Department of Electrical Engineering
Assignment Spring 2020
Date: 20/04/2020

Course Details

Course Title: Communication Systems **Module:** ______
Instructor: Dr. Engr. Shahid Latif **Total Marks:** 30

Student Details

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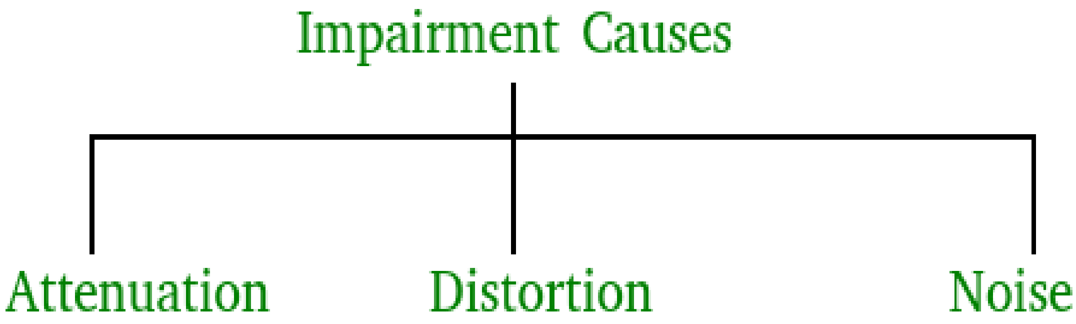
Q 1.	**(a)**	**What are major causes for transmission impairments? Describe using example of various degradations.**	**Marks 5**
	(b)	**Suppose the signals k1(t) and k2(t) are defined as follows:** $$k_1(t) = \begin{cases} 0, & t < 1 \\ 1, & 1 \le t \le 2 \\ 0, & 2 < t < 3 \\ 1, & 3 \le t \le 4 \\ 0, & 4 < t \end{cases}$$ and $$k_2(t) = \begin{cases} 0, & t < 0 \\ 2, & 0 \le t \le 2 \\ 0, & 2 < t \end{cases}$$ Determine $k_3(t) = k_1(t) + k_2(t)$ and $k_4(t) = k_1(t)\, k_2(t)$.	**Marks 5**
Q 2.	**(a)**	**Explain how signals can be broadly classified? Describe in detail any five types of signals.**	**Marks 5**
	(b)	**Determine whether the signal z(t) = $t^3 + t^2$ is an odd signal or an even signal or neither; if it is neither, then determine the odd and even parts of it.**	**Marks 5**
Q 3.		**Explain main characteristics of Sinusoidal Signals. Describe benefits and applications of Sinusoidal Signals.**	**Marks 10**

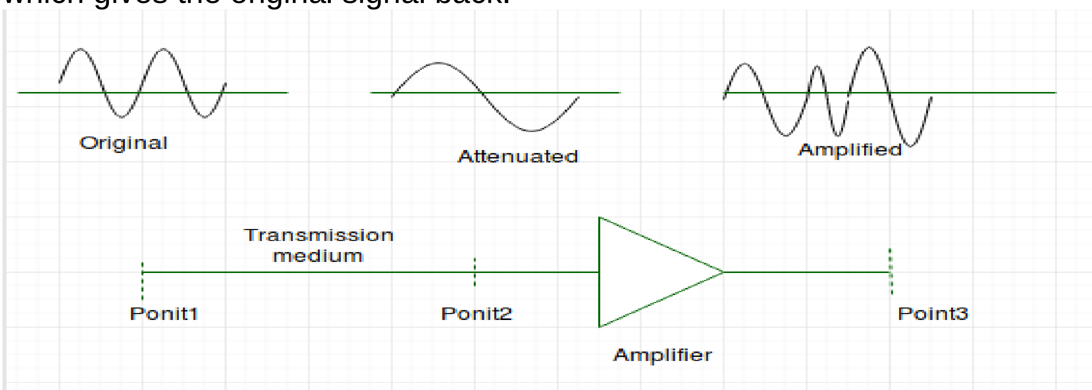
Ans 1(a).

In communication system, analog signals travel through transmission media, which tends to deteriorate the quality of analog signal. This imperfection causes signal impairment. This means that received signal is not same as the signal that was send.

Major Causes of impairment



- **Attenuation –**
  It means loss of energy. The strength of signal decreases with increasing distance which causes loss of energy in overcoming resistance of medium. This is also known as attenuated signal. Amplifiers are used to amplify the attenuated signal which gives the original signal back.

