

Homework Assignment #3
(70 points)

Due Tuesday, October 4
(at lecture)

3.1 (10 points) CT H_{II}.3

3.2 (10 points) CT H_{II}.5

3.3 (10 points) CT H_{II}.6

3.4 (10 points) Challenge problem (a)

3.5 (10 points) CT H_{II}.10

3.6 (10 points) **Operator algebra.** Consider a one-dimensional quantum system with position operator \hat{x} and momentum operator \hat{p} , which satisfy the commutation relation $[\hat{x}, \hat{p}] = i\hbar$. Position and momentum are certainly not the only operators of the system, but one suspects that they are the only operators you need to construct all possible operators. In this problem you are asked to show this.

Show that any operator \hat{O} can be written as a function of \hat{x} and \hat{p} . [Hint: Consider the matrix elements $\langle x|\hat{O}|p\rangle$. Show that $|x\rangle\langle p| = \delta(\hat{x} - x)\delta(\hat{p} - p)$. An aficionado would then Fourier transform the δ functions to put \hat{O} in terms of translation operators.]

3.7 (10 points) Challenge problem (b)