Tutorial- 1
Signals & Systems

Q.1 (a) For the following describe time system check whether the system are:
(i) Static or dynamic
(ii) Linear or non linear
(iii) Shift invariant or shift variant
(iv) Causal or non-causal
(v) Stable or non-stable

$$y(n) = \sum_{k=x}^{n+1} x(k)$$
$$y(n) = x(n)\cos\omega n$$
$$y(n) = x(-n+2)$$
$$y(n) = a(n) + nx(n+1)$$
$$y(n) = x(2n)$$

(b) let x(t) an arbitrary signal with even and odd past denoted by $x_e(t)\ and\ x_0(t)$ respectively show that

$$\int_{-x}^{x} x^2(t)\,dt = \int_{-x}^{x} x_e^2(t)\,dt + \int_{-x}^{x} x_o^2(t)\,dt$$

(c) Determine whether following signals are energy signals power signal or neither

I. $x(t) = e^{-at}u(t)$
II. $x(t) = tu(t)$
III. $x(n) = u(n)$
IV. $x[n] = 2e^{j3n}$

Q.2 (a) Define linear time invariant system:
(b) Check whether the following system is:
(i) Static or dynamic
(ii) Linear or non-linear
(iii) causal or non-casual
(iv) Time invariant or time variant
Given that:

$$Y[n] = \sum_{k=-x}^{n+1} x(K)$$

(c) Sketch the following signals and calculate their energies:
(i) $e^{-10t}u(t)$
(ii) $u(t) - u(t-15)$

(d) Give the graphical and mathematical representation
(i) Unit step sequence
(ii) Unit ramp sequence
(iii) Unit sample sequence
(iv) Exponential sequence

Q.3 (a) Is the discrete time system described by the equation

$$y(n) = \frac{1}{2m+1}\sum_{k=-m}^{+m} x(n-k)$$

Causal or non-causal?

(b) Sketch the signals:

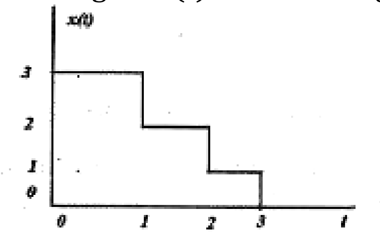
$$x(t) = [u(t) + r(t-1) - 2u(t-3)].u(-t+5)$$

(c) Explain the following system with respect to linearly property:

$$y(n) = x(n) + nx(n+1)$$

(d) Assume $x_1(t)$ and $x_2(t)$ are periodic signals with periods T_1 *and* T_2 respectively. Under what conditions is the sum $x(t) = x_1(t) + x_1(t)$ periodic and what will be the period of x(t) if it is periodic?

Q.4 (a) Find the even odd component of signal x(t). Shown in figure?



(b) The system defined by their input (x)-output (y) relationship. Check whether the following systems are:

(i) Linear (ii) Time invariant

(i) $Y(t) = \sum_{k=-x}^{+x} x(t)\,\delta(t-kT_s)$

(ii) $Y[n] = m \times [n] + c, m\ and\ c\ are\ constants$

(c) Evaluate the following integrals?

(i) $I = \int_{-x}^{t} (\cos\pi)\, u(\pi) d\pi$

(ii) $I = \int_{0}^{2\pi} t \sin\frac{t}{2}\ \delta(\pi - t)dt$

Q.5 (a) Define energy signal & power signal

(b) Explain following properties of continuous time system with example:

(i) Dynamic or static (ii) Linear or Non-linear (iii) Shift variant or invariant

(c) Find whether the given system is causal or non-casual stable or unstable

(i) $Y(t) = \cos[x(t)]$

(ii) $Y[n] = \sum_{k=-00}^{n} x(k+2)$

(iii) $Y[n] = x(n) + \frac{1}{8}x(n-1) + \frac{1}{3x}(n-2)$

(d) Draw the following symbols with mathematical analysis:

(i) Addition (iii) Unit delay function

(ii) Multiplication (iv) Unit advance function

Q.6 (a) Define energy and power signal

(b) Sketch the following signals and determine whether the signals are power o energy Signal or neither

(i) $x(t) = u(t)$

(ii) $x(t) = tu(t)$

(c) A discrete time system is described by the following expression

$$y(n) = y^2(n-1) + x(n)$$

Now, a bounded input of $x(n) = 2\delta(n)$ is applied to this system. Assuming that the system is initially relaxed check whether this system is stable or unstable?

(d) The discrete time system are represented by the following difference equation in which x(n) is the input and y(n) is the output

(i) $y(n) = 3y^2(n-1) - nx(n) + 4x(n-1) - 2x(n+1)$

(ii) $y(n) = x(n+1) - 3x(n) + x(n-1);\ \ for\ n \geq 0$

Are these systems linear? Shift variant in each case justify your answer.

Q.7 (a) Determine whether energy signal power signal or neither

(i) $y(n) = x(-0.5)^n u(n)$ (ii) $x(t) = \cos^2 wt$

(b) Check whether the following systems are static/dynamic, linear/non-linear, causal/non-causal and time-invariant/time-variant

(i) $y(n) = x(n)x(n-1)$ (ii) $y(n) = \cos x(n)$

(c) Sketch the single-sided and double-sided spectra of the following signal

$$x(t) = 2\sin\left(10\pi t - \frac{\pi}{6}\right) + Cos\ 20\pi t$$

(d) Check the stability if impulse response is given as

(i) $h(t) = e^{-2|t|}$ (ii) $h(t) = e^{-t}\cos 2t\, u(t)$

Q.8 (a) Define separately the terms signals and systems

(b) Sketch the following signal $x(t) = e^{-a|t|}$ for a>0. Also determines whether the signal is a power signal or energy signal or neither

(c) Given a system whose input-output relation is given by the linear equation Y $(t) = ax(t) + b$ where x(t) and y(t) are the input and output of the system respectively and a and b are constant. Determine if this system is linear.

(d) Define the static and dynamic system

Q.9 (a) Represent unit step sequence mathematically and graphically

(b) Given a trapezoidal pulse

$$X(t) = \{t + 5;\ -5 \leq t \leq -4\}$$

$$1; for -4 \le t \le 4$$
$$5 - t; for\ 4 \le t \le 5$$

Determine the total energy and power of x(t) also find the total energy and power of the differentiated signal $y(t) = d\big(x(t)\big)/dt$

(c) Determine whether the given signals are periodic or a periodic. Find their fundamental period if periodic

(i) $x(t) = 3\sin(7\pi t) + \cos(10\,\pi t)$ (ii) $x(n) = e^{j2\pi\, n/7} + e^{j3\pi\, n/2}$

(d) Determine whether the system discrete by the following input-output relationship is

(i) Static or dynamic (ii) causal or non-casual

(i) Linear or non-linear (ii) Time invariant or time-variant

Q.10 (a) What do you mean by aliasing? Define the Nyquist rate of sampling?

(b) Given the following signals:

(ii) $2\cos 3\pi t + 3\sin 6\pi t$ (iii) $e^{-5t}u(t)$

(iii) $2\sin 2t + 3\cos \pi t$ (iv) $e^{t}\, u(t)$

1. Identify the periodic signals and their fundamental periods.
2. Identify the power signals and calculate their average power
3. Identify energy signals and calculate their energies.

(c) For the sinusoidal signal $x(t) = \cos 8t$ find the following:

(i) the value of sampling interval $T_s\ so\ that\ x(n) = x(nT_s)$ is a periodic sequence

(d) Check whether the following system are stable or not:

(i) $Y(n) = ax(n) + b$ (ii) $Y(n) = e^{-x(n)}$