  Attenuation is measured in **decibels (dB)**. It measures the relative strengths of two signals or one signal at two different point.

  Attenuation (dB) = 10log10 (P2/P1)

  P1 is power at sending end and P2 is power at receiving end.

- **Distortion –**
  It means change in the shape of signal. This is generally seen in composite signals with different frequencies. Each frequency component has its own propagation speed travelling through a medium. Every component arrive at different time which leads to delay distortion. Therefore, they have different phases at receiver end from what they had at senders end.

- **Noise –**
  The random or unwanted signal that mixes up with the original signal is called noise. There are several types of noise such as induced noise, crosstalk noise, thermal noise and impulse noise which may corrupt the signal.

1. **Induced** noise comes from sources such as motors and appliances. These devices act as sending antenna and transmission medium act as receiving antenna.
2. **Thermal** noise is movement of electrons in wire which creates an extra signal.
3. **Crosstalk** noise is when one wire affects the other wire.
4. **Impulse** noise is a signal with high energy that comes from lightning or power lines

Q1. (b) Suppose the signals k1 (t) and k2 (t) are defined as follows:

$$k_1(t) = \begin{cases} 0, & t < 1 \\ 1, & 1 \leq t \leq 2 \\ 0, & 2 < t < 3 \\ 1, & 3 \leq t \leq 4 \\ 0, & 4 < t \end{cases}$$

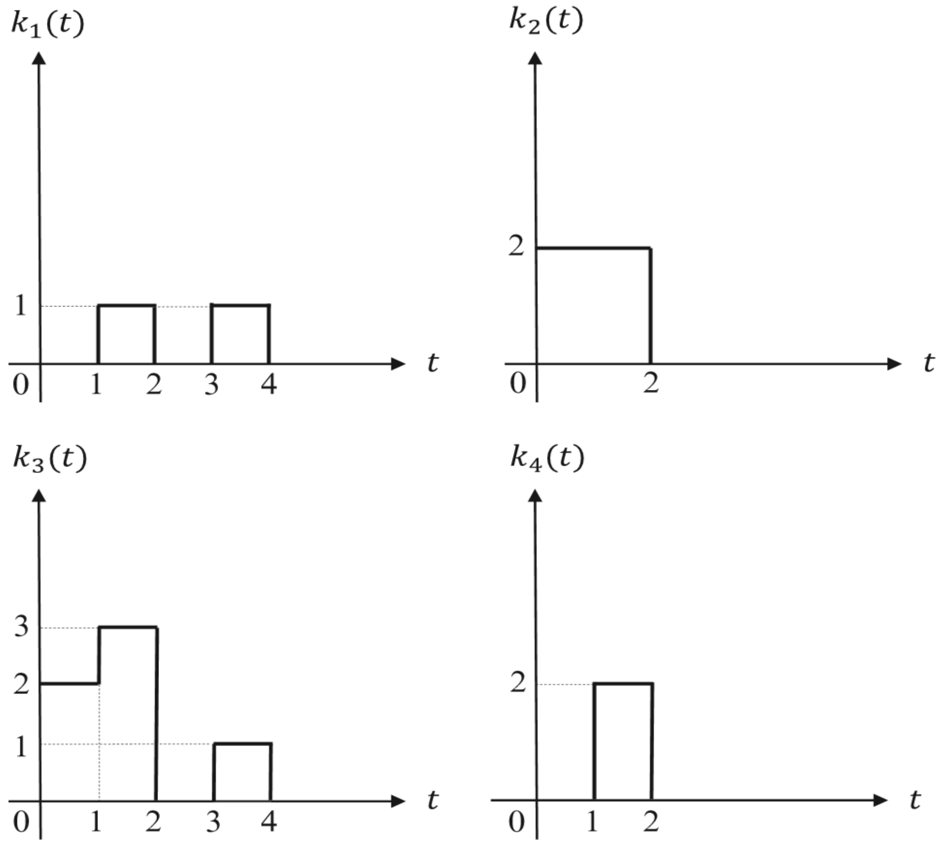
and

$$k_2(t) = \begin{cases} 0, & t < 0 \\ 2, & 0 \leq t \leq 2 \\ 0, & 2 < t \end{cases}$$

Determine $k_3(t) = k_1(t) + k_2(t)$ and $k_4(t) = k_1(t)\,k_2(t)$.

