Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2009-2010 (2 hours)

Radio Frequency and Optical Communications 6

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. Describe two types of multiple access systems used for satellite links. **(8)**

What type is most likely to be used for a satellite mobile telephone link?

b. A satellite based mobile phone communications system operates at 1.6 GHz. Calculate the transmit power required from a handset of the system and comment on the result. **(12)**

System parameters are:

Satellite antenna diameter	1 m
Satellite antenna efficiency	80%
Satellite receiver antenna noise figure	500 K
Signal bandwidth	150 kHz
Satellite receiver noise figure	3 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
Path length	800 km

2. **a.** Discuss the advantages and disadvantages of satellite communication systems compared with terrestrial communication systems. **(5)**

b. Describe with the aid of a block diagram the main components of a communications system on board a satellite. **(8)**

c. What factors affect the choice of operating frequency for a commercial satellite system? **(4)**

d. Briefly describe two practical ways in which the communication capacity of a satellite link can be increased. **(3)**

3. **a.** Describe using diagrams the cross section and refractive index profile of a single mode step index (SI), a multimode SI and a multi mode graded index fibre. **(3)**

b. Compare the merits of each type of fibre above as optical communication channels using ray optics diagrams to describe the light propagation. **(6)**

c. In a certain optical fibre communication system the receiver needs a minimum power at the photo detector of -50 dBm. The transmitted power is 1 dBm and the link losses are:

Fibre loss 2dB/km
Splice loss 0.2dB/km
Two connector losses at 4dB each
Operating margin 10dB

i. Calculate the maximum link length, **(4)**

ii. If the fibre dispersion is 0.7 ns/km, for the length of fibre found in (a) determine the maximum transmission bit rate, **(3)**

iii. Derive an expression for the bandwidth-length product in relation to fibre dispersion for a NRZ pulse stream. Calculate the maximum bandwidth for a length of 30 km. **(4)**

4. **a.** Describe the topologies for a Bus, Ring and Star Network. **(6)**

What are the advantages of a star network over a bus network? **(1)**

b. A bus network of N stations uses passive optical couplers. Derive an expression for the total loss in the network. **(8)**

Hence determine the dynamic range of the network if N = 10, the stations are 500m apart, the fibre loss = 0.4 dB/km, and the couplers have the following parameters: **(5)**

Tap loss L_{tap} = 10 dB

Connector loss L_c = 1 dB

Intrinsic transmission loss L_i = 0.5 dB

RJL