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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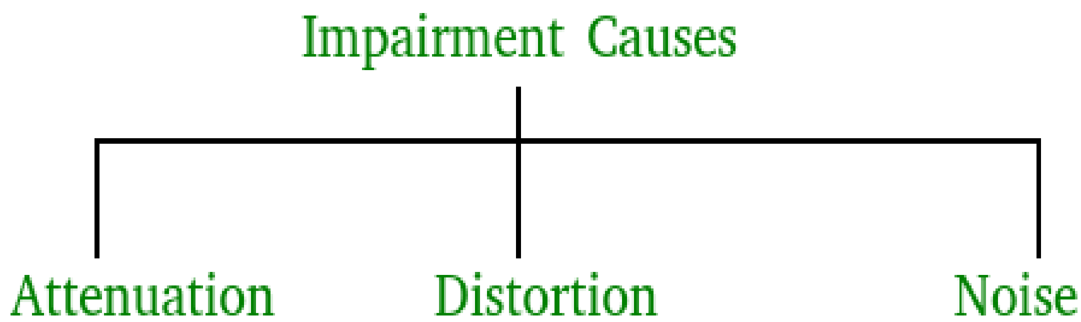
Q 1.	**(a)**	**What are major causes for transmission impairments? Describe using example of various degradations.**	**Marks 5**
	(b)	**Suppose the signals k1(t) and k2(t) are defined as follows:** $k_1(t) = \begin{cases} 0, & t < 1 \\ 1, & 1 \le t \le 2 \\ 0, & 2 < t < 3 \\ 1, & 3 \le t \le 4 \\ 0, & 4 < t \end{cases}$ 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).

Signals travel though transmission media that are not perfect. The received signal is therefore different from the transmitted one. There are a few major causes for transmission impairments. Shows an example of various degradations.

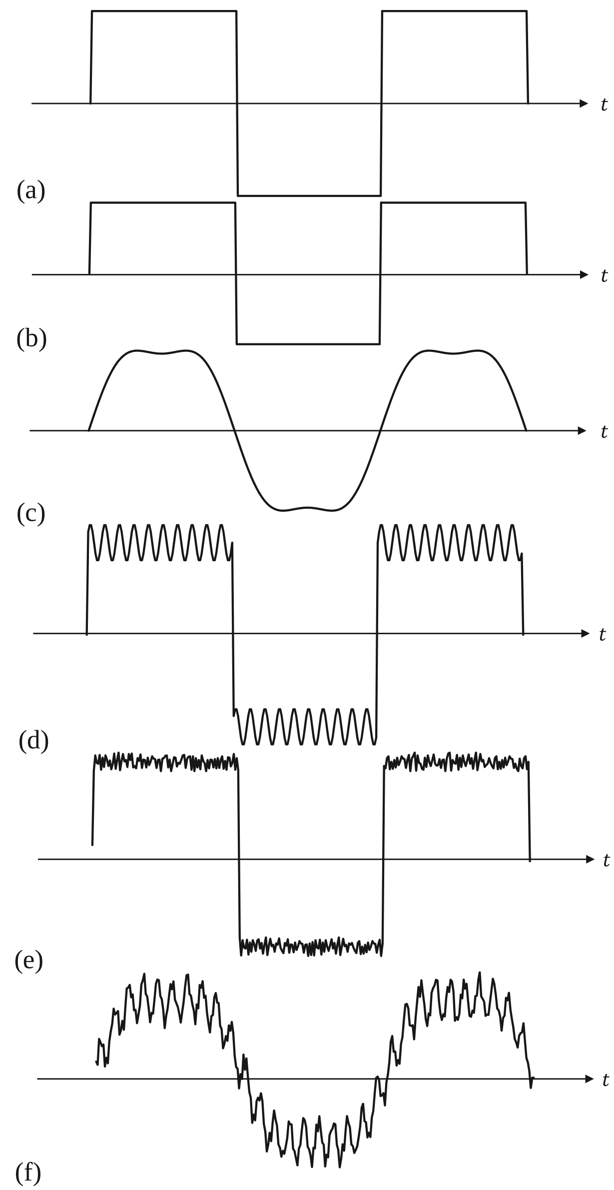
Major Causes of impairment



Attenuation

Every channel introduces some transmission attenuation (loss). By increasing the physical distance between the transmitter and the receiver, the signal power (strength) at the receiver decreases. This loss is due to overcoming the resistance of the medium. For wired media, attenuation has an exponential dependence on distance, i.e., the attenuation in dB increases linearly with the distance, whereas for wireless systems the attenuation in dB increases logarithmically with the distance.