<u>Solution:</u>

k_3 (t) and k_4 (t), respectively. All signals are shown below



In differentiation operations, the derivative of the signal g (t) with respect to time t is taken, and thus defined by d

$$Y(t) = \frac{d}{dt} g(t) = g'(t)$$

A physical example is an inductor, as the voltage across the inductor with inductance L is equal to L times the derivative of the current flowing through it.

In integration operations, the integral of the signal g (t) with respect to time t is taken, and thus is defined by

Y (t) =integral of g (t) dt

A physical example is a capacitor, as the voltage across the capacitor with capacitance C is equal to $1/c$-times the integral of the current flowing through it.

Ans 2(a).

Signals are classified into the following mentioned below.

1. Continuous Time and Discrete Time Signals
2. Deterministic and Non-deterministic Signals
3. Even and Odd Signals
4. Periodic and Aperiodic Signals
5. Energy and Power Signals

1. Continuous Time and Discrete Time Signals

Continuous time signal is the "function of continuous time variable that has uncountable or infinite set of numbers in its sequence". The continuous time signal can be represented and defined at any instant of the time in its sequence. The continuous time signal is also termed as analog signal.
Discrete time signals are "the signals or quantities that can be defined and represented at certain time instants of the sequence." They are also called digitalized signals.

2. Deterministic and Non-deterministic Signals

In deterministic signal for a given particular input, the computer will always produce the same output going through the same states but in case of non-deterministic signal, for the same input, the compiler may produce different output in different runs. In fact non-deterministic signals can't solve the problem in polynomial time and can't determine what the next step is. The non-deterministic signals can show different behaviors for the same input on different execution and there is a degree of randomness to it.

3. Even and Odd Signals

One of characteristics of signal is symmetry that may be useful for signal analysis. Even signals are symmetric around vertical axis, and Odd signals are symmetric about origin.

Even Signal
A signal is referred to as an even if it is identical to its time-reversed counterparts; x (t) = x (-t).

Odd Signal
A signal is odd if x (t) = -x (-t).
An odd signal must be 0 at t=0, in other words, odd signal passes the origin.

Using the definition of even and odd signal, any signal may be decomposed into a sum of its even part, xe(t), and its odd part, xo(t), as follows:

$$= \frac{1}{2}\{x(t) + x(-t)\} + \frac{1}{2}\{x(t) - x(-t)\}$$

$$where \quad x_e(t) = \frac{1}{2}\{x(t) + x(-t)\}, \quad x_o(t) = \frac{1}{2}\{x(t) - x(-t)\}$$

4. Periodic and Aperiodic Signals

A signal which repeats itself after a specific interval of time is called periodic signal.

A signal that repeats its pattern over a period is called periodic signal.

A signal that does not repeats its pattern over a period is called aperiodic signal or non periodic.

5. Energy and Power Signals

A signal having only one square pulse is energy signal. A signal that decays exponentially has finite energy, so, it is also an energy signal.

The power of an energy signal is 0, because of dividing finite energy by infinite time (or length). For example, sine wave in infinite length is power signal.

