Lab 1

Mainly from Chapter 1 of online course textbook

CSCI 420 Applied Quantum Computing for Computer Scientists

Due Tuesday June 6, 20 points

OBJECTIVE

1. Complete the following problems. Rather than hand-written, try to use a nice professional tool such as **LaTeX or Microsoft Equation** that professionally makes the brackets which completely encompass multi-dimensional matrices. However, scanned hand-written work is ok but ensure it is legible.
2. For all problems, ensure that your work is shown.

PROBLEMS

1. **1.1** Come up with two equations that have no solution with real numbers. However, the equation should have a solution with complex numbers. Make sure to solve the equation. For example, an equation is $x^2 + 1 = 0$ and it is solved as $x^2 = -1, \text{hence } x = i$.
2. **1.2.3** Given $c_1 = 5 + 3i$ and $c_2 = 9 - 2i$, calculate $\frac{c_1}{c_2}$.
3. **1.2.3** What is the modulus of $7 - 2i$?
4. **1.3.2** What is the polar representation of $5 + 3i$? Draw it using a similar figure as Figure 1.5 from the textbook using degrees to measure the angle.
5. **2.2.1** Let r1 = 4, r2 = 5, and $V = \begin{bmatrix} 2 \\ -3 \\ 6 \end{bmatrix}$, verify the property (*vi*) from page 34 of our textbook. Show that $r_1 \cdot (r_2 \cdot V)$ and $(r_1 \; x \; r_2) \cdot V$ coincide.
6. **2.2.1** Let $c_1 = 4i$, $c_2 = 2 + 3i$, and $V = \begin{bmatrix} 2 - i & 4 + 2i \\ 3 & 1 + i \end{bmatrix}$. Verify property (viii) from page 34 of our textbook in showing $\mathbb{C}^{2 \text{ x } 2}$ is a complex vector space.
7. **2.2.5** Find the conjugate transpose of the following matrix:

$$\begin{bmatrix} i & 2 + i \\ 5 & 5 \\ 9 + 7i & -3 - 3i \end{bmatrix}$$

8. **2.4.1** Given $V_1 = [5, 1, 2]^T, V_2 = [3, 2, 1]^T$, and $c = 5$, show that the inner product respects the following multiplication equation: $\langle c \cdot V_1, V_2 \rangle = c \text{ x } \langle V_1, V_2 \rangle$
9. **2.4.7** Calculate the distance between these 2 vectors, $V_1 = \begin{bmatrix} 2 \\ 3 \\ 1 \end{bmatrix}$ and $V_2 = \begin{bmatrix} -1 \\ 3 \\ -2 \end{bmatrix}$
10. **2.6.1** Show that the following is Hermitian $\begin{bmatrix} 5 & 4 + 5i & 6 - 16i \\ 4 - 5i & 13 & 7 \\ 6 + 16i & 7 & -2.1 \end{bmatrix}$

11. **2.6.1** Is the following matrix a Hermitian matrix? Show your work.

$$\begin{bmatrix} 3i & 2+2i \\ 2-2i & 1 \end{bmatrix}$$

12. **2.6.3 (Example)** Is the following matrix a Unitary matrix? Show your work.

$$\frac{1}{\sqrt{3}}\begin{bmatrix} 1+i & -1 \\ 1 & 1-i \end{bmatrix}$$

13. **2.7.5** Let $A = [3 \quad 4]$ and $B = \begin{bmatrix} 3 & 1 \\ 2 & 4 \end{bmatrix}$. Calculate $(A \otimes B)^\dagger$ and $A^\dagger \otimes B^\dagger$. Then, show that they are equal.

SUBMITTING WORK

Your deliverables are the following:

1. Ensure all your work is in **one file** (Word or PDF format).
2. In order to maximize credit (i.e. partial credit), show as much work as possible.
3. Submit on Blackboard

GRADING

To achieve a maximum score, students will need to clearly prove that they completed the goal. A clear description of the steps taken, and screen shots are essential. Partial credit is given if students can clearly state what was done and what is not working. If the instructor is required to decipher incompleteness, much less partial credit will be given.

Points lost for incompleteness, sloppiness, lateness, or failure to follow instructions.

Late policy: refer to syllabus