The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

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Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Codes and Title	**: EEX6339 WIRELESS COMMUNICATION**
Academic Year	: 2020/21
Date	: 09th January 2022
Time	: 09:30-12:30hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **six (06)** questions in **four (04)** pages.
3. Answer all the questions in Section I (60 marks).
4. Answer ONLY **two (02)** questions in Section II (40 marks). Each question in Section II is worth 20 marks.
5. Calculators are permitted to use.
6. This is a Closed Book Test (CBT).
7. Do not use a red colour pen to write the answers.

SECTION I

Question 1 **(20 marks)**

1) Consider a transmitter transmitting at 1MHz with 50W power using an antenna with 1.5 gain. The terrain between the transmitter does not have any obstructions. The receiving antenna has a gain of 2. (10 marks)
   a) State the type of fading that occurs in this scenario.
   b) State the suitable propagation model for this scenario. Clearly state any assumptions and support your answer with reasons.
   c) Calculate the received power in dBm at a far-field distance of 10km. Assume the system loss of 1 in your calculations.

2) Consider the following scenario and answer the following questions. Separation between the transmitter and the receiver is 20km, Effective heights of the mobile station and the base station antennas are given as 3m and 200m respectively. The base station transmits with an EIRP of 0.5kW at 1MHz. Gain of the receiving end antenna is 2. (10 marks)
   a) Find the approximate median path loss using the Okumura model for the given scenario using the curves shown in Figure 1.
   b) Calculate the free space loss.
   c) Calculate the base station antenna gain factor and the mobile station antenna gain factor.

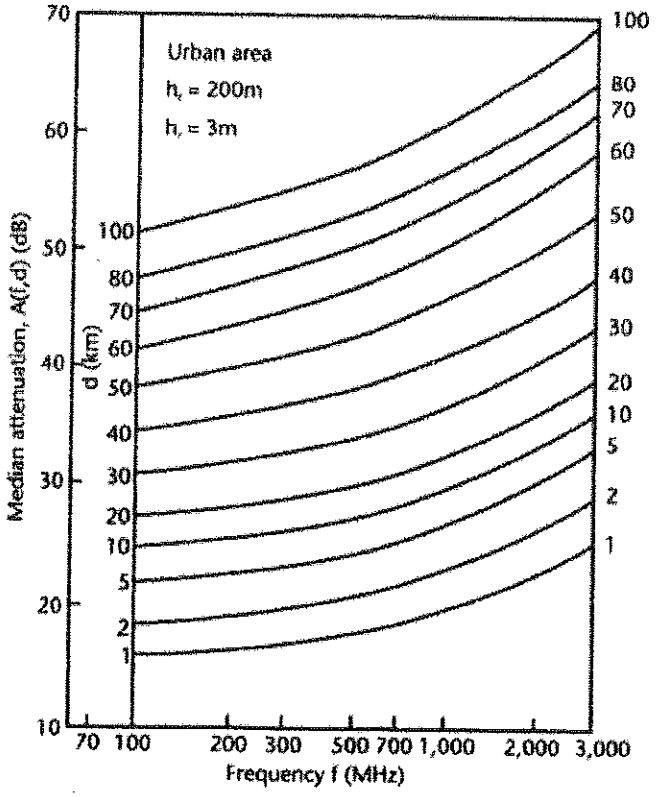

Figure 1

Question 2 **(20 marks)**

1) Discuss at least three limitations of using linear filters for channel equalization in wireless communication systems. (04 marks)

2) Describe a general decision feedback equalizer (DFE) using an appropriate block diagram. (05 marks)

3) Describe a modification that you can make to the DFE in 2) above to mitigate possible error propagation in estimation. (03 marks)

4) State the main requirement from the transmitter for the adaptive equalizers to begin the adaptation. (03 marks)

5) Consider a binary symmetric channel (BSC) denoted as BSC(p) where p is in the range of [0,1].
   a) If the entropy function is given as H(p), write an expression for the channel capacity. (02 marks)
   b) Write the expressions to compute the probability of reception for all possible transmission and reception of single bits in BSC. (03 marks)

