NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCE
JULY 2017 EXAMINATIONS

COURSE CODE: CIT754
COURSE TITLE: DIGITAL COMMUNICATIONS
CREDIT UNITS: 2
TIME ALLOTED: 2 HOURS
INSTRUCTION: ***Answer Question 1 and any other THREE questions.***

Q1.

a) Write down the expression for the lowpass equivalent of a bandpass digitally modulated signal in terms of the information sequence (I_1, I_2, I_3, ... I_{n-2}, I_{n-1}, I_n).
(2 marks)

b) Briefly describe the concept of **diversity techniques** for multipath fading channels.   (4 marks)

c) Consider the linear (7, 4) code given as:

$$G = [I_4 \,|\, P] = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$$

  i. Determine the parity check matrix H for the code.
     (4 marks)
  ii. Write down an expression for the weight enumeration function A (Z) for the code.
     (5 marks)

d) For a linear block code, briefly explain what the following are:
i.   Generator matrix;
ii. Hamming distance;
iii. Minimum distance;
iv. Minimum weight   (10 marks)

Q2.

a) Briefly describe the two components of a systematic linear block code.
   (3 marks)

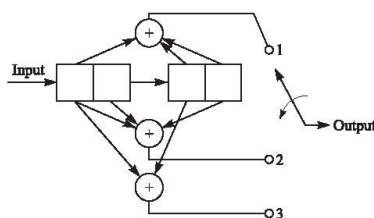b) The convolutional encoder shown in Fig Q3 has 2 bits at a time shifted into it and three output bits generated.

Fig.Q3

I. Write down the corresponding three binary generators g1, g2 and g3.
(3 marks)

II. Using a suitable diagram, describe the double shift register realization of the encoder in Fig Q3.
(3 marks)

III. Write down the six impulse responses of the resulting encoder and hence obtain the corresponding transfer functions.
(6 marks)

Q3.

a) Distinguish between **bloc**k and **convolutional** codes.
(8 marks)

b) Derive an expression for the **transmission rate** R in terms of the code rate R_c, the constellation size M and the symbol duration T_s.
(7 marks)

Q4.

a) Briefly describe what a space-time block code (STBC) is.
(8 marks)

b) Write down the generated matrix for the Alamouti code and hence determine the value of the corresponding spatial code rate R. (6marks)
(7 marks)

Q5.

a) For an (n, k) linear block code, determine the following:
   i. The maximum possible number of codewords;
   ii. The range of codeword weights;
   iii. The code rate;
   iv. The length of each codeword. (8 marks)

b) Briefly explain what a slowly fading channel is. (7 marks)

Q6.

a.) Using a suitable diagram, describe the graphical technique for determining the **error-correction capability** of an (n,k) code.
(8 marks)

b.) Distinguish between a **perfect code** and a **quasi-perfect code**.
(7 marks)