band Uplink Budget in Rain  **5.10** Link Budget Example : C-Band Uplink for Earth Coverage Beam  Satellite Systems using small earth Satiations | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand the importance of System Design. 2. Understand how to design Ku Band Uplink and Downlink system. 3. Rain Effects at Ku band. | **Chapter 5. Satellite Link Design- System Design Example (KU Band).**  **5.11** Ku-Satellite parameters  Transmitting and Receiving Ku-Band earth station.  **5.12** System Design Example  Ku-Band Uplink Design  Ku-Band Downlink Design  **5.13** Rain effects at Ku Band  Summary of Ku-Band link Performance  Personal Communication System Using Low Earth Orbit Satellites. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand the basic concept of Modulation and Multiplexing Techniques for satellite Communication. 2. Sketch, recognise and analyse the resulting waveforms for a sinusoidal carrier being frequency modulated by a single frequency audio signal. 3. Learn of Bandwidth of FM Signals. 4. Become familiar with Carson’s Rule. | **Chapter 6.**  **Modulation and Multiplexing techniques for satellite Links-**   * **Frequency Modulation**   **6.1** Frequency Modulation.  Waveform Equation for FM.  **6.2** Bandwidth of FM Signals: Carson’s Rule.  Baseband S/N Ration for FM Signals.  **6.3** Pre-emphasis and De-emphasis.  Sketch, recognise and analyse the resulting waveforms for a sinusoidal signal. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand S/N Ratio for FM Video Transmission system. 2. Learn SCPC FM Links. 3. Learn how to data transmit using analog FM channels. | **Chapter 6.** **Modulation and Multiplexing techniques for satellite Links-**  **Analog FM Transmission by Satellite.**  6.4Basic concept analog FM transmission process by satellite communication system.  Television signals.  **6.5** S/N Ratio for FM Video Transmission.  Example  FM Threshold.  **6.6** SCPC FM Links  Data Transmission using analog FM Channels. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Basic working principle of Digital transmission system. 2. Baseband Digital Signals. 3. Band-pass Transmission of Digital Data. 4. Transmission of QPSK Signals through a Band limited Channel. | **Chapter 6.**  **Modulation and Multiplexing techniques for satellite Links-**  **Digital Modulation .**  **6.7** Basic working principle of Digital transmission system.  Baseband digital Signals.  **6.8** Baseband Transmission of Digital Data.  Band-pass Transmission of Digital Data.  **6.9** Transmission of QPSK Signals through a Band limited Channel.  Example | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Basic working principle of Digital Modulation and Demodulation Process . 2. Modulation and coding. 3. Binary Phase Shift Keying (BPSK). 4. BPSK and QPSK Bit Error rate. | **Chapter 6 . Modulation and Multiplexing techniques for satellite Links-**  **Digital Modulation and Demodulation .**  **6.10** Basic working principle of Digital Modulation and Demodulation Process.  Modulation and Coding.  **6.11** Bit and Symbol Error Rates.  Binary Phase Shift Keying (BPSK).  BPSK and QPSK Bit error Rate.  **6.12** Generation of Quadrature Phase Shift Keying(QPSK) Signals.  QPSK Variants | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand Frequency Division Multiple Access (FDMA). 2. Understand Time Division Multiple Access (TDMA). 3. Understand Code Division Multiple Access (CDMA). | **Chapter 7. Multiple Access**  **7.1** Frequency Division Multiple Access (FDMA).  Intermodulation.  Channel Capacity with Demand Access FDMA.  **7.2** Time Division Multiple Access (TDMA).  Bits, Symbols, and Channels.  TDMA Frame Structure.  **7.3** Code Division Multiple Access (CDMA).  Spread Spectrum Transmission and Reception.  DS-SS CDMA Capacity. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand the Error Detection and Correction 2. Understand the Implementation of Error Detection on Satellite Links. | **Chapter 8.**   * **Error Detection and Correction** * **Implementation of Error Detection on Satellite Links**   **8.1** Error Detection and Correction  Channel Capacity  **8.2** Error Control Coding  Example  Linear and Cycle Block Codes  Golay Codes  **8.3** Performance of Block Error Correction Codes  Convolution Codes  **8.4** Implementation of error Detection on Satellite Links  Concatenated Coding and Interleaving | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Unde Understand the introduction of the propagation effects and impact on satellite earth links. 