

**UNIVERSITY OF SWAZILAND**  
**MAIN EXAMINATION MAY 2007**  
**FACULTY OF SCIENCE**  
**DEPARTMENT OF ELECTRONIC ENGINEERING**

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**TITLE OF PAPER:** TELECOMMUNICATIONS SYSTEMS.  
OPTICAL AND MICROWAVE TRANSMISSION

**COURSE NUMBER:** ECO530

**TIME ALLOWED:** THREE HOURS

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**INSTRUCTIONS:**

- 1) This paper contains 5 questions. 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 6 pages including this page

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

**QUESTION 1 (COMPULSORY) (25 marks)**

- (a) What are the terrestrial propagation models that are used in the design of line of sight systems and which one is generally used and why?  
**(5 marks)**
- (b) A 45 km hop operating at 3GHz is to be implemented using a microwave system. Assuming transmitter power of 1 watt and total feeder loss of 6dB, the required minimum received signal level is  $-70\text{dBW}$  with a fade margin of 10dB. What will be the total antenna gain for the link?  
**(5 marks)**
- (c) A satellite link is operating on QPSK modems for TDMA signals at 140Mb/s. The modems are within 2dB of the theoretical QPSK modem. Due to link impairments, additional 2dB degradation in performance exists. If the theoretical  $E_b/N_o = 11.5\text{dB}$  (to maintain the required probability of error) determine
- (a) The required  $E_b/N_o$  and **(2 Marks)**
- (b) The C/N to be measured **(2 Marks)**
- (d) Calculate EIRP of a Line of Sight(LOS) microwave transmitting system where the transmitter has a 1 Watt power output, a 20m wave guide with a loss of 0.05 dB/m and the antenna gain of 30 dBi.  
**(5 Marks)**
- (e) Calculate the RSL and the size of the dish if there is 50 km link, that is operating in the 6GHz frequency, has a transmitter output of 1 Watt, a total antenna gain of 60 dBi and a 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 difference 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. In addition, draw a diagram of a S-T-S switch. **(1 mark)**

(c) With the aid of a diagram, describe the basic steps involved in the development of a PCM signal

**(6 marks)**

(d) A 10 MHz analog signal is to be digitised for transmission over a digital link using advanced encoding techniques utilizing 8 bits per sample using European standard. What is the transmission rate?

**(5 marks)**

**QUESTION 3 (25 marks)**

- (a) 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)**  
and answer the following questions:
- i. What is the most powerful tool in the SDH technology and explain why **(2 Marks)**
  - ii. What is STM-16 in terms of bandwidth (Show your calculations) **(2 Marks)**
  - iii. What is STM-4 in terms of the number of circuits available(Show your calculations) **(2 Marks)**
- (b) Explain the following terms as applied to SDH:  
i) Virtual Container  
ii) Tributary Unit  
iii) Container  
iv) Section Overhead  
v) Concatenation **(5 marks)**
- (c) In designing an optic fibre communication system what four basic system parameters have to be considered, name them. And explain why optic fibre has an advantage over other transmission mediums. **(6 Marks)**
- (d) 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 the two types of ISDN **(2 Marks)**
- i. Show the calculations of the bandwidth for each type 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

(a) Give the general structure of a cellular public land mobile network (PLMN) as standardized by the ITU. And explain the function of each component.  
(10 marks)

(b) Given that a micro cell GSM 900 network is designed based on three RF carriers/cell, each cell is  $1000\text{m}^2$ , 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 provided)

(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)