

UNIVERSITY OF SWAZILAND

FINAL EXAMINATION 2011

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 ONE and any other THREE questions.**
 - 2) Each question carries 25 marks
 - 3) Marks for different sections are shown on the right hand margin.
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THIS PAPER HAS 7 PAGES INCLUDING THIS PAGE

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QUESTION 1 (COMPULSORY) (25 marks)

- a. What are the terrestrial propagation models that are used in the design of line of sight systems? Which one is generally used and why?
(5 marks)
- b. A 45-km hop operating at 3 GHz is to be implemented using a microwave system. The transmitter power is 1 W, total feeder loss is 6 dB and the required minimum received signal level is -70 dBW with a fade margin of 10 dB. Calculate the total antenna gain for the link?
(5 marks)
- c. A satellite link is operating with QPSK modems for TDMA signals at 140 Mb/s. The modems are within 2 dB of the theoretical QPSK modem. Due to link impairments, an additional 2 dB degradation in performance exists. If the theoretical E_b/N_0 is 11.5 dB (to maintain the required probability of error) determine
- i. The required E_b/N_0 and **(2 Marks)**
 - ii. The C/N to be measured. **(2 Marks)**
- d. Calculate EIRP of a Line-of-Sight (LOS) microwave transmitting system consisting of a 1-W power output transmitter, a 22 m long wave guide with a loss of 0.05dB/m and an antenna of gain 30 dBi.
(5 Marks)
- e. Calculate the received signal level (RSL) and the size of the dish for a 50-km link operating at 7 GHz with a transmitter output of 1 W, total antenna gain of 60dBi and total feeder loss of 6 dB.
(6 Marks)

QUESTION 2 (25 marks)

- a. Draw a block diagram of a generic digital switch and list the 8 basic functions expected from a digital switch. **(10 marks)**
- b. Show your understanding of switching by explaining the differences between the following:
- a. Analogue switch and a digital switch **(1 mark)**
 - b. Circuit switching and packet switching **(1 mark)**
 - c. A space switch and a time switch. **(1 mark)**
 - d. Draw a diagram of an S-T-S switch. **(1 mark)**
- c. With the aid of a diagram, describe the basic steps involved in the conversion of an analogue signal into a PCM signal. **(6 marks)**
- d. An 8-MHz analogue signal is to be digitised for transmission over a digital link using advanced encoding techniques and 8 bits per sample European standard. What is the transmission rate? **(5 marks)**

QUESTION 3 (25 marks)

- a. i. Draw a four-node ring topology SDH Network, with two digital switches requiring more than 2000 circuits and the other two requiring less than 10 circuits.
(4 Marks)
- ii. What is the most powerful tool in the SDH technology? Explain why it is so.
(2 Marks)
- i. What is STM-16 in terms of bandwidth (show your calculations)?
(2 Marks)
- ii. What is STM-4 in terms of the number of circuits available (show your calculations)?
(2 Marks)
- c. Explain the following terms as applied to SDH:
i) Virtual Container
ii) Tributary Unit
iii) Container
iv) Section Overhead
v) Concatenation
(5 marks)
- d. In designing an optical fibre communication system what four basic system parameters have to be considered?. Explain why optical fibre has an advantage over other transmission media.
(6 Marks)
- e. Light is launched into optical fibre with refractive indices for core and cladding of 1.47 and 1.45 respectively. What is the minimum acceptable core half angle?
(4 Marks)

QUESTION 4 (25 marks)

- a. Define ISDN and name two types of ISDN. **(2 Marks)**
- i) Show the calculations of the bandwidth for each of the two types of ISDN. **(4 Marks)**
- ii) List four types of services that can be carried on ISDN. **(2 Marks)**
- b. 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. **(7 Marks)**
- c. Give the structure of ITU No. 7 signalling which is compatible with ISDN and explain the function at each level and give two main reasons why channel associated signalling is not compatible with ISDN. **(10 Marks)**

QUESTION 5 (25 marks)

- a. Give the general structure of a cellular public land mobile network (PLMN) as standardized by the ITU. Explain the function of each component.
(10 marks)
- b. Given that a micro cell GSM 900 network is designed based on three RF carriers per cell, each cell is 1000m^2 , and that each user generates 0.3 Erlangs. How many users per square kilometre may be served by the network:
a. Assuming a 0.002 grade of service?
b. Assuming a 0.1 grade of service? (Erlang B table is attached at the end of paper)
(9 Marks)
- c. What would be the propagation loss if the radial distance from the base station to the mobile station was 2000 m and the height of the tower was 20m and the height of the mobile was 1m?
(6 Marks)

QUESTION 6 (25 marks)

- a. Name and define two types of attenuation found in silicon fibre
(4 Marks)
- b. In order to use optical fibre for transmitting signals there has to be an optical source and a detector.
- i. Give two light sources and the advantage and disadvantage of each.
(3 Marks)
- ii. Give two optic detectors and the advantage and disadvantage of each
(3 Marks)
- c. Explain the theory of modal dispersion. How does it relate to bandwidth?
(4 marks)
- d. Given that the refractive index of glass as 1.457 and the refractive index of the covering material as 1.343, find the critical angle.
(3 Marks)
- e. In an optic fibre link budget, what are the three factors we should consider when assigning a dB value to the link margin.
(3 Marks)
- f. An optic fibre with a bit rate of 622 Mb/s has a laser diode with an output of 0 dBm and APD-based receiver with a threshold of -40 dBm. Design a link around these parameters. What is the maximum length achievable without repeaters?
(5 Marks)

=== END OF QUESTION PAPER, ERLANG B TRAFFIC TABLE FOLLOWS ===