1. Given a system $y(t) = tx(t) + 3$

6 pts each

a. Is the system linear or nonlinear? Circle LINEAR or NONLINEAR and justify.

b. Is the system time invariant or time varying? Circle TIME INVARIANT or TIME VARYING and justify.

c. Is the system dynamic (with memory) or static (memory-less)? Circle DYNAMIC or STATICand justify.

a. Non-linear

b. time varying

c. static

|

2. Given z(t)=10cos(5t),

$x(t) = 10\cos(5t) + 20\cos(10t)$, and

$y(t) = 10\,\text{rect}(\frac{t-1}{4})$.

a. 4 pts What is the period of z(t)?

b. 3 pts Find the energy in x(t).

c. 3 ptsFind the power in x(t).

d. 3 pts Is x(t) an energy or power signal?

e. 3 pts Find the energy in y(t).

f. 3 pts Find the power in y(t).

g. 3 pts Is y(t) an energy or power signal?

a.

In[ ]:=
```
2. π
────
 5
```

Out[ ]=
```
1.25664
```

b. E_x=∞

c. & d   250   Power signal

In[ ]:=
```
10^2   20^2
──── + ────
 2      2
```

Out[ ]=
```
250
```

e.

In[ ]:=

$$\int_{-\infty}^{\infty} \left(10 * \text{UnitBox}\left[\frac{t-1}{4}\right]\right)^2 dt$$

Out[ ]=
```
400
```

f. P_y=0 g. Energy signal

|

3. Given a LTI system has an impulse response $h(t) = r(t)\text{rect}(\frac{t-2}{2})$.

6 pts each

a. Find and sketch the system output for an input of $\delta(t)$.

b. Is the system causal? Circle YES or NO and justify your answer.

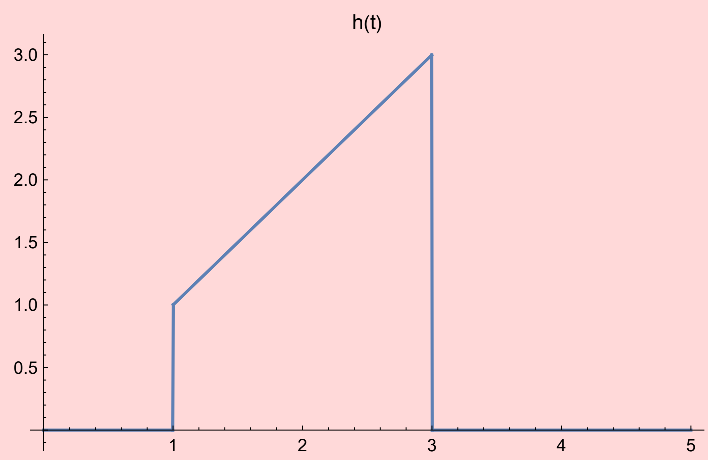
c. Is the system BIBO stable? Circle YES or NO and justify your answer.

For an input signal $x(t) = 10\ \text{rect}(\frac{t-4}{4})$

d. Find the system output at t=2, i.e., y(2).

e. Find the system output at t=4, i.e., y(4).

Out[ ]=



b. Causal

c. Stable

In[ ]:=

```
y3[2]
y3[4]
```

Out[ ]=

```
0
```

Out[ ]=

```
15
```

4. LTI system is described by a the linear, constant-coefficient, differential equation

$$\frac{1}{4}\frac{dy(t)}{dt} + y(t) = x(t)$$

15 pts each

a. Find H(ω).

b. Given x(t) = 1+2cos(t) + 4cos(4t) find the system output y(t)

In[ ]:=
```
H[w_] = 1/((I*w)/4 + 1)
```

Out[ ]=

$$\frac{1}{1 + \frac{i\, w}{4}}$$

Out[ ]=

$$\frac{1}{1 + \frac{w^2}{16}}$$

Out[ ]=

$$-\text{ArcTan}\left[\frac{w}{4}\right]$$

```
H[0] * 1 + 2 * absH4[1.] * Cos[t + angH4[1.]] + 4. * absH4[4.] * Cos[4 * t + angH4[4.]]
```

Out[ ]=

```
1 + 2.82843 Cos[0.785398 - 4 t] + 1.94029 Cos[0.244979 - t]
```

$$\cos(x)\cos(y) = \frac{1}{2}[\cos(x-y) + \cos(x+y)]$$

$$\sin(x)\sin(y) = \frac{1}{2}[\cos(x-y) - \cos(x+y)]$$

$$\sin(x)\cos(y) = \frac{1}{2}[\sin(x-y) + \sin(x+y)]$$

$$\cos(x+y) = \cos(x)\cos(y) - \sin(x)\sin(y)$$

$$\sin(x+y) = \sin(x)\cos(y) + \cos(x)\sin(y)$$

$$\frac{d}{dx}[\tan^{-1}(x)] = \frac{1}{1+x^2}$$

$$\int u\,dv = uv - \int v\,du$$

$$\int x^n \sin(x)\,dx = -x^n \cos(x) + n\int x^{n-1}\cos(x)\,dx$$

$$\int x^n \cos(x)\,dx = x^n \sin(x) - n\int x^{n-1}\sin(x)\,dx$$

$$\int x^n e^{ax}\,dx = \frac{e^{ax}}{a^{n+1}}[(ax)^n - n(ax)^{n-1} + n(n-1)(ax)^{n-2} + \ \ldots\ + (-1)^{n-1}n!(ax) + (-1)^n n!],\ n \geq 0$$

$$\int e^{ax}\sin(bx)\,dx = \frac{e^{ax}}{a^2+b^2}[a\sin(bx) - b\cos(bx)]$$

$$\int e^{ax}\cos(bx)\,dx = \frac{e^{ax}}{a^2+b^2}[a\cos(bx) + b\sin(bx)]$$

$$\int \frac{dx}{a^2+(bx)^2} = \frac{1}{ab}\tan^{-1}\left(\frac{bx}{a}\right)$$

$$\int \frac{dx}{(x^2 \pm a^2)^{\frac{1}{2}}} = \ln\left|x + (x^2 \pm a^2)^{\frac{1}{2}}\right|$$

$$\int_0^{\infty} \frac{\sin(mx)}{x}\,dx = \begin{Bmatrix} \pi/2, & m>0 \\ 0, & m=0 \\ -\pi/2, & m<0 \end{Bmatrix} = \frac{\pi}{2}\operatorname{sgn}(m)$$

$$|Z|^2 = ZZ^*$$

$$\sum_{n=0}^{N-1} r^n = \begin{cases} \frac{1-r^N}{1-r}, & r \neq 1 \\ N, & r = 1 \end{cases}$$

$$\sum_{n=0}^{\infty} r^n = \frac{1}{1-r},\ \ |r|<1$$

$$\sum_{n=k}^{\infty} r^n = \frac{r^k}{1-r},\ \ |r|<1$$

$$\sum_{n=0}^{\infty} nr^n = \frac{r}{(1-r)^2},\ \ |r|<1$$