Homework Sets

Physics 421

- Problem Set 1
  - Problems 1–8 in section 1 of the *Quick Reference Guide to Linear Algebra in Quantum Mechanics*
- Problem Set 2
  - Exercises 2.7, 2.8, 2.10, 2.11, 2.12, 2.13, 2.15, and 2.17 from Schumacher and Westmoreland.
  - Problems 2.1 and 2.2 from Schumacher and Westmoreland.
- Problem Set 3
  - Problems 2.5, 2.7, and 2.8 from Schumacher and Westmoreland.
  - Problems 1, 2, 4, 5, 9, 10, 11, 12, and 15 from the *Kets Homework*.
- Problem Set 4
  - Kronecker Delta Exercises (separate sheet)
  - Exercise 3.3 from Schumacher and Westmoreland
  - Let $|\psi\rangle = \sum_n a_n |\phi_n\rangle$ for an orthonormal basis $\{|\phi_n\rangle\}$. Show that $\langle\psi|\psi\rangle = \sum_n |a_n|^2$.
  - Exercises 3.5, 3.6, 3.8, 3.14, 3.16–3.18, 3.22, 3.24, 3.25, 3.27, 3.28 from Schmacher and Westmoreland
  - Problem 3.1 from Schumacher and Westmoreland.
  - Problems 1 and 2 from the *Operators Homework*.
- Problem Set 5
  - Exercises 3.30, 3.31, 3.33, 3.37–3.42, 3.44, 3.45, 3.47–3.56

- Let A, B, and C be Hermitian operators. Consider the following statement. If $[A, B] = 0$ and $[B, C] = 0$, then $[A, C] = 0$. Is this statement true or false? If true, prove it. If false, find a counterexample.
- Give an example of a matrix with no real eigenvalue. How do you know it has no real eigenvalue?

- Problem Set 6
  - Problem 1 from Spin-1/2 Dynamics Homework
  - Problem 2, parts 1 and 4 only, from Spin-1/2 Dynamics Homework
  - Problem 1 from Fall 2011 Exam 2
  - Schumacher/Westmoreland Problem 5.2
  - Schumacher/Westmoreland Problem 5.4

- Problem Set 7
  - Schumacher/Westmoreland Exercise 6.24
  - Schumacher/Westmoreland Exercise 6.31
  - Let

    $$\left|\Psi^{(AB)}\right\rangle = \frac{2}{\sqrt{87}}\left|0,0\right\rangle + \frac{3}{\sqrt{87}}\left|0,1\right\rangle + \frac{5}{\sqrt{87}}\left|1,0\right\rangle + \frac{7}{\sqrt{87}}\left|1,1\right\rangle$$

    be the state of the system of qubits A and B. Let $\left|\hat{\psi}_b^{(A)}\right\rangle$ be the conditional state of qubit A given the measurement outcome b for qubit B. Let $\left|\hat{\psi}_a^{(B)}\right\rangle$ be the conditional state of qubit B given the measurement outcome a for qubit A. Find $\left|\hat{\psi}_0^{(A)}\right\rangle$, $\left|\hat{\psi}_1^{(A)}\right\rangle$, $\left|\hat{\psi}_0^{(B)}\right\rangle$, and $\left|\hat{\psi}_1^{(B)}\right\rangle$.
  - Schumacher/Westmoreland Exercise 6.34
  - Problem 1 from 2012 Exam 3
  - Problem 1 from 2013 Exam 3

- Problem Set 8
  - Exercise B.1

- Exercise B.2
- (from Griffiths' *Introduction to Quantum Mechanics*) Evaluate the following integrals:
  (a) $\int_{-3}^{+1}(x^3 - 3x^2 + 2x - 1)\delta(x+2)dx$.
  (b) $\int_0^{\infty}[\cos(3x) + 2]\delta(x - \pi)dx$.
  (c) $\int_{-1}^{+1}\exp(|x| + 3)\delta(x - 2)dx$.
- Exercise 10.2
- Exercise 10.3
- Exercise 10.4
- Exercise 10.5
- Exercise 10.6
- Do any three problems from Chapter 10. (Problems 10.2, 10.3, and 10.4 are straightforward, if long, problems of the kind that you should be able to do on an exam. Problems 10.5 and 10.6 are shorter, but harder, because you need to come up with solid reasons. Problem 10.1 is kind of mathy, but give it a try if it looks interesting. Problem 10.7 is very interesting, but looks rather challenging. Problem 10.8 involves density operators, the subject of Chapter 8, which we skipped, so you'd have to be a serious overachiever to do Problem 10.8. I am happy to help you with any of these problems.)

- Problem Set 9
  - Exercise B.3
  - Exercise B.4
  - Problem 11.1
  - Problem 11.2