

Birla Institute of Technology & Science, Pilani,
Rajasthan
First Semester 2021-2022
Comprehensive Exam: Lab Test (05-12-2021)

Name:

ID:

Duration: 120 Minutes, Marks =16

-
1. You have three bits 101 to be transmitted over a band-limited channel with bandwidth $B = 1$ Hz. The bits are line encoded to pulses $\pm m(t)$ and are transmitted every T_s seconds where $m(t) = 2\text{sinc}(2\pi t)$ denotes a bit 1 and $m(t) = -2\text{sinc}(2\pi t)$ denotes a 0. Thus $x(t) = m(t - nT_s)$ is the sequence of transmission of symbols and $R_s = 1/T_s$ denotes the rate of transmission.
 - (a) Plot three time-domain signals (corresponding to 1, 0, 1) in the same figure (figure 1) at the output of channel when $T_s = 1$. **[2 Marks]**
 - (b) Plot three time-domain signals (corresponding to 1, 0, 1) in the same figure (figure 2) at the output of channel when $T_s = 1/4$. **[2 Marks]**
 - (c) Plot three time-domain signals (corresponding to 1, 0, 1) in the same figure (figure 3) at the output of channel by taking optimum T_s . **[2 Marks]**
 - (d) From above figures, write your observations about the impact of rate of transmission over a band-limited channel. **[2 Marks]**
 2. Digital transmission is an involved process where a transmitter sends encoded pulses over a channel for a receiver to be decoded correctly. However, the channel attenuation and additive noise are major impairments which cause errors in detection. Thus, the received signal is expressed as $y = \sqrt{P}hx + n$ where x is a constellation point, h is channel attenuation, P is the transmitted power, and n is the additive noise. The analysis of system now is restricted to a simple linear equation with SNR defined as $SNR = \frac{Ph^2|x|^2}{\sigma_n^2}$. Use BPSK modulation with constellation points $[-1, 1]$. Take $\sigma_n^2 = 2$, $h = \frac{G_t G_r \lambda}{4\pi d}$ with $d = 100$ m, $\lambda = 10$ m, and $G_t = G_r = 5\text{dB}$.
 - (a) Plot average BER (theoretical) versus P (in the range of 100 to 1000 in the interval of 10). **[2 Marks]**
 - (b) Plot average BER (Monte Carlo) versus P (in the range of 100 to 1000 in the interval of 10). Both plots i.e., Monte Carlo and theoretical should be in one figure. **[4 Marks]**
 - (c) Instead of BPSK, if QPSK or 4-QAM is used with two-dimensional constellations $[(1/\sqrt{2}, 1/\sqrt{2}), (-1/\sqrt{2}, 1/\sqrt{2}), (1/\sqrt{2}, -1/\sqrt{2}), (-1/\sqrt{2}, -1/\sqrt{2})]$, plot the scatter plot of transmitted constellation X and received constellation Y . **[2 Marks]**