As an example, suppose for a given distance the loss in a guided medium and an unguided medium are both x dB. If we increase the distance by a factor of 1000, then the loss in the guided medium is 1000x dB, whereas that in the unguided medium is only x + 10log1000 ¼ x + 30 dB. Thus, the signal level is more attenuated in wired systems than in wireless systems. To compensate for transmission loss, amplifiers must be used to enhance the signal level; however, amplification can then boost other types of degradations, such as noise and interference levels, as well.
Due to the non-ideal channel, the transmitted signal changes its form or shape, thus resulting in signal perturbation. This is known as distortion. Unlike noise



An example of transmission impairments: (a) transmitt

- **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 –

Noise refers to unwanted, ever-present, random waves that tend to disturb the transmission and processing of signals in a communication system, thus yielding a corrupted version of the transmitted signal. There are several types of noise, such as thermal noise (due to the random motion of electrons in a conductor), shot noise (due to the discrete nature of current flow in electronic devices), and impulse noise (due to natural sources, such as lightning, and man-made sources, such as high-voltage power lines).

Noise is generally assumed to be added to the signal. Filtering can be used to maximize SNR at the receiver (i.e., it can reduce noise contamination), but there inevitably remains some amount of noise that cannot be eliminated. Moreover, due to the central limit theorem, the aggregate of a number of different noises can be assumed to have a Gaussian distribution. It is also generally assumed that noise is white and thus emanates an equal amount of noise power per unit bandwidth at all frequencies. To this effect, additive white Gaussian noise (AWGN) is the most common type of noise considered in digital communication systems, and constitutes one of the most fundamental system limitations. The effects of noise cannot be eliminated, but by appropriate filtering the SNR value can be maximized.

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

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

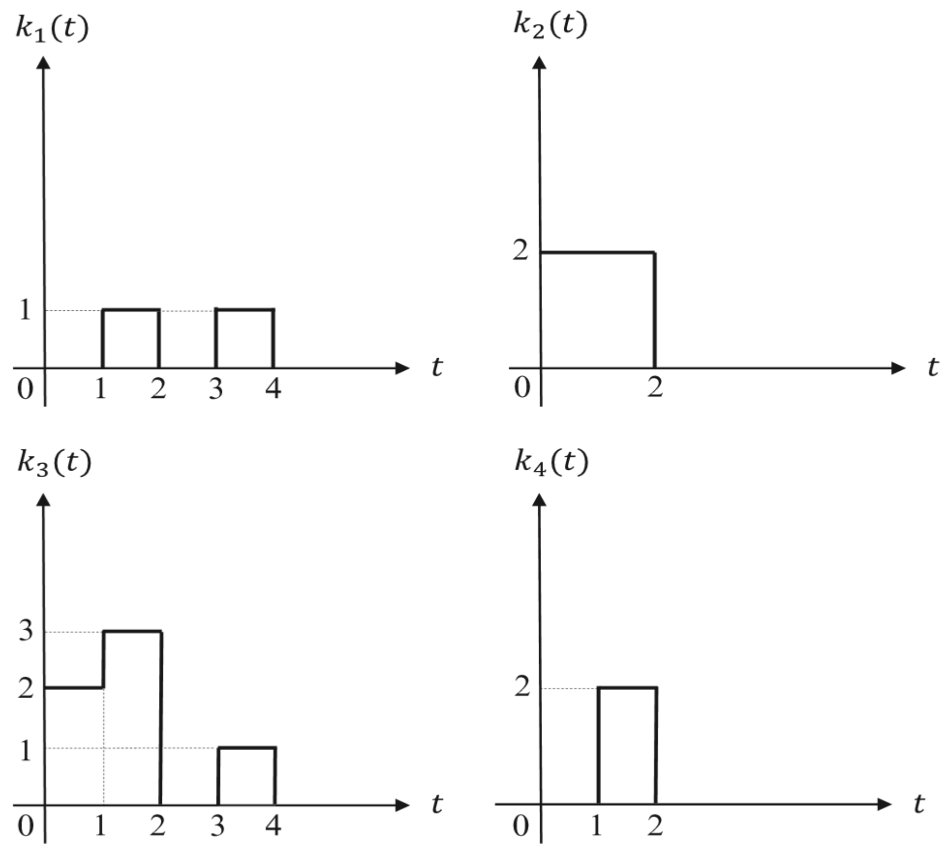
and

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

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

Solution:

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.

