

# Digital Communication: UE20EC254

IV Sem ECE, PESU: Jan-May 2022

## Assignment-2

1. The instantaneous frequency of an angle modulated signal is given by  $f_i(t) = 10^8 - 10^5 \cos(10^4 \pi t)$ .
  - (a) Assuming it is FM, find a) the bandwidth and b) the expression for the FM signal, assuming  $A_c = 1$  V.
  - (b) Assuming it is PM, find the phase sensitivity if  $A_m = 10$  V.
2. The signal  $m(t)$ , with a bandwidth of 20 kHz, modulates a 5 MHz carrier to generate a narrowband FM signal with a frequency deviation of 6 kHz. Using this narrowband FM signal, a wideband FM signal with  $f_c = 30$  MHz and  $\Delta f = 24$  kHz is to be generated. Square law devices, bandpass filters, and a 10 MHz crystal oscillator are available. Draw the block diagram of the wideband FM generator. Indicate the center frequency and bandwidth of each bandpass filter used.
3. An FM signal is obtained by modulating the carrier  $c(t) = \cos 10^8 \pi t$  with the message signal  $m(t) = 2 \cos 1000 \pi t$ . The frequency sensitivity is  $k_f = 1 \text{ kHz/V}$ .
  - (a) Find the modulation index, maximum frequency deviation, maximum phase deviation, and bandwidth. Also write the expression for the FM signal.
  - (b) If the same  $c(t)$  and  $m(t)$  are used to generate a PM signal with the same maximum frequency deviation, what should be the value of  $k_p$ ?
4. Consider the signal  $g(t) = 5 \cos(2000 \pi t) + 10 \cos(6000 \pi t)$ . Draw the spectrum of the sampled signal, if it is sampled at  $f_s = 6000$  Hz.
5. Two signals  $g_1(t)$  and  $g_2(t)$  are to be transmitted over a common channel by means of TDM. The highest frequency of  $g_1(t)$  is 1 kHz and that of  $g_2(t)$  is 1.5 kHz. What is the minimum value of the permissible sampling rate? Justify your answer.
6. Six independent message signals of bandwidth  $w, w, 2w, 2w, 3w$  and  $3w$  Hz are to be transmitted on a time-division multiplexed basis using common communication channel.

- (a) Setup a scheme for accomplishing this multiplexing requirement, with each message signal sampled at its Nyquist rate.
  - (b) Determine the minimum transmission bandwidth of the channel.
7. Let  $g(t) = 10 \cos(50\pi t)$  be sampled with  $f_s = 75$  Hz.
- (a) Find the sampled signal  $g(n)$
  - (b) Find another signal  $g'(t)$  that results in the same sampled signal  $g(n)$  when sampled with  $f_s = 75$  Hz. What is this phenomenon called?
  - (c) Find all the different  $g(t)$  that result in the same sampled signal  $g(n)$  when sampled with  $f_s = 75$  Hz.
8. The signal  $g(t) = A \cos(2\pi f_0 t)$  is sampled at  $f_s$  Hz to obtain the discrete time sequence  $g(n)$ . Find the general expression for all the sinusoids that result in the same  $g(n)$  when sampled at  $f_s$  Hz.
9. The signal  $g(t) = 10 \sin(20\pi t) + 4$  is sampled using a periodic sequence of rectangular pulses, with a fundamental frequency of 50 Hz. The pulses are of width 10 ms. What frequencies are present in the sampled signal between 0 Hz and 200 Hz, for the following cases:
- (a) natural sampling
  - (b) flat-top sampling