# UNIVERSITY OF MANITOBA 

EXAMINATION: Vector Geometry and Linear Algebra

NAME: (Print in ink) $\qquad$
STUDENT NUMBER: $\qquad$
SEAT NUMBER: $\qquad$
SIGNATURE: (in ink)
(I understand that cheating is a serious offense)

Please place a check mark $(\checkmark)$ for your section.

| $\square$ | A01 | 10:30-11:20 AM | MWF (206 Human Ecology) | Michel Virgilio |
| :--- | :--- | :--- | :--- | :--- |
| $\square$ | A02 | 10:00-11:15 AM | TR (206 Human Ecology) | Michael Szestopalow |
| $\square$ | A03 | $1: 30-2: 20$ PM | MWF (206 Human Ecology) | G. I. Moghaddam |
| $\square$ | D01 | Distance Course | On Line Education | Stephanie Portet |

## INSTRUCTIONS TO STUDENTS:

This is a 1 hour exam. Please show your work clearly.

No texts, notes, or other aids are permitted. There are no calculators, cellphones or electronic translators permitted.

This exam has a title page, 8 pages of questions and also 1 blank page for rough work. Please check that you have all the pages. You may remove the blank page if you want, but be careful not to loosen the staple.

The value of each question is indicated in the left hand 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 page, but CLEARLYINDICATE that your work is continued.

EXAMINATION: Vector Geometry and Linear Algebra
[9] 1. Solve the following system of linear equations:

$$
\begin{aligned}
5 w+7 x+3 y+3 z & =2 \\
-x+y+z & =-1 \\
x-y-z & =1 \\
4 w+5 x+3 y+3 z & =1 .
\end{aligned}
$$

Indicate what elementary row operations you are using.

EXAMINATION: Vector Geometry and Linear Algebra
2. Let $A=\left(\begin{array}{lll}1 & 0 & 0 \\ 1 & 2 & 0 \\ 1 & 2 & 3\end{array}\right)$ and $\mathbf{b}=\left(\begin{array}{l}12 \\ 12 \\ 12\end{array}\right)$.
[6] (a) Compute $A^{-1}$.
[3] (b) Solve $A \mathbf{x}=\mathbf{b}$ using $A^{-1}$.

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[5] 3. Let $A$ and $B$ be $n \times n$ matrices. Simplify the following expression as much as possible:

$$
\left(A+B B^{T}\right)^{-1} B\left(I_{n}+B^{T} A^{-1} B\right) B^{-1} A
$$

Assume all necessary inverses exist.

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[7] 4. Let $C=\left(\begin{array}{ll}1 & -3 \\ 2 & -1\end{array}\right)$. Write $C^{-1}$ as a product of elementary matrices.

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[10] 5. Let $X=\left(\begin{array}{ccc}2 & 0 & 0 \\ 0 & 1 & -1\end{array}\right), Y=\left(\begin{array}{cc}1 & 4 \\ -2 & 3 \\ 1 & -2\end{array}\right)$, and $Z=\left(\begin{array}{ccc}-2 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -4\end{array}\right)$. Compute the following, if they are defined. If not, explain why.
(a) $2 X^{T} Y+Z^{3}$
(b) $Y X-2 Z^{2}$
(c) $(X Y)^{T}-Z$

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[6] 6. Let $A=\left[\begin{array}{lll}3 & 3 & -4 \\ 0 & 3 & -1 \\ 0 & 0 & -2\end{array}\right]$. Given that $|B A-B|=60$ find $|B|$.

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[6] 7. Let $\left|\begin{array}{ccc}2 & a & b \\ c & -1 & 3 \\ d & e & f\end{array}\right|=-7$. Use properties of determinant to evaluate $\left|\begin{array}{ccc}2 & a & b \\ 8-c & 4 a+1 & 4 b-3 \\ d+3 c & e-3 & f+9\end{array}\right|$. Explain your work.

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[8] 8. Consider the following linear system in which $a$ is a real number.

$$
\begin{aligned}
x & +3 z
\end{aligned}=6
$$

Use Cramer's rule to solve this linear system for $y$ only.
(No mark will be given for any other method.)

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