UNIVERSITY OF SWAZILAND

MAIN EXAMINATION APRIL/MAY 2008

TITLE OF PAPER: TELECOMMUNICATIONS SYSTEMS

OPTICAL FIBRE AND MICROWAVE TRANSMISSION

COURSE NUMBER: ECO530

TIME ALLOWED: TWO HOURS

INSTRUCTIONS:

1) Answer **any FOUR (4)** of the following six questions.

2) Each question carries 25 marks.

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

This paper has 7 pages including this page

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QUESTION 1

a. Give the basic elements of a telecommunications network and their functions.
(4 marks)

b. The OSI model is the standard model for communication in the ICT era. Draw the model and significantly explain what takes place at each layer.
(10 marks)

c. Name five basic functions of Signalling and explain the significance of CCITT/ITU-T Signalling System No. 7.
(7 marks)

d. Explain what multiplexing is and name and define two types of Multiplexing.
(4 marks)

QUESTION 2

a) Give the basic diagram of, and describe:

(i) the main functions of a digital concentrator of a switching system.
(5 marks)

(ii) In addition to the main functions of a concentrator, what three additional functions and features are required in a remote concentrator?
(5 marks)

b) Briefly describe the structure of the stored program control (SPC) software and give the main requirements of the application software of switching systems.
(5 marks)

c) A Call Center handles 45 calls per hour with 8 minutes per call and 10% grade of service.

(i) Calculate the traffic.

(ii) What is the number of agents needed to keep the grade of service at 10%?

(iii) What will be the grade of service if you lower the number of agents by two?

(5 marks)

d) Six agents will be selling insurance and at peek times they will spend on average 20 minutes per hour on the phone. Each phone is connected to the PBX. How many trunks are required if the grade of service is to be 0.05? What would you do to bring the grade of service up to 0.01? Give two options.
(5 marks)

QUESTION 3

a. Give the standard definition of integrated services digital network (ISDN) and explain the basic requirements for ISDN to exist in a network.

(5 marks)

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

(2 marks)

c. Give the structure of CCITT No. 7 signalling compatible with ISDN and explain the function at each level.

(3 marks)

d. What is the main difference between basic rate ISDN (BRI) and primary rate ISDN (PRI)? Show how the bit rate of 192Kb/s is arrived at for a basic rate access ISDN by outlining what each component is used for.

(5 marks)

e. 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.

(10 marks)

QUESTION 4

a. Given a receiver with an effective noise temperature of 110K, and a 10-MHz bandwidth, what is the thermal noise level at the output?

(4 marks)

b. A 40-km hop operating at 18 GHz is to be implemented using a microwave system. Assume transmitter power of 1 W, total feeder loss of 6 dB and required minimum received signal level of –70dBW with a fade margin of 10dB. What will be the total antenna gain for the link? What will be the diameter of this antenna and what would be your recommendation?

(10 marks)

c. A transmitter has an output power of 1 W, and a 6-metre dish operating at 3 GHz. What will be the EIRP?

(5 marks)

d. A 40 km link is installed with a total antenna gain of 60 dBi, operating at 7 GHz, with a transmitter power of 1 W and total feeder loss of 6 dB.

i) What will be the incident received signal level? **(4 marks)**

ii) What is the received signal level? **(2 marks)**

QUESTION 5

a. Explain the basic difference(s) between the ITU specified cell phone network and GSM network.

(5 marks)

b. What is a cell phone (handset)? Explain the functions of its different parts.

(5 marks)

c. Explain why frequency reuse is critical in a cellular network and how you would go about calculating the reused distance in a 7-cell cluster.

(5 marks)

d. A base station operating at 900 MHz, situated at 300 metres above sea level, transmits 10 watts with a 30dB gain antenna and 3dB feeder loss. The average land usage is 40% and the average ground height of the mobile is 200 metres above sea level. Calculate the received signal level at a distance 1 km from the base station, assuming 0 dB gain and 0 dB feeder loss?

(10 marks)

QUESTION 6

a. Explain what is meant by material attenuation in silicon fibre and give two types of material attenuation.

(2 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 the other nodes warrants less than 2000 circuits. Draw a diagram of your proposed ring and justify the capacities and label the equipment and medium to be used.

(10 marks)

c. Draw a cross section of a twelve-core, single mode, 1310nm, optic fibre cable, Label your diagram clearly and explain what losses are expected for a 40-km aerial cable link.

(5 marks)

d. If the refractive indexes of an optical fiber are given as is n1=1.457 and n2=1.343 calculate

- **(i)** the critical angle
- **(ii)** the acceptance angle
- **(iii)** the numerical aperture
- **(iv)** the bandwidth for 60 km of the fibre, and
- **(v)** show the location of each angle using a diagram.

(8 marks)