**Homework #2**

(due Wednesday, October 11, 2023)

1. (20 pts) In the following expressions, where A is an operator, specify the nature of each expression (i.e. whether it's an operator, a bra or a ket) and then find its Hermitian conjugate:

(a) $\langle \psi | A | \varphi \rangle \langle \varphi |$

(b) $A | \varphi \rangle \langle \psi |$

(c) $\langle \psi | A | \varphi \rangle | \varphi \rangle \langle \psi | A$

(d) $\langle \varphi | A | \psi \rangle | \varphi \rangle - iA | \psi \rangle$

(e) $| \varphi \rangle \langle \varphi | (A + iA) | \psi \rangle \langle \psi |$

2. (15 pts) In class, we looked at the "hermiticivity" of the operators X, d/dx and $-i\hbar$(d/dx).

(a) Use our results to explore whether the following operators are Hermitian $e^{X}$, $e^{d/dx}$ and $e^{-i\hbar d/dx}$.

(b) Find the Hermitian conjugate of the operator X(d/dx), where X is a position operator. Present your result as XA+B, where A and B are some operators. What are these operators A and B?

3. (20 pts) Consider an operator $A = i\left(X^2 + 1\right)d/dx + iX$

(a) Show that A is Hermitian

(b) Find the normalized state $\psi$(x), where x spans from -∞ to +∞, for which A$\psi$(x) = 0.

(c) Calculate the probability of finding the particle (represented by $\psi$(x)) in the region -1 ≤ x ≤ 1.

4. Reading assignment: Sakurai 1.2