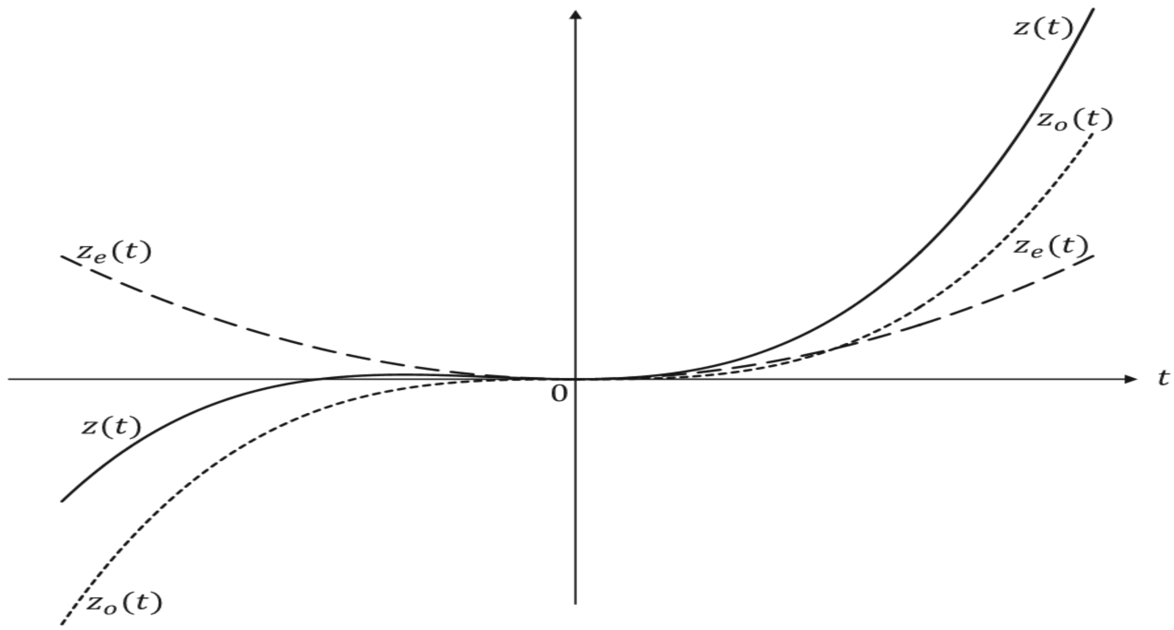
Ans 2(b).
Solution

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**

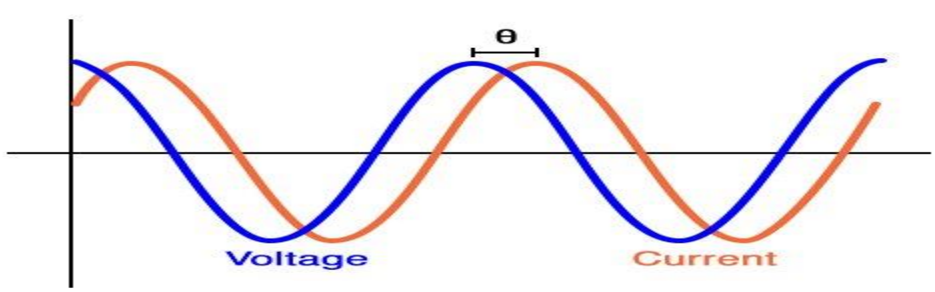
  This specifies the maximum distance between the horizontal axis and the vertical position of the waveform. A sine wave with an amplitude of 5 V, for example, has a maximum value of +5 V and a minimum value of –5 V.

- **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

Sinusoidal wave form is universally accepted because it has certain advantages. π

1. It produces minimum disturbance in the electrical circuits during operation.

2. It produces less interference to nearby communication lines in the case of transmission of power.

3. It results in low iron as well as copper losses in transformers, and AC rotating power for a given output. So AC machines have higher efficiency with sinusoidal waveform of current and voltage.

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.)