Sample Mid-Term Examination

Communications II, Spring 2021

Consider the random process, $X(t) = A\cos(2\pi t) - B\sin(2\pi t)$, where A and B are two independent random variables with zero mean and unit variance. (Answer questions 1) – 3) based on the above)

1) $E\{X(t)\} = \boxed{0}$

2) $E\{X(t)X(t+\tau)\} = \boxed{b}$

a. $\sin(2\pi\tau)$; b. $\cos(2\pi\tau)$; c. $\dfrac{\cos(2\pi\tau)+\sin(2\pi\tau)}{2}$; d. $\dfrac{\cos(2\pi\tau)-\sin(2\pi\tau)}{2}$

3) Whether the random process, *X(t),* is wide-sense stationary (WSS) or not? $\boxed{a}$

a. yes; b. no; c. not sure.

4) Let $u(t) = \cos\left(2\pi \times 1005 \times t\right)$ be a passband signal corresponding the carrier frequency, $f_c = 1000$ Hz. The corresponding in-phase signal and quadrature signal will be $\boxed{a}$

a. $u_I(t) = \cos\left(2\pi \times 5 \times t\right),\ u_Q(t) = \sin\left(2\pi \times 5 \times t\right);$

b. $u_I(t) = 0,\ u_Q(t) = \sin\left(2\pi \times 5 \times t\right);$

c. $u_I(t) = \cos\left(2\pi \times 5 \times t\right),\ u_Q(t) = 0;$

d. $u_I(t) = \cos\left(2\pi \times 5 \times t\right),\ u_Q(t) = -\sin\left(2\pi \times 5 \times t\right);$

Consider a passband Gaussian noise, $n(t)$, with the power spectrum density function as

$$S_n(f) = \begin{cases} 2, & |f - f_c| \le 1 \text{ or } |f + f_c| \le 1, \\ 0, & \text{otherwise,} \end{cases}$$

where f_c $(\gg 3)$ is the career frequency. Denote the corresponding in-phase noise and quadrature noise components as $n_I(t)$ and $n_Q(t)$, respectively. Then the passband noise can be expressed as $n(t) = n_I(t)\cos(2\pi f_c t) - n_Q(t)\sin(2\pi f_c t)$. (Answer questions 5) – 6) based on the above)

5) Then $E\{n_I^2(t)\} = \boxed{8}$ and $E\{n_Q^2(t)\} = \boxed{8}$;

6) What is the distribution of its envelop, $r(t) = \sqrt{n_I^2(t) + n_Q^2(t)}$? $\boxed{b}$

a. Exponential distribution; b. Rayleigh distribution; c. Rice distribution; d. not sure.

7) Consider a message signal, $m(t)$, with bandwidth $W = 1500$ Hz ($2W$ if counting negative frequency). If double-sideband (DSB) modulation is used with carrier frequency $f_c = 6000$ Hz, then the bandwidth of passband signal will be $\boxed{b}$

a. 1500 Hz (double if including the negative frequency)

b. 3000 Hz (double if including the negative frequency)

c. 6000 Hz (double if including the negative frequency)

d. 12000 Hz (double if including the negative frequency)

8) Consider a message signal, $m(t)$, with bandwidth $W = 1500$ Hz ($2W$ if counting negative frequency). If signal-sideband (SSB) modulation is used with carrier frequency $f_c = 6000$ Hz, then the bandwidth of passband signal will be $\boxed{a}$

a. 1500 Hz (double if including the negative frequency)

b. 3000 Hz (double if including the negative frequency)

c. 6000 Hz (double if including the negative frequency)

d. 12000 Hz (double if including the negative frequency)

9) Consider a message signal, $m(t)$, with bandwidth $W = 1500$ Hz ($2W$ if counting negative frequency). If standard amplitude modulation (standard AM) is used with carrier frequency $f_c = 6000$ Hz, then the bandwidth of passband signal will be $\boxed{b}$

a. 1500 Hz (double if including the negative frequency)

b. 3000 Hz (double if including the negative frequency)

c. 6000 Hz (double if including the negative frequency)

d. 12000 Hz (double if including the negative frequency)

