UNIVERSITY OF SWAZILAND

MAIN EXAMINATION 2004/2005

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

TITLE OF PAPER: **TELECOMMUNICATION SYSTEMS AND**

OPTICAL AND MICROWAVE TRANSMISSION

COURSE NUMBER: **ECO530**

TIME ALLOWED: **THREE HOURS**

INSTRUCTIONS:

1. Answer any <u>FOUR</u> (4) of the following six questions.

2. Each question carries 25 marks.

3. Graph of BER performance for modulation schemes is attached.

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

THIS PAPER CONTAINS SEVEN (8) PAGES INCLUDING THIS PAGE

QUESTION ONE *(25 marks)*

(a) A Line of sight (LOS) microwave transmission system operates at a frequency of 7GHz over a distance of 40km and consists of a transmitter of output power 1 W, a 41.8 m waveguide with a loss of 0.05 dB/m and a total antenna of gain 70 dBi. Calculate

    (i) the EIRP, and   *(5 marks)*

    (ii) the RSL.   *(5 marks)*

(b) A satellite receiver operates at room temperature. Its noise figure is 11 dB and its bandwidth is 2 MHz. What is the thermal noise threshold of the system?

                                                         (3 marks)

(c) An isotropic receive level (IRL) is -121 dBW. The receive antenna gain is 31 dB and the line losses are 5.6 dB. What would the RSL be?   *(3 marks)*

(d) A radio system receives 1.544 Mbps and the RSL is -108 dBW. Calculate the energy per bit.   *(3 marks)*

(e) Given an LOS system where the frequency is 6 GHz and the gain is 35 dBi, what size of antenna would be used in the system?   *(6 marks)*

QUESTION TWO   *(25 marks)*

A decision has been made to establish a line-of-sight digital microwave link between two exchanges which are 40 km apart. The link operates in the 7-GHz band at a bit rate of 140 Mbps using 64 QAM. The BER for the link is 1×10^{-6} and the modulation implementation loss is 2 dB. The receiver noise figure is 8 dB and the antennas have 35 dB gain. If the transmission losses are 2 dB at each end, evaluate the link margin expected.   *(25 marks)*

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QUESTION THREE *(25 marks)*

(a) With the aid of a basic diagram, describe the main functions of a digital concentrator of a switching system.   *(7 marks)*

(b) In addition to the main functions of a concentrator, what additional functions and features are required in a remote concentrator?   *(3 marks)*

(c) (i)   What is the essential difference between a stand-alone exchange and a PABX.   *(2 marks)*

    (ii) What are the features and facilities offered by PABXs ?   *(3 marks)*

(d) A 1000-line exchange is connected to another 1000-line exchange. There are 120 circuits between the two exchanges. Assume that 40% of the traffic is local and that each line generates 0.3 erlangs. Find the probability of outgoing calls finding lines busy and your recommendation to the operator regarding the circuits between the two exchanges, giving the reasoning behind the recommendation.

(10 marks)

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QUESTION FOUR *(25 marks)*

(a)   (i)   Name and describe two optical light sources and detectors currently being used in telecommunications systems   *(4 marks)*

       (ii)   What causes material attenuation in silicon fibre?   *(2 marks)*

(b)   The refractive index for glass is 1.48 and the index for the cover material is 1.46. What is the half core angle?   *(5 marks)*

(c)   Find the propagation time at $\lambda = 1330$ nm for 10 km of glass fibre with a diameter of 4 μm, if the refractive index of glass is 1.48 and the index of the cover material is 1.45.

       (5 marks)

(d)   What is meant by modal dispersion and how does it relate to bandwidth?

       (3 marks)

(e)   In designing an optic fibre transmission system one has to consider the maximum capacity available in the market. In the SDH hierarchy, what is the highest bandwidth in operation in the market and what is its circuit capacity?   *(6 marks)*

QUESTION FIVE *(25 marks)*

(a)   (i)   What is a cell phone? Explain step by step from a technical point of view.

(5 marks)

       (ii)   When a cellular user crosses the boundary from one cell to another the call is not terminated. Explain why this is so.   *(5 marks)*

(b)   Given that a cellular mobile network is based on 9 cell cluster pattern operating in the 1900 MHz band, calculate:

       (i)   the mean re-use distance ratio   *(2 marks)*

       (ii)   the carrier-to-interference ratio (C/I)   *(3 marks)*

(c)   A base station operating at 900 MHz, situated at a site 500 meters above sea level transmits 10 W with a 30 dB gain antenna and a 3 dB feeder loss. The average land usage is 50% and the average ground height of the mobile is 200 m above sea level. What will be the received signal level operating 1 km away from the base station assuming 0 dB gain and 0 dB feeder loss.   *(10 marks)*

QUESTION SIX *(25 marks)*

(a)   What steps would be involved in multiplexing 120 circuits into a 140 Mbps transmission system?   *(5 marks)*

(b)   Four exchanges as shown below are to be interconnected using SDH technology and optic fibre and one STM-1 is dropped/inserted at every exchange. Give a diagram of a secure network with minimum node interconnections.   *(5 marks)*

Fig. Q.6b

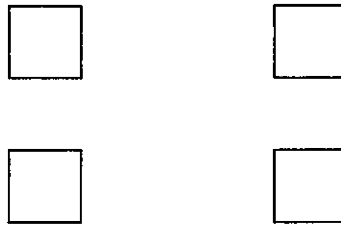**(c)**   Explain the difference between channel-associated signaling and common-channel signaling.   Which one is applicable to ISDN and why?

                                                                                                    (5 marks)

(d)   Explain the difference between an ISDN BRA and a PRA; and with the aid of a diagram explain the components of a user network as standardized by the ITU.

                                                                                                    (10 marks)

======= *END OF QUESTION PAPER, ATTACHMENT FOLLOWS* =======

BER PERFORMANCE FOR SEVERAL MUDULATION TYPES

Code	Modulation
A	BPSK, QPSK
B	8-phase
C	16-QAM
D	32-QAM
E	64-QAM

BER where BER is 10 xx exp

Energy-per-bit/Noise-density in dB E_B/N_0