

Name: \_\_\_\_\_

Student number: \_\_\_\_\_ Student email: \_\_\_\_\_

Deadline **December 6th** right before the final exam, 4:30 PM. If you are ASA, drop your file in the main office. (I will not accept the Quiz once the final exam starts).

## 1 True or False

- For the following questions, write True or False

1. if  $\mathbf{B}$  is a symmetric matrix,

$$\frac{\partial \mathbf{x}^\top \mathbf{B} \mathbf{x}}{\partial \mathbf{x}} = 2 \mathbf{B} \mathbf{x}$$

Answer: \_\_\_\_\_

2. For hermitian matrices with real numbers,  $\mathbf{A} \neq \mathbf{A}^\dagger$ .

Answer: \_\_\_\_\_

3. The multiplication of two matrices commutes, meaning  $\mathbf{A} \mathbf{B} = \mathbf{B} \mathbf{A}$ .

Answer: \_\_\_\_\_

4. Can we use the gradient to search the maximum of a function?

Answer: \_\_\_\_\_

5. The half-life time of a second order reaction does not depend on the initial concentration.

Answer: \_\_\_\_\_

6. For a linear set of equations ( $\mathbf{A} \mathbf{x} = \mathbf{y}$ ), where we have more equations than variables, meaning the matrix  $\mathbf{A}$  has  $n$ -rows and  $m$ -columns and  $n > m$ , can we do matrix inversion to solve for  $\mathbf{x}$ ?

Answer: \_\_\_\_\_

7. Is the matrix  $\mathbf{A}$  an orthogonal matrix?

$$\mathbf{A} = \frac{1}{3} \begin{pmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ -2 & 2 & 1 \end{pmatrix}$$

Answer:\_\_\_\_\_

8. Are the eigenvalues of the following matrix  $\mathbf{A}$  real?

$$\mathbf{A} = \begin{pmatrix} 1 & i & i-i \\ -i & 0 & -i+1 \\ 1+i & -1-i & 3 \end{pmatrix}$$

Answer:\_\_\_\_\_

9. Is the following matrix  $\mathbf{A}$  a singular matrix?

$$\mathbf{A} = \begin{pmatrix} 1 & 2 & 2 \\ 1 & 2 & 2 \\ 3 & 2 & -1 \end{pmatrix}$$

Answer:\_\_\_\_\_

10. Is  $\mathbf{A}^{-1}$  the correct inverse of  $\mathbf{A}$ ?

$$\mathbf{A}^{-1} = \begin{pmatrix} 5 & 2 \\ -7 & -3 \end{pmatrix} \quad \mathbf{A} = \begin{pmatrix} 3 & 2 \\ -7 & 5 \end{pmatrix} \quad (1)$$

Answer:\_\_\_\_\_

## 2 Pencil and Paper Questions

- Answer the following questions.

1. What is the following derivative equal to

$$\frac{\partial(\mathbf{x}^\top \mathbf{a})^\top}{\partial \mathbf{x}} = ?$$

Answer: \_\_\_\_\_

2. What is the following derivative equal to when  $\mathbf{W}$  is a symmetric matrix?

$$\frac{\partial ((\mathbf{x}^\top - \mathbf{s})^\top \mathbf{W}(\mathbf{x}^\top - \mathbf{s}))}{\partial \mathbf{x}}$$

Answer: \_\_\_\_\_

3. How many rows and columns does the Jacobian of  $F(\mathbf{x})$  has?

$$F(\mathbf{x}) = \begin{bmatrix} f_1(x_1, x_2, x_3) \\ f_2(x_1, x_2, x_3) \end{bmatrix}$$

Answer: \_\_\_\_\_

4. Compute the Taylor expansion of  $f(x) = x^3 - 10x^2 + 6$  at  $x = 3$ .

Answer: \_\_\_\_\_

5. Let's assume  $\mathbf{x}$  is an eigenvector of the matrix  $\mathbf{A}$  with the eigenvalue  $\lambda$ .  
What is  $\mathbf{x}^\top \mathbf{A} \mathbf{x}$  equal to ?

Answer: \_\_\_\_\_

6. What type of matrices have real eigenvalues?

Answer: \_\_\_\_\_

7. Compute the eigenvalues and eigenvectors for the matrix  $\mathbf{A}$ .

$$\mathbf{A} = \begin{pmatrix} 1 & -2 \\ -2 & 1 \end{pmatrix}$$

Answer:\_\_\_\_\_

8. What are the eigenvalues and eigenvectors for the matrix  $\mathbf{A}$ .

$$\mathbf{A} = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$$

Answer:\_\_\_\_\_

9. Explain why for the least square problem we set  $\frac{\partial \mathcal{L}(\mathbf{w})}{\partial \mathbf{w}} = 0$ .  
 $\mathcal{L}(\mathbf{w})$  is the mean square error function.

Answer:\_\_\_\_\_

10. What is the rate law of a second order reaction, choose the correct option(s).

**A)**  $r = k[\text{A}]^2$

**B)**  $r = k[\text{A}]^{\frac{1}{2}}[\text{B}]^{\frac{1}{2}}[\text{C}]$

**C)**  $r = k[\text{A}]^2[\text{B}]$

**D)**  $r = k[\text{A}][\text{B}]$

**E)**  $r = k[\text{A}]^{\frac{1}{2}}[\text{B}]^{\frac{1}{2}}$

Answer:\_\_\_\_\_