2. Understand the Qualifying Attenuation and Depolarization 3. Understand the propagation effects that are not associated with Hydrometeors. | **Chapter 9.**  **Propagation Effects and Their Impact on Satellite –Earth Links**  **9.1** Introduction  Qualifying Attenuation and Depolarization  **9.2** Propagation that are not associated with Hydrometeors  Cloud Attenuation  Tropospheric scintillation and low angle fading.  **9.3** Definitions of Terms for Earth-Orbiting Satellite.  Orbital Elements. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand Rain and Ice Effects. 2. Learn how to predict of Rain Attenuation. 3. Propagation Impairment Countermeasures. | **Chapter 9.** **Propagation Effects and Their Impact on Satellite –Earth Links**  **9.5** Rain and Ice effects.  Charactering rain and Rain Climate Maps.  Rain drop Distributions.  **9.6** Prediction of Rain attenuation.  Calculation of Long-Term statics for NGSO systems.  ITU-R Long term Frequency scaling of rain attenuation.  **9.8** Propagation Impairment Countermeasures.  Attenuation, Power Control, Signal Processing, Diversity, and Depolarization. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand the basic working principle of VSAT Systems. 2. Understand the Network architecture and Access Control Protocols. 3. Implement and utilize with basic techniques. | **Chapter 10**. **VSAT SYSTEMS**  **10.1** Introduction  Overview of VSAT Systems.  **10.2** Network Architecture.  One-Way Implementation.  Split-Two-Way (Split IP) Implementation.  **10.3** Access control Protocols. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Learn System design procedure. 2. Understand VSAT Earth station Engineering. | **Chapter 10.** **VSAT SYSTEMS**  10.3 System Design Procedure.  Description of System.  System Parameters.  10.4 Preliminary Calculations.  Link C/N ratios.  System Analysis.  10.5 VSAT Earth Station Engineering.  Antennas.  Transmitters and Receivers. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand the Orbit Considerations. 2. Coverage and Frequency Considerations. | **Chapter 11.**  **Low Earth Orbit and Non-Geostationary Satellite Systems.**  11.1 Introduction  Orbit Considerations- Equatorial Orbits, Inclined Orbits, Elliptical Orbits, Molniya Orbit , Radiation Effects, Sun synchronous Orbit.  11.2 Coverage and frequency considerations.  General aspects.  Frequency Band.  Number o Beams per Coverage.  Off-axis Scanning.  11.3 Determination of Optimum Orbital Altitude.  Radiation Safety and satellite Telephones. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand Delay and Throughput Considerations. 2. System Considerations. 3. Determine Operational NGSO Constellation Designs. | **Chapter 11.**  **Low Earth Orbit and Non-Geostationary Satellite Systems.**  11.4 Introduction  Delay and Throughput Considerations.  System Considerations.  11.5 System Considerations-  Incremental Growth.  Interim Operations End-to-End System Implementations.  11.6 Operational NGSO CoonstellationDesigns.  Ellipso, Globalstar, New ICO, Iridiam, Orbcomm, Skybrige. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand Digital DBS TV. 2. Learn How to Design DBS-TV system. 3. Learn about DBS-TV Link Budget. | **Chapter 12.**  **Direct broadcast Satellite Television and Radio**.  12.1 Introduction to Direct broadcast Satellite Television and Radio.  C-Band and Ku-Band Home Satellite TV.  12.2 Digital DBS TV.  DBS-TV System Design.  12.3 DBSTV Link Budget  . | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Error Control in Digital DBS-TV. 2. Installation of DBS-TV Antennas. 3. Satellite Radio Broadcasting. | **Chapter 12.**  **Direct broadcast Satellite Television and Radio.**  12.4 Error Control in Digital DBS-TV.  Master Control Station and Uplink.  12.5 Installation of DBS-TV Antennas.  Satellite Radio Broadcasting. | Lecture, Discussion, Problem based learning, Exercise | Do |
| 1. Understand Radio and satellite Navigation. 2. GPS Position Location Principles. 3. GPS Navigation Message. | **Chapter 13. Satellite Navigation and the Global Positioning system.**  13.1 Introduction.  Radio and satellite Navigation.  GPS Position Location principles.  13.2 GPS Receivers and Codes.  Satellite Signal Acquisition.  13.3 GPS Navigation Message.  GPS Signal levels.  . | Lecture, Discussion, Problem based learning, Exercise | Do |

|  |  |
| --- | --- |
| **Recommended Books and Materials** | |
| ***Text Books:***   1. Satellite Communications ,Second Edition,   Timothy Pratt, Charles Bostain,Jeremy Allnutt.   1. Satellite Communications ,Robert M. Gagliardi. | ***References:***   1. Satellite Communications, Fourth Edition, Dennis Roddy. |