PHYS 3701 - Assignment #2
Due Friday February 6, 2015

1. Determine which of the following are linear operators:
   a) $\hat{T}_1\psi(x) = x^3\psi(x)$
   b) $\hat{T}_2\psi(x) = x\dfrac{d}{dx}\psi(x)$
   c) $\hat{T}_3\psi(x) = \lambda\psi^*(x)$
   d) $\hat{T}_4\psi(x) = e^{\psi(x)}$
   e) $\hat{T}_5\psi(x) = \dfrac{d}{dx}\psi(x) + a$
   f) $\hat{T}_6\psi(x) = \displaystyle\int_{-\infty}^{x} y\psi(y)dy$

   Solve the eigenvalue problem $\hat{T}_6\psi(x) = \lambda\psi(x)$. What values of λ give square-integrable wave functions?

   Determine the commutators $\left[\hat{T}_2,\hat{T}_6\right]$ and $\left[\hat{T}_1,\hat{T}_2\right]$.

2. Question #1 from Chapter 3 of Scherrer.

3. Question #7 from Chapter 4 of Scherrer.

4. Recall that solutions to the infinite square well with width a and centred on a/2 are $\psi_n(x) = \sqrt{\dfrac{2}{a}}\sin\left(\dfrac{n\pi x}{a}\right)$ $0 < x < a$ with energies $E_n = \dfrac{(n\pi\hbar)^2}{2ma^2}$. For a particle at time t=0 in state $\Psi(x,0) = A\sin^3\left(\dfrac{\pi x}{a}\right)$

   a) Find the normalization constant A.

   b) Determine $\Psi(x,t)$ and $\left|\Psi(x,t)\right|^2$.

   c) What energies might be measured for particles in this state and with what probabilities?

Use the fact that $\sin(3\theta) = 3\sin(\theta) - 4\sin^3(\theta)$.