Consider a message signal, $m(t) = \cos(100\pi t)$. If the standard AM is used, then the modulated signal can be expressed as $s_{AM}(t) = (A + m(t))\cos(2\pi \times 60000 \times t)$. (Answer questions 10) – 11) based on the above)

10) To ensure coherent detection without distortion, then A should be $\boxed{d}$

a. $A = 0$;

b. $0 < A < 1$;

c. $A \geq 1$;

d. All above.

11) To ensure envelop detection without distortion, then A should be $\boxed{c}$

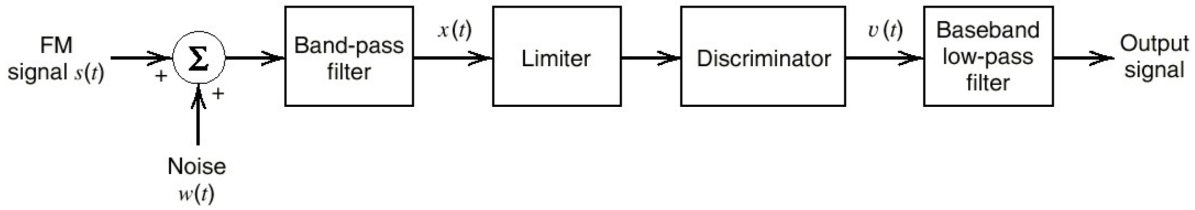
a. $A = 0$;

b. $0 < A < 1$;

c. $A \geq 1$;

d. All above

Consider a message signal, $m(t)$, with bandwidth $W = 1000$ Hz ($2W$ if including negative frequency) and $m_p = \max|m(t)|$=2. Frequency modulation (FM) is used with carrier frequency $f_c = 4000$ kHz and frequency sensitivity $k_f = 2500$ and the receiver as the following diagram is used to demodulate the massage signal.



12) The bandwidth of the modulated signal, according to the Carson's rule of thumb, is $\boxed{d}$

a. $B_T = 1000$ Hz;

b. $B_T = 2000$ Hz;

c. $B_T = 6000$ Hz;

d. $B_T = 12000$ Hz;

13) The bandwidth of the bandpass filter in the block diagram is $\boxed{c}$

a. 1000 Hz (double if including the negative frequency);

b. 2000 Hz (double if including the negative frequency);

c. same as the Carson's bandwidth (double if including the negative frequency);

d. twice of the Carson's bandwidth (double if including the negative frequency);

14) The bandwidth of the baseband low-pass filter in the block diagram is $\boxed{a}$

a. 1000 Hz (double if including the negative frequency);

b. 2000 Hz (double if including the negative frequency);

c. same as the Carson's bandwidth (double if including the negative frequency);

d. twice of the Carson's bandwidth (double if including the negative frequency);

15) For the band-limited signal, $s(t) = 0.2 + 2\cos(200\pi t - \frac{\pi}{4}) - 0.5\sin(3000t) + \cos(1000\pi t)$, what is the minimum sample frequency/rate, f_s, to ensure exact reconstruction from its samples? $\boxed{c}$

a. $f_s = 200$ Hz;

b. $f_s = 500$ Hz;

c. $f_s = 1000$ Hz;

d. $f_s = 3000$ Hz.

16) Which of the following is **not** true on quantization? $\boxed{b}$

a. For uniform quantization, increasing the number of encoded bits for each symbol/sample by one will reduce the average power of quantization error by 6 dB;

b. For uniform quantization, the number of quantization levels will increase linearly with the number of encoded bits;

c. Non-uniform quantization (or companding) reduces the average power of the quantization error;

d. Non-uniform quantization (or companding) may increase quantization error for signal in certain range.