AFE BABALOLA UNIVERSITY, ADO-EKITI
DEPARTMENT OF ELECTRICAL ELECTRONIC AND COMPUTER ENGINEERING
SECOND SEMESTER 2018/2019 EXAMINATION, APRIL 2019.
COURSE TITLE: WIRELESS COMMUNICATION (EEE 536)
TIME ALLOWED: 3 HOURS

INSTRUCTION: ANSWER QUESTION 1 AND ANY OTHER FOUR

QUESTION 1

(a) Describe the following terms, indicating their importance in wireless communication systems.

(i) Handoff [2 marks]

(ii) Mobile telephone switching office (MTSO) [2 marks]

(iii) Public Switched telephone network (PSTN) [2 marks]

(b) Mention any four empirical path loss models and specify their respective frequency range of applicability. [4 marks]

(c) Consider the set of empirical measurements of $\frac{P_r}{P_t}$ given in the Table 1 for an indoor system at 6 GHz.

Table 1

Distance from transmitter (m)	$\frac{P_r}{P_t}$ **in (dB)**
10	-70
20	-75
30	-95
80	-110
150	-120

(i) Find the path loss exponent γ which minimizes the error between the simplified model and the empirical loss measurement. Assume $d_0 = 1\,m$ and K is determined from the free space path loss formula $K(dB) = -20\log_{10}\left(\frac{4\pi d_0}{\lambda}\right)$. [8 marks]

(ii) Compute the received power at $150\,m$ for the simplified path loss model with this path loss exponent and a transmit power of $1\,mW$. [2 marks]

QUESTION 2

(a) (i) Define the term "Multiuser MIMO System" and enumerate any three (3) merits offered by the system. [4 marks]

(ii) In terms of basic wave properties, define the term "critical distance" and highlight the key importance of this term to radio planning. [3 marks]

(b) (i) Discuss the frequency-distance tradeoff of wireless signal transmission. [2 marks]

(ii) Mention any three options that can be explored in order to improve the transmission range in the presence of signal impairments. [3 marks]

(c) (i) Given that at a ground reflection coefficient of 0.26, the path loss of the two-ray model shown in Figure Q2 is 40 dB, determine the gain of the horizontally polarized receive antenna in the LOS direction if that of the transmit antenna is 0.61. [6 marks]

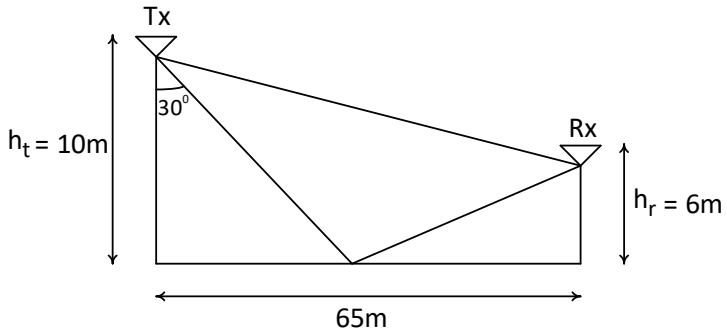

Figure Q2

(ii) What is the dielectric constant under the above transmission condition? [2 mark]

QUESTION 3

(a) (i) Define and explain the essence of the term "diversity" in radio frequency communication. [6 marks]

(ii) Describe any two techniques whereby diversity can be achieved. [4 marks]

(b) With the aid of applicable sketches, describe any three diversity combining techniques for receivers. [6 marks]

(c) The individual branch signal for a common combining technique is expressed as

$$x_n = A \cdot h_n + \xi_n$$

Explain the expression and explicate each variable. [4 marks]

QUESTION 4

(a) Explain the phenomenon that results in the term "multipath propagation" [4 marks]

(b) Enumerate the difference between "path loss" and "shadowing" [4 marks]

(c) Discuss the modifications that can be implemented in order to take advantage of multipath propagation in MIMO systems. [3 marks]

(d) (i) Consider an indoor wireless LAN with $f_c = 900\,MHz$, cells of radius $100\,m$, and non-directional antennas. Under the free space path loss model, what transmit power is required at the access point such that all terminals within the cell receive a minimum power of $10\,\mu W$.

[7 marks]

(ii) How does this change if the system frequency is 5 GHz? [2 marks]

QUESTION 5

(a) Define the term "Digital Modulation" [4 marks]

(b) Mention any four (4) likely channel impairments when signals are transmitted through free space. [4 marks]

(c) Digital modulation can be classified using the memory criterion and linearity criterion, discuss the two groups of modulation under each criterion. [4 marks]

(d) Show that the average energy ε_{avg} for a signal $S_m(t) = A_m p(t)$ whose amplitude A_m is described as

$$A_m = 2m - 1 - M, \qquad m = 1, 2, \ldots M$$

Can be expressed as

$$\varepsilon_{avg} = \frac{(M^2 - 1)\varepsilon_p}{3}$$

[4 marks]

QUESTION 6

(a) Using a suitable diagram, describe the dielectric canyon. [4 marks]

(b) A communication system Engineer rightly decides to employ the dielectric canyon propagation model in a certain scenario, itemize four factors that must have influenced this decision. [4 marks]

(c) For a ten-ray model, the received signal may be simplified to

$$P_r = P_t \left[\frac{\lambda}{4\pi}\right]^2 \left|\frac{\sqrt{G_l}}{l} + \sum_{i=1}^{9} \frac{R_i \sqrt{G_{x_i}} e^{j\phi_i}}{x_i}\right|^2$$

(i) Describe the above relation, identify the components and every entity thereof. [4 marks]

(ii) Mention one valid assumption leading to the simplified dielectric canyon equation [4 marks]

(iii) Using this model, by what factor would the received signal change if the frequency of transmission is doubled? [4 marks]

QUESTION 7

(a) Define the term "Fresnel zone" [2 marks]

(b) Differentiate between large-scale and small-scale propagation effects. [4 marks]

(c) Describe, using appropriate diagram, the different kinds of waves employed for long distance wireless communication. [4 marks]

(d) (i) The curvature of the earth is a crucial factor to be considered when planning long distance line-of-sight communication, compute the minimum height of the receive antenna required for LOS transmission from a 25 m high transmit antenna over a distance of 35.5 km.

[8 marks]

(ii) Compute the LOS distance under the above scenario if the transmit antenna is situated on a 80 m high hill. [2 marks]