Question 3 **(20 marks)**

1) In a GSM communication system, assume that 100 MHz is available for forward channels. Each channel is 200 kHz. However, when using TDMA, 8 simultaneous calls can be made on each channel. Calculate the frequency reuse factor when i) N=4, ii) N=7 and iii) N=11. (05 marks)\

2) Compare and discuss the advantages and limitations of frequency reuse and cell splitting techniques which aim at increasing the capacity in a cellular system. (04 marks)

3) Discuss the limitations of channel assignment strategies in a cellular communication system to achieve minimum interferences. (05 marks)

4) A mobile user in a vehicle moves at a speed of a mobile be V = 35 m/s. Power requirement can be expressed as $P = \Gamma - 10n \log_{10}(d)$ where 'Γ' is a constant and 'd' is the distance (in meters). You can consider having the threshold power level at the edge of the cell. To complete the handoff it takes 03 seconds. (06 marks)
   a) Derive two expressions using the above formulation to compute the minimum average power (P_{min}) when the vehicle is at the center of the cell and threshold power (P_{thr}).
   b) For n = 4, a cell radius of R= 500m, calculate the handoff margin in dB when make-before-break hand-off takes place.

SECTION II

Question 4 **(20 marks)**

1) Uplink of a GSM system requires a signal-to-noise ratio of 10 dB. Assume a maximum mobile transmit power of 30 dBm, 0dB antenna gain at the mobile, and 12dB gain at the base station. Assume path loss is given by the urban area Hata model, with fc = 850 MHz. Consider the base station antenna height of 30m, mobile height of 1m. Assume that the other losses are insignificant. calculate the maximum range of the link. (10 marks)

2) Design an OFDM system to operate in a 20 MHz bandwidth at 1300 MHz in outdoor environments with large delay spreads of 5μs. (06 marks)
   a) Calculate the symbol period.
   b) Do you think it is necessary to use multi-carrier modulation? Support your answer with reasons.

3) Discuss advantages and disadvantages of using block codes in communication systems. (04 marks)

Question 5 **(20 marks)**

1) Name the two spread spectrum modulation techniques and describe the advantages of each technique. (10 marks)

2) Selection combining method is one of the techniques that can be used to combine the signals received from diversity branches in a wireless communication system. (10 marks)
   a) Describe the principle used for selection combining.
   b) Calculate the required fade margin considering the number of branches (M=2) are statistically independent channels undergoing Rayleigh fading and are required to be above the prescribed threshold with 0.99 probability.

Question 6 **(20 marks)**

1) Describe the following multiple access methods using appropriate diagrams to support you answer: (06 marks)
   a) Frequency division multiple access
   b) Time division multiple access
   c) Code division multiple access

2) Maximal length sequences are generated using linear shift registers connected with tap points and modulo-2 addition. (10 marks)
   a) Write the recursive relations for outputs at S1, S2, S3, S4, and S5.
   b) Compute the first five outputs of the linear feedback shift register shown in Figure 2, if the initial state is 00101.

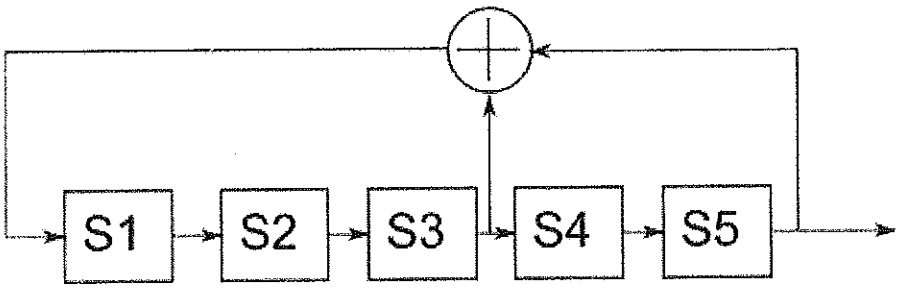

Figure 2

3) Describe an application of using mobile adhoc networks (MANETs) and discuss advantages and limitations in using MANETs. (04 marks)