Communication Theory
EC5.203 - Spring 2023

Exam: Midsem

Total Marks: 50

Date: 02 March 2023

Time: 02:30 to 04:00

Instructions:

- Answering all the questions is compulsory.

- Clearly state the assumptions (*if any*) made that are not specified in the question.

- Use of a calculator is allowed.

1. Answer the following questions. [6x4]

   (a) Consider a rectangular pulse of duration T_b is applied at the input of an ideal integrator. Find out the energy and ESD of the output.

   (b) Show that the energy of two orthogonal signals is equal to the sum of their individual energies.

   (c) Derive the instantaneous frequencies of the FM and PM signals. Explain how FM signal can be constructed using PM modulator.

   (d) Explain the working principle of the switching modulator in detail.

2. Consider a subspace $U \subset \mathbb{R}^4$ as the span of vectors [7]

$$u_1 = \begin{bmatrix} 1 \\ 2 \\ 4 \\ 3 \end{bmatrix} \qquad u_2 = \begin{bmatrix} -1 \\ 0 \\ 3 \\ 5 \end{bmatrix} \qquad u_3 = \begin{bmatrix} 0 \\ 1 \\ -3 \\ 2 \end{bmatrix}$$

   Find out the complete basis set of U.

3. Derive the bandwidth of wide band frequency modulated signal. [8]

4. Consider that $m(t) = 2\cos(200\pi t)$ is a modulating signal and $c(t) = 3\cos(2000\pi t)$ is a carrier signal, and answer the following questions. [11]

   (a) Draw the AM signal and its spectrum.

   (b) Find the modulation index and power efficiency of AM signal.

   (c) Find out the RC time constant for the envelope detector.

   (d) Determine the frequency deviation and Carson bandwidth of FM signal when $k_f = 1$.

   (e) State the condition for the NBFM and write the expression of NBFM signal.

   (f) Find the instantaneous frequencies of FM and PM signals.