UNIVERSITY OF SWAZILAND

MAIN EXAMINATION, SECOND SEMESTER, MAY 2009

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TITLE OF PAPER:	TELECOMMUNICATIONS SYSTEMS
	OPTICAL FIBRE AND MICROWAVE TRANSMISSION
COURSE NUMBER:	ECO530
TIME ALLOWED:	THREE HOURS

INSTRUCTIONS:

1) There are six questions in this paper. Answer **Question 1** and any other **three** questions.

2) Each question carries 25 marks

3) Marks for different sections are shown on the right hand margin.

4) Erlang B Tables are provided.

This paper has 7 pages including this cover page

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

QUESTION 1

a. Demonstrate the relationship between the basic elements of a telecommunications network by producing a basic network diagram of a telecommunication network that gives service to 4 cities.

(5 marks)

b. With the aid of a diagram, define and describe the process of 64 kb/s PCM A/D conversion based on commercial speech.

(5 marks)

c. A 30kHz analog signal is to be digitised for transmission over a digital link using advanced encoding techniques utilizing 3 bits per sample using European standard. What is the transmission rate?

(4 marks)

d. Optic fibre is one of the mediums used in transmission systems. If light is launched into optical fibre with refractive indices for core and cladding of 1.48 and 1.46 respectively, what is the minimum acceptable core half angle.

(6 marks)

e. A satellite receiver operating at room temperature (290k) with noise figure 8dB, receives a 1Mb/s QPSK modulated signal and the received signal level is −108dBW. What is the energy per bit over noise per bit (E_b/N_o)?

(5 marks)

QUESTION 2

a) Give the basic diagram of a subscriber line interface card (SLIC) and briefly
   describe its main functions in the switching system.

   (10 marks)

b) During the busy hour, 1600 calls were offered to a group of trunk & 240 calls
   were lost. The average call duration was 3 min. What is the

       i.   Offered Traffic

                                       (2 Marks)

       ii. Carried traffic

                                         (1 mark)

       iii. Lost traffic

                                           (1 mark)

       iv. Grade of Service

                                           (1 mark)

c) What is the relationship between the traffic offered and the holding time?
   Given that the traffic observed over 10 mins for 20 circuits is 2 Erlangs, what
   would be the holding time?
   Obtain the Grade of Service.
   If it is required that the Grade of Service be improved to 0.001, use the Erlang B
   table to find the number of circuits that would be required.

   (5 marks)

d) A 30 extensions PABX is connected to the local exchange with 4 lines for out
   going traffic. Assuming 80% of the PABX traffic is local and each line generates
   0.2 Erlangs, what is the probability of outgoing calls finding lines busy.

   (5 marks)

QUESTION 3

a. With the aid of a diagram, describe the ISDN reference model as
prescribed in ITU-T Recommendations I.411 and I.430 by providing the
configuration of ISDN user-network.

(9 marks)

b. Give the structure of ITU No. 7 signalling which is compatible with ISDN
and explain the function at each level.

(7 marks)

c. Give two main reasons why channel associated signalling is not
compatible with ISDN.

(4marks)

d. Explain why channel associated signalling is not compatible with ISDN
What is the main difference between basic rate ISDN (BRI) and primary
rate ISDN (PRI)?

By outlining what each component is used for, show how the bit rate of
192Kb/s is arrived at for a basic rate access ISDN.

(5 marks)

QUESTION 4

a. For a transmitter of output of 1 watt, with feeder loss of 3dB and a 1.2 metre dish operating at 2GHz, what will be the EIRP?

(6 marks)

b. A 45 km hop operating at 6 GHz is to be implemented using a microwave transmission system. Assume that the transmitter power is 1 watt, total feeder loss is 6 dB and the required minimum received signal level is −70dBW with a fade margin of 10dB. Calculate the total antenna gain for the link?

(9 marks)

c. A 50 km link is installed with a total antenna gain of 60 dBi, operating at 2 GHz, with a transmitter of 1 watt and total feeder loss of 6 dB.

i) Find the available incident signal level.   (6 marks)

ii) What is the actual received signal level (RSL)?   (4 marks)

QUESTION 5

a. Explain the differences in the following transmission mediums and their advantages and disadvantages:

    i. Copper pairs

    ii. Coaxial cable

    iii. Optic Fibre

    iv. Microwave Radio

    v. Satellite

(5 marks)

b. A 4 node transmission ring is to be created to protect the 4 nodes. The traffic between node 1 & all other nodes warrants at least 4000 circuits and the traffic between all other nodes warrants less than 2000 circuits. Draw a diagram of your proposed ring and justify the capacities.

(8 marks)

c. Draw a cross section of a twelve core, 1310nm, single mode optic fibre cable. Label it and explain what losses are expected in a 60 km link.

(5 marks)

d. If the refractive indexes are given as n1=1.457 and n2=1.343 cabulate and demonstrate the location of each of the following angles:

    i. Critical angle

    ii. The acceptance angle

    iii. The numerical aperture

(7 marks)

QUESTION 6

a. Give the general structure of a cellular public land mobile network (PLMN) as standardized by the ITU.

(3 marks)

b. What is a cell phone? Explain step by step. (4 marks)

c. When a cellular user crosses the boundary from one cell to another, the call is not terminated. Explain why? (4 marks)

d. Given that a cellular mobile network is passed on the 3 cell cluster pattern (operating in the 900 MHz band), calculate:

   a. The mean re-use distance ratio, (2 marks)

   b. The carrier to interference ratio (C/I) (2 marks)

e. Given that a micro cell GSM 900 network is designed based on three RF carriers/cell, each cell is $500m^2$, and that each user generates 0.03 Erlangs. Assumming a Grade of Service of 2% (ie Erlang B tables 24 channels gives 15.3 Erlangs per cell), how many users per square kilometre may be served by the network?

(5 marks)

f. What would be the propagation loss if the radial distance from the base station to the mobile station was 1500 m and the height of the tower was 25m and the height of the mobile was 1m?

(5 marks)