Digital Data Processing.

Test 1.

Instructions:

- Answer **All** questions
- Make sure your Name is written in every page.
- No mobile phone is allowed during the test
- The test is for **60** Min.

Questions:

1. Define the following
    a. Signal- Information converted in electrical form suitable for transformation.
        i. An electromagnetic or electrical current that carries data from one system or network to another.
        ii. In electronics, a signal is often a time-varying voltage that is also an electromagnetic wave carrying information, though it can take on other forms, such as current.

    b. Digital signal- Converts information into ON (1) or OFF (0) pulses technically known binary system- Discrete and finite value system.
    c. Analog signal- type of signals that Continuously changes to convey the signal's information with an infinite/ continuous number of values.
    d. Signal frequency- the total number of complete cycles of a waveform that are existing per sec (Number of cycles per second).

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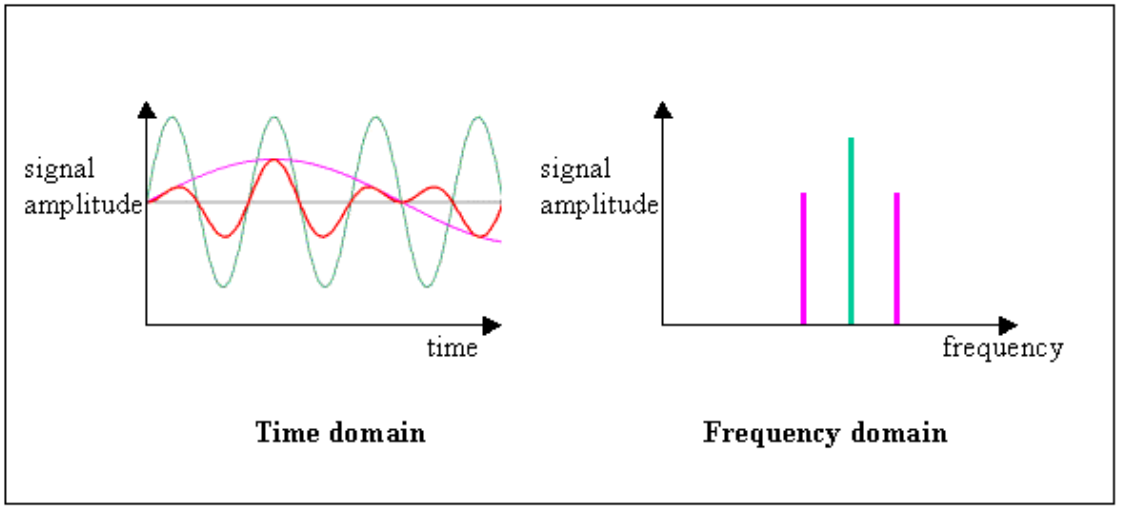
e. Signal processing- The process of converting or transforming data in a way that allows us to see things in it that are not possible via direct observation. Signal processing allows engineers and scientists to analyze, optimize, and correct signals, including scientific data, audio streams, images, and video.

   ii. Data signal processing- The numerical manipulation associated with signals, usually with all the intention to evaluate, filter, produce as well as compress continuous analog signals.

f. Frequency domain- the analytic space in which mathematical functions or signals are conveyed in terms of frequency, rather than time.

   For example, where a time-domain graph may display changes over time, a frequency-domain graph displays how much of the signal is present among each given frequency band. For example, where a time-domain graph may display changes over time, a frequency-domain graph displays how much of the signal is present among each given frequency band.



g. Time domain- refers to variation of amplitude of signal with time. For example consider a typical Electro cardiogram (ECG).

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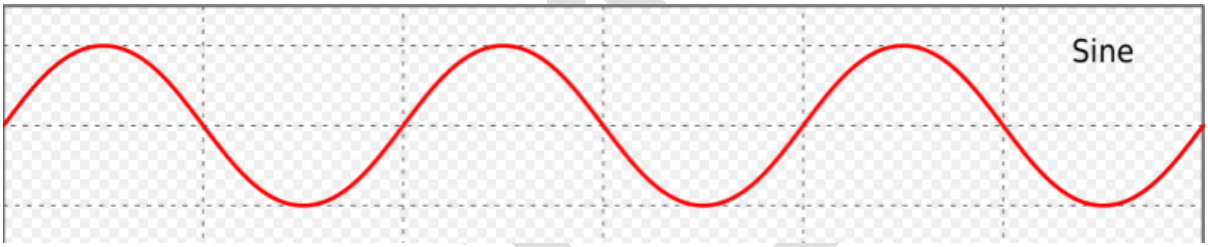
If the doctor maps the heartbeat with time say the recording is done for 20 minutes, we call it a time domain signal.

h. Sine wave- a smooth, periodic waveform that represents a pure tone of a specific frequency

i. Square wave- a waveform that alternates between two fixed amplitude levels in a square or rectangular pattern, representing a digital signal.

2. Sketch digital signal wave forms you are aware of.

Analog:



Digital signals

3. Describe at least 3 ways you can generate different signals.

- Analog circuitry: Analog signals can be generated using circuits that manipulate continuous voltages or currents to produce a desired waveform. Examples of analog circuitry include oscillators, amplifiers, filters, and mixers.
- Digital circuitry: Digital signals can be generated using circuits that operate on discrete binary values of 0 and 1. Digital signals can be generated using logic gates, counters, shift registers, and microcontrollers.
- Signal generators: Specialized signal generators are devices that are designed to produce specific types of signals, such as sine waves, square waves, triangle waves, and pulse trains. Signal generators typically offer a range of frequency, amplitude, and

waveform options, and can be controlled using software or hardware interfaces.

- Software-based signal generation: Signals can also be generated using software applications running on a computer or mobile device. These applications can produce signals using mathematical algorithms or by playing back pre-recorded audio or video files.
- Electromagnetic radiation: Signals can be generated using electromagnetic radiation, such as radio waves, microwaves, and light waves. In these cases, the signal is generated by modulating the frequency or amplitude of the electromagnetic wave to encode information.

4. State Nquist theorem and Fourier Transformation:
   Inquist theorem states that; a periodic signal must be sampled at more than twice the highest frequency component of the signal.
   Fourier Transformation: a PERIODIC function f(x) which is reasonably continuous may be expressed as the sum of a series of sine or cosine terms (called the Fourier series), each of which has specific AMPLITUDE and PHASE coefficients known as Fourier coefficients.
   Or
   The sum of square of a function g(t) equals the sum of the square of its Fourier transform, G(f). Duality – If g(t) has the Fourier transform G(f), then the Fourier transform of G(t) is g(-f).
5. If the total distance between 8 consecutive peaks of a transverse wave is 12m, what is the wavelength?
   Soln:
   $\lambda = v/f$
   Wavelength= 12/8= 1.5m
   b. What is the period of a wave of frequency equal to 10Hz?
   $\omega T = 2\pi$, or $T = 2\pi/\omega$. The reciprocal of the period, or the frequency f, in oscillations per second, is given by $f = 1/T = \omega/2\pi$.= 1/10=0.1s

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c. When a string is vibrated at a frequency of 10Hz, producing a transverse wave of wavelength 0.25m what is the speed of the wave traveling along the string?

Soln

$\lambda = v/f$

Speed= $\lambda * f = 0.25 * 10 = 2.5 m/s.$