UNIVERSITY OF THE WEST INDIES
CAVE HILL CAMPUS
Department of Computer Science, Mathematics & Physics

ELET2230 - Digital Communications 1

Class Test 2 **Thursday, November 26, 2020**

1. Energy in BPSK modulation

show that the energy of the basis function $\emptyset_1(t) = \sqrt{\frac{2}{T_s}}cos(2\pi f_c t)$ is 1 joule.
Hence, show that the output of the BPSK receiver under a noiseless channel is $\sqrt{E_b}$ for the input signal $s_1(t) = \sqrt{\frac{2E_b}{T_s}}cos(2\pi f_c t)$. [8]

2. Energy in M-ary Phase Shift Keying (MPSK) modulation

In M-ary Phase Shift Keying (PSK), $\log_2 M$ code digits are represented by a signal $s_i(t)$ of time duration T_s given by $s_i(t) = Acos\left(2\pi f_c t + \frac{2\pi i}{M}\right)$, where f_c is the carrier frequency and A is the amplitude of the signal.

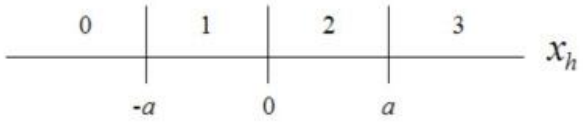
Prove that the energy of an MPSK signal $E_s = \frac{A^2}{2}T_s$ joules. Make use of the fact that an ideal MPSK signal contains an integer number of cycles and also the identity $(\cos\theta)^2 = \frac{1+\cos 2\theta}{2}$. [6]

3. Soft Decision - 8-level and 4-level

(a) Draw a diagram to show the forward transition probabilities P(3|0) and P(3|1) in 8-level soft decision [4]
(b) How would you determine the forward transition probability P(6|1) by simulation ? [2]
(c) Write an expression for the binary crossover probability α in terms of the 8-level forward transition probabilities [2]

(d)

If the horizontal axis of x_h is split into four sections as shown



Determine expressions for the forward transition probabilities P(1|0) and P(2|0). You may use the following to help you [8]

$$f(x_h|0) = \frac{1}{\sigma\sqrt{2\pi}}\exp\left[-\frac{\left(x_h+\sqrt{E_b}\right)^2}{2\sigma^2}\right]$$

$$Q(x) = \frac{1}{\sqrt{2\pi}}\int_x^\infty \exp\left(-\frac{u^2}{2}\right)du.$$

You may take the standard deviation of the PDF curves to be $\sigma = \sqrt{\frac{N_o}{2}}$.