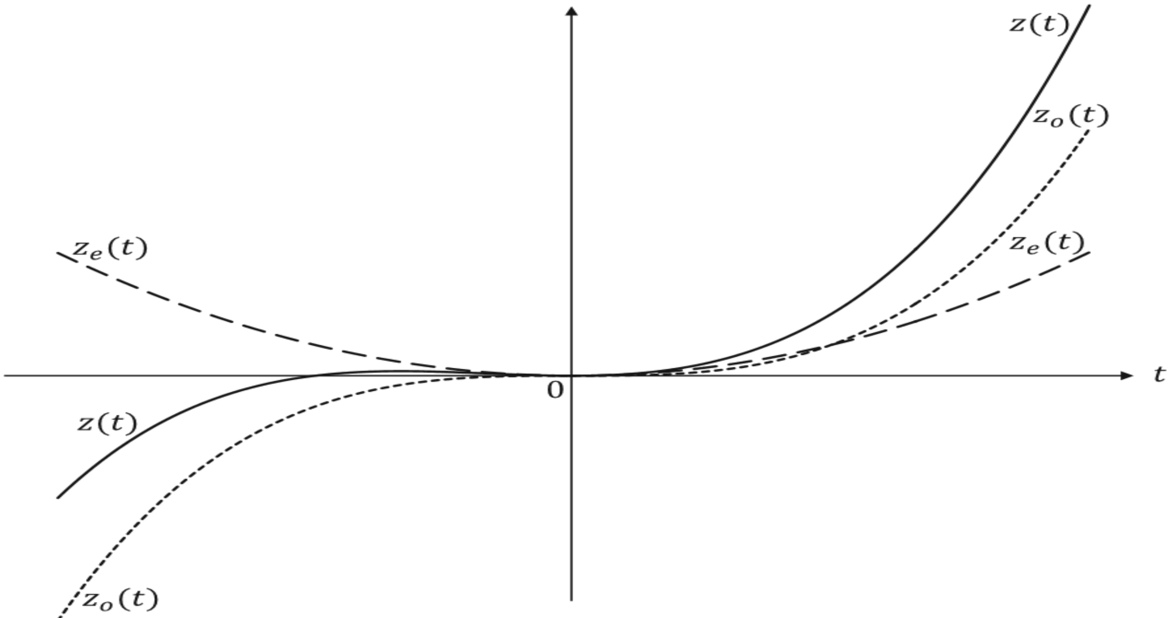
Ans 2(b).
Solution

From z (t), we find z (-t) = $-t^3 + t^2$. Since we have z (t) NOT EQUAL TO z (t) is not an even function, since we have z (t) NOT EQUAL TO –z (-t). Z (t) is not an odd function. We therefore have to find the odd and even parts of z (t). The even and odd parts of z (t) are, respectively

$$z_e(t) = \frac{z(t) + z(-t)}{2} = \frac{t^3 + t^2 - t^3 + t^2}{2} = t^2$$

$$z_o(t) = \frac{z(t) - z(-t)}{2} = \frac{t^3 + t^2 + t^3 - t^2}{2} = t^3$$

This shows $z(t)$, $z_e(t)$, and $z_o(t)$.



Ans 3(a).

All sinusoidal signals have the same general shape, but they are not identical. The three characteristics that separate one sinusoid from another are amplitude, frequency, and phase.

- **Amplitude**

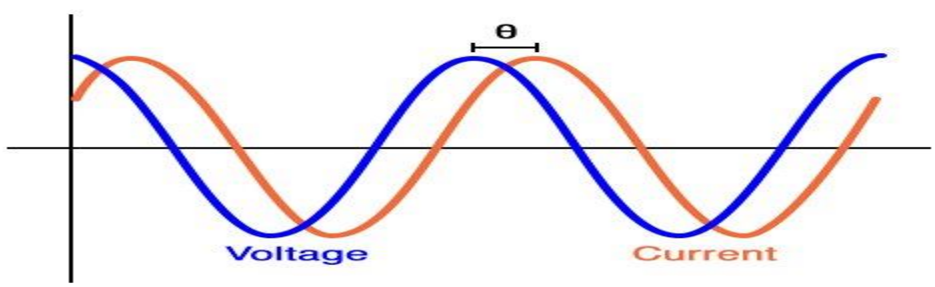
  This specifies the maximum distance between the horizontal axis and the vertical position of the waveform. A sine wave with an amplitude of 5 V, for example, has a maximum value of +5 V and a minimum value of –5 V.

- **Frequency**

  Tells us how quickly the sinusoid completes full cycles. This important characteristic influences the maximum rate at which a sinusoidal signal can transmit information and determines how a sinusoidal signal will be affected by circuits that include capacitors and inductors.

- **Phase**

  Refers to the horizontal position of a waveform with respect to one cycle. It is easier to understand in the context of phase shift or phase difference; we use these terms when describing the extent to which one signal is shifted to the left or right relative to another signal or to a theoretical reference signal. In the following diagram, the symbol θ indicates the phase shift (which can be measured in degrees) between a sinusoidal voltage signal and a sinusoidal current signal.



Benefits of sinusoidal wave

- Generates less electrical noise in your equipment. ...
- Microwave ovens cook faster.
- Equipment and appliances lasts longer.
- Equipment and appliances run cooler and more efficiently.

Applications of sinusoidal wave

Sinusoids are an extremely important category of time-varying functions (or signals). Here are some examples of their uses: In the electrical power industry sinusoids are the dominant signal used to transfer power. In communication systems (cellular telephones, radio signals, etc.)