Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2012-13 (2.0 hours)

EEE6420 Satellite and Optical Telecommunications

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

1. a. Discuss the role of a satellite telephone system in the context of enhancing the wireless communications networks on earth. **(4)**

b. Describe a satellite system currently in service for satellite telephone communications. Include the type of satellite, orbit, how earth coverage is achieved and the challenges faced by designers. **(6)**

c. A satellite based mobile phone communications system operates at 1.6 GHz. Calculate the distance of the user from the satellite.

System parameters are:

Satellite antenna diameter	1.2 m
Satellite antenna efficiency	80%
Satellite receiver antenna noise figure	600 K
Signal bandwidth	150 kHz
Satellite receiver noise figure	2 dB
Boltzman's constant k	1.38×10^{-23} J/K
Operating margin	15 dB
Uplink C/N	10 dB
Handset antenna gain	0 dB
Handset transmit power	6 W
Path length	? km

Note: antenna gain $4\pi A\eta/\lambda^2$

(10)

2. **a.** Describe the design of a typical dual reflector antenna used to receive satellite signals on earth.
How are the efficiency and noise performance of the antenna optimized? **(7)**

b. A satellite receiver operating at 12 GHz has a noise figure of 2 dB.
(i) If it is directly connected to an antenna/pre-amplifier with a gain of 7 dB and a noise temperature of 100 K, estimate the overall system noise figure.
(ii) If the antenna/pre-amplifier is now connected to the receiver via a 5 m length of coaxial cable with an attenuation of 3 dB, estimate the new system noise figure. **(7)**

c. Why is frequency reuse important in satellite communication systems?
Describe two different frequency reuse schemes. **(6)**

3. **a.** What are the main limitations of an optical fibre used for long distance communication? **(2)**

b. A high bit rate submarine optical fibre crossing the Atlantic ocean is to be designed. Which of the following devices and techniques would you recommend? Explain your choices.

i. A 1300 nm or 1550 nm wavelength of operation?
ii. LEDs or laser diodes?
iii. APDs or PIN photodiodes?
iv. Optical amplifiers or regenerative repeaters?
v. Coherent detection or intensity modulation/direct detection? **(5)**

c. A long distance optical fibre communication system needs a minimum received power at the photo detector of -60 dBm. The transmitted power is 5 dBm and the link losses are:

Fibre loss 2dB/km
Splice loss 0.2dB/km
Two connector losses at 3dB each
Operating margin 10dB

i. Calculate the maximum link length,
ii. If the fibre dispersion is 0.7 ns/km, for the length of fibre found in (a) determine the maximum transmission bit rate,
iii. Derive an expression for the bandwidth-length product in relation to fibre dispersion for a NRZ pulse stream. Calculate the maximum bit rate for a length of 20 km. **(11)**

d. Which fibre parameter should be changed to extend the range? Give your reasoning. **(2)**

4. **a.** i. What is wavelength division multiplexing? **(2)**

ii. Describe two multiplexing devices. **(8)**

b. i. Describe a Star network and a Bus network. **(2)**

ii. Derive expressions for the total loss in a Star network and a Bus network for N stations if passive couplers are used. **(6)**

iii. Hence determine the loss of both networks if N = 10, the stations are 500m apart, the fibre loss = 0.4 dB/km, and the couplers have the following parameters:

Tap loss L_{tap} = 10 dB

Connector loss L_c = 1 dB

Intrinsic transmission loss L_i = 0.5 dB

Through loss L_{thru} = 0.9 dB

Excess loss L_{excess} = 2 dB **(2)**

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