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Please staple this cover sheet in front of your answers. (Behind Department of Physics coversheet.)

NAME: **ID#:**

ELEC441: Assignment 4
Due 1pm Thursday 1st April 2021

1. For each of the following functions, find the Fourier transform, sketch the function and sketch its Fourier transform.
   (a) $f(t) = t\exp(-\alpha t^2)$, (where α is real and positive)
   (b) $f(t) = \exp(-(t-t_0)^2)$
2. Sketch the function $f(t) = u(t)\exp(-t^2)$ and calculate and sketch the real part of its Fourier transform. You can use without proof the result $\exp(-\pi t^2) \longleftrightarrow \exp(-\pi v^2)$. Do this *without* the convolution theorem and *without* using the fact that $u(t) \longleftrightarrow \delta(t)/2 + 1/(j2\pi v)$.
3. Sketch the function $f(t) = m(t)\sin(5\pi t)$ where
$$m(t) = \begin{cases} 1-|t|, & |t|<1 \\ 0, & |t|>1 \end{cases}$$
   Then calculate and sketch its Fourier transform.
4. The "differentiator" gives an output equal to the derivative of it's input. Show that the differentiator is a linear time invariant system, calculate its impulse response. Justifying your answer, state whether or not the differentiator is a stable system.
   Hint: Consider the input $f(t) = \sin(t^2)$.
5. For the input $f(t)$, the "integrator" gives and output equal to:
$$g(t) = \int_{-\infty}^{t} f(\tau)\,d\tau \tag{1}$$
   Show that the integrator is a linear time invariant system, and calculate its impulse response. Justifying your answer, state whether or not the integrator is a stable system.
6. Calculate the convolution of $\mathrm{sinc}(\alpha t)$ and $\mathrm{sinc}(\beta t)$? Assume that α and β are real and that $|\alpha| > |\beta|$.

SCORE: