M. E. Electronics & Telecommunication Engineering Examination 2025
(1st Year, 2nd Semester)
Satellite and Optical Communication System

Time: 3 Hours **Full Marks: 100**

Use separate answer script for each part
Answer all the parts of a question in the same place

PART I

CO-1 and CO-2
Answer any two questions (Marks: 2×10)

1. a) Why higher frequencies are used for uplink compared to downlink?
   b) Write the effects of solar eclipse and sun transit outage in satellite communication.
   c) For a satellite communication link with equal uplink and downlink performance, show that the composite system carrier to noise ratio is 3 dB below the value of each of the individual links.

(3+5+2)

2. a) Write the names and main functions of different sub-systems of a communication satellite.
   b) Derive an expression for (G/T) ratio at a receiving Earth station.

(4+6)

3. a) A certain 6/4 GHz satellite uplink has the following data: Earth station EIRP is 80 dBW; distance between the Earth station and satellite is 35780 km; attenuation due to atmospheric effects is 2 dB; satellite antenna's aperture efficiency = 0.8; satellite antenna's aperture area = 0.5 m^2 ; satellite receiver's effective noise temperature is 190 K; satellite receiver's bandwidth = 20 MHz; Determine the link margin for satisfactory quality of service if the threshold value of received carrier-to-ratio is 25 dB.
   b) Explain the effect of attenuation due to rain in the uplink and downlink satellite communication paths.

(7+3)

CO-4 and CO-5
Answer any three questions (Marks: 3×10)

4. a) What do you mean by dispersion? How is the data rate of the fiber link related to total dispersion?
   b) Explain the effects of microbending and macrobending losses in optical fiber.

c) Calculate the waveguide dispersion in a 1-km long single mode fiber link having core diameter 9 μm and cladding diameter 125 μm with core refractive index 1.48 and fractional refractive index difference 0.22%, operating wavelength = 1300 nm.

(3+4+3)

5. a) What do you mean by active optical component and passive optical component?
   b) With a neat diagram explain the working principle of an optical isolator.
   c) Write the advantages and disadvantages of a LASER over LED as an optical source.

(2+4+4)

6. a) Write the expression for power budget of an optical fiber link and also explain each term.
   b) Calculate the maximum possible link length for a long-haul single mode optical fiber system operating at a wavelength of 1300 nm. Specifications of the link are as follows.

   Mean power launched from the laser transmitter is -3dBm, Cable fiber loss is 0.4 dB/km, Splice loss 0.1 dB/km, Connector loss at the transmitter and receiver is 1 dB each, Mean power required at APD receiver when operating at 400 Mbps with BER 10^{-9} is -44 dBm, required safety margin is 7 dB.

(4+6)

7. a) With a neat block schematic briefly explain the operation of a WDM system.
   b) Describe some common applications of optical amplifiers.
   c) Write the applications of optical fiber for backbone and access networks.

(4+3+3)

PART II

CO-3

Answer Q4 (Marks: 10) and any two questions from Q1-Q3 (Marks: 2×20)

Q1. a) Consider a satellite communication sub-system of 24 transponders for the 6/4 GHz band operated with orthogonal circularly polarized signals. There are 12 numbers of 36 MHz bandwidth transponders for each polarization spaced 40 MHz apart. Moreover, all downlink channels are centered at a carrier frequency 2225 MHz bellow the corresponding uplink channel. Also, there is a 20 MHz offset between the transponders. Show the corresponding frequency plan for this satellite sub-system with neat sketches and proper justification. [8]

b) Consider that a TDMA frame is shared equally by the 'N' earth stations with a transmission bit rate of R_b bps. Also consider that the duration of TDMA frame is T_{frame} sec, guard time is

t_{guard} sec and preamble time is t_{pre} sec. Derive the expression of the number of channels/stations that can be carried by each station. [6]

c) A TDMA network of five earth stations shares a single transponder equally. The frame duration is 8 ms, the overhead time per station is 80 μs, and guard bands of 20 μs are used between bursts. Transmission bursts are QPSK at 30 Msps. Calculate the following:

i) The number of 256 Kbps channels that each TDMA earth station can transmit, assuming that each channel is encoded with rate ¾ FEC coding.

ii)The maximum number of channels that could be sent when the transmission is a continuous stream of data bits with no time lost in overhead or guard times.

iii)The efficiency of the TDMA system.

[4+1+1]

Q2. a) With a neat labelled diagram, show the configuration of the Intermediate Frequency (IF) bandwidth (54MHz) of a FDMA receiver, centered at 70 MHz with 25 data channels, each with an occupied bandwidth of 1.94 MHz. (No description is required). [3]

b) Draw the block diagram of the above IF section and explain its operation by identifying each block. [7]

c) Model the non-linear characteristic of the transponder High Power Amplifier (HPA) with a cubic voltage relationship and establish mathematically, how, the third order Inter Modulation (IM) products are generated in the transponder of the satellite communication system, using FDMA. [10]

Q3. a) Draw a labelled sketch to represent the GPS satellite signals. [2]

b) In the above context, discuss the following:

i) L1 and L2 carrier

ii) C/A code and P code [3+5]

c) Draw the block diagram of a Single Channel Correlator for C/A code acquisition used in GPS and explain its operation in detail. While describing its operation, include two situations: i) when the locally generated C/A code exactly matches the received code; ii) when the locally generated C/A code does not match the received code. [10]

Q4. Draw the Star and Mesh network configurations of VSAT and state the point of differences between them. [10]