

UNIVERSITY OF MANITOBA

DATE: October 20, 2017

COURSE: MATH 1300

EXAMINATION: Vector Geometry and Linear Algebra

Midterm Exam

TITLE PAGE

TIME: 60 minutes

FAMILY NAME: (Print in ink, capitals) \_\_\_\_\_

GIVEN NAME(S): (Print in ink, capitals) \_\_\_\_\_

STUDENT NUMBER: \_\_\_\_\_

SIGNATURE: (in ink) \_\_\_\_\_

(I understand that cheating is a serious offense. I have read the instructions below twice.)

- ☐ A019:30-10:20 MWF Lilitana Y. Menjivar Lopez
- ☐ A028:30 - 9:45 TR Karen R. Gunderson
- ☐ A0311:30-12:20 MWF Michel F. Virgilio
- ☐ A0411:30-12:45 TR Yang Zhang
- ☐ D01Distance and On-Line Julien Arino
- ☐ SJR Carole Bilyk

INSTRUCTIONS TO STUDENTS:

This is a 60 minute exam. **Please show your work clearly.**

No calculators, texts, notes, or other aids are permitted. No cellphones, electronic translators, or other electronic devices able to receive or transmit a signal are permitted.

This exam has a title page and 7 pages of questions. Please check that you have all the pages.

The value of each question is indicated in the lefthand margin beside the statement of the question. The total value of all questions is 60 points.

**Answer all questions on the exam paper** in the space provided beneath the question. If you need more room, you may continue your work on the reverse side of the previous page, but **CLEARLY INDICATE** that your work is continued.

Question	Points	Score
1	3	
2	8	
3	8	
4	5	
5	10	
6	8	
7	6	
8	4	
9	8	
Total:	60	

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- [3] 1. Indicate whether the matrices below are in RREF, REF (but not RREF), or neither.

(i)  $\begin{bmatrix} 1 & 0 & 3 & 0 & 9 \\ 0 & 1 & 0 & 0 & 5 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$       (ii)  $\begin{bmatrix} 1 & 2 & 4 & -1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 2 & 0 \end{bmatrix}$       (iii)  $\begin{bmatrix} 0 & 1 & 0 & -1 & 1 \\ 0 & 0 & 1 & 3 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$

- [8] 2. Use **Gauss-Jordan elimination** to solve the following system of linear equations

$$x - y - z + 2w = 3$$

$$z - w = 1$$

$$x - y + 2z = 2$$

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- [8] 3. Let  $A = \begin{bmatrix} -1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix}$ ,  $B = \begin{bmatrix} 2 & 1 \\ 3 & 1 \end{bmatrix}$ ,  $C = \begin{bmatrix} -2 & 0 \\ 0 & 1 \\ -1 & -3 \end{bmatrix}$ . In each of the following parts, calculate the matrix or value, if the expression is defined. If the expression is not defined, explain why.

(a)  $A^T B - C^T$  (b)  $\text{tr}(CC^T)$  (c)  $A^T + C$  (d) The second column (only) of  $CA$

- [5] 4. Find the values of  $k$  so that  $A = \begin{bmatrix} k+1 & -7 \\ -3 & k-3 \end{bmatrix}$  is invertible.

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- [10] 5. Let  $A = \begin{bmatrix} -4 & 3 \\ 1 & 0 \end{bmatrix}$ . Express  $A$  as a product of elementary matrices. Show all of your work and give all entries of the elementary matrices.

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- [8] 6. Let  $A = \begin{bmatrix} -1 & 0 & 1 \\ 0 & 1 & 0 \\ 2 & 3 & -1 \end{bmatrix}$ . Find  $A^{-1}$  using elementary row operations. No marks will be given for any other method.

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- [6] 7. Let  $A$  and  $B$  be the following  $4 \times 4$  matrices:

$$A = \begin{bmatrix} 2 & 1 & 5 & 3 \\ 1 & a & b & 2 \\ d & -3 & 4 & d \\ 3 & c & d & 0 \end{bmatrix} \quad B = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 3 & k-2 & 0 & 0 \\ k-1 & -1 & k+1 & 0 \\ 2 & 0 & 1 & 3 \end{bmatrix}.$$

- (a) Find all values of  $a, b, c, d$  so that  $A$  is symmetric.
- (b) Find all values of  $k$  so that  $B$  is not invertible.
- (c) Find all values of  $k$  so that the matrix  $BB^T$  is symmetric. Explain your answer.

- [4] 8. State 4 equivalent conditions for an  $n \times n$  matrix  $A$  to be invertible.

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[8] 9. Evaluate the determinant

$$\begin{vmatrix} 2 & 3 & 4 & 5 & 1 \\ 4 & 5 & 1 & 0 & 0 \\ 3 & 4 & 5 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 5 & 1 & 0 & 0 & 0 \end{vmatrix}.$$

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