COURSE CODE: CIT754
COURSE TITLE: DIGITAL COMMUNICATIONS
CREDIT UNITS: 3
TIME ALLOTED: 2 HOURS, 30 MINUTES
INSTRUCTION: *Answer any FIVE questions. Cordless nonprogrammable calculators may be used.*

1.

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

b.) Briefly define what a lowpass (baseband) signal is.

c.) Sketch the spectrum of a real-valued lowpass signal.   (14 marks)

2.

a.) Distinguish between **bloc**k and **convolutional** codes.

b.) Briefly define the **rate** of a code.

c.) 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.   (14 marks)

3.

a.) Briefly explain what a **finite field** is.

b.) Define what an **Abelian group** is listing its four main properties.

c.) Distinguish between **Rayleigh** and **Ricean** fading channels.
(14 marks)

4.

a.) Derive an expression for the rate of a **Hamming** code.

b.) Generate the **parity check matrix** H for a (7,4) Hamming code.

c.) Briefly describe the concept of **diversity techniques** for multipath fading channels.

(14 marks)

5.

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

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

c.) Briefly describe the concept of a **RAKE** demodulator.   (14 marks)

6.

a.) With the aid of a suitable diagram, describe the structure of a **convolutional** encoder.

b.) Derive the code that will be generated by the convolutional encoder shown in **Fig. Q6b** if the input sequence is u = (100111).

c.) Briefly explain what a **frequency-selective** channel is.   (14 marks)

7.

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

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

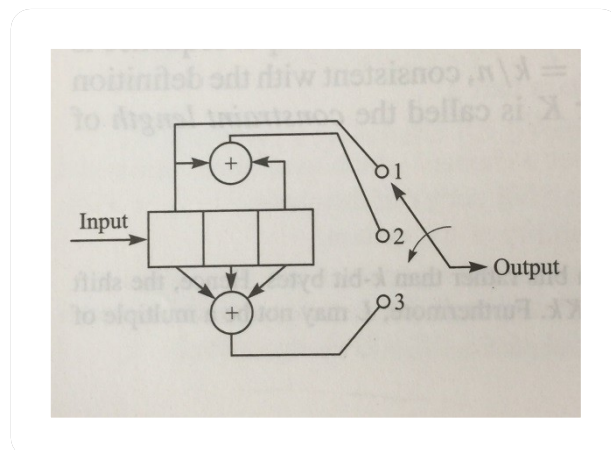c.) Briefly explain what a **slowly fading** channel is.   (14 marks)

Fig. Q6b: K=3, k = 1, n = 3