

MT 1 Review

- Wednesday (9/23)
- 8-9 PM
- Lectures 2-10
- WTHR 200 ← Main Floor NOT Balcony

Make Sure to Bring:

- Pencil / Erasers
- PUID
- Calculator TI 30XA
- Single Line Only

Balcony Ashton Keith

V1	V2	V3	V4	V5	V6
U1	U2	U3	U4	U5	U7
T1	T2	T3	T4	T5	T7
S1	S2	S3	S4	S5	S7

V7	V8	V9	V10	V11	V12	V13	V14		
U8	U9	U10	U11	U12	U13	U14	U15	U16	U17
T8	T9	T10	T11	T12	T13	T14	T15	T16	T17
S8	S9	S10	S11	S12	S13	S14	S15	S16	S17

V15	V16	V17	V18	V19	V20	
U18	U19	U20	U21	U22	U23	U24
T18	T19	T20	T21	T22	T23	T24
S18	S19	S20	S21	S22	S23	S24

R1	R2	R3	R4	Sarah Anderson		
Q1	Q2	Q3	Q4			
P1	P2	P3	P4	P5	P6	P7
O1	O2	O3	O4	O5	O6	O7
N1	N2	N3	N4	N5	N6	N7
M1	M2	M3	M4	M5	M6	M7
L1	L2	L3	L4	L5	L6	L7
K1	K2	K3	K4	K5	K6	K7
J1	J2	J3	J4	J5	J6	J7
I1	I2	I3	I4	I5	I6	I7
H1	H2	H3	H4	H5	H6	H7

G1	G2	G3	G4	G5	G6	G7
F1	F2	F3	F4	F5	F6	F7
E1	E2	E3	E4	E5	E6	E7
D1	D2	D3	D4	D5	D6	D7
C1	C2	C3	C4	C5	C6	C7
B1	B2	B3	B4	B5	B6	B7
A1	A2	A3	A4	A5	A6	A7

Main Floor

Liam Ashton																
P8	X	X	X	X												P9
O8	O9	O10	O11	O12	O13	O14	O15	O16	O17							
N8	N9	N10	N11	N12	N13	N14	N15	N16	N17							
M8	M9	M10	M11	M12	M13	M14	M15	M16	M17							
L8	L9	L10	L11	L12	L13	L14	L15	L16	L17							
K8	K9	K10	K11	K12	K13	K14	K15	K16	K17							
J8	J9	J10	J11	J12	J13	J14	J15	J16	J17							
I8	I9	I10	I11	I12	I13	I14	I15	I16	I17							
H8	H9	H10	H11	H12	H13	H14	H15	H16	H17							
G8	G9	G10	G11	G12	G13	G14	G15	G16	G17							
F8	F9	F10	F11	F12	F13	F14	F15	F16	F17							
E8	E9	E10	E11	E12	E13	E14	E15	E16	E17							
D8	D9	D10	D11	D12	D13	D14	D15	D16	D17							
C8	C9	C10	C11	C12	C13	C14	C15	C16	C17							
B8	B9	B10	B11	B12	B13	B14	B15	B16	B17							
X	A8	A9	A10	A11	A12	A13										X

		R5		R6		R7		R8	
Q8	Q9	Q10	Q11	Q12	Q13	Q14			
P10	P11	P12	P13	P14	P15	P16			
O18	O19	O20	O21	O22	O23	O24			
N18	N19	N20	N21	N22	N23	N24			
M18	M19	M20	M21	M22	M23	M24			
L18	L19	L20	L21	L22	L23	L24			
K18	K19	K20	K21	K22	K23	K24			
J18	J19	J20	J21	J22	J23	J24			
I18	I19	I20	I21	I22	I23	I24			
H18	H19	H20	H21	H22	H23	H24			
G18	G19	G20	G21	G22	G23	G24			
F18	F19	F20	F21	F22	F23	F24			
E18	E19	E20	E21	E22	E23	E24			
D18	D19	D20	D21	D22	D23	D24			
C18	C19	C20	C21	C22	C23	C24			
B18	B19	B20	B21	B22	B23	B24			
A14	A15	A16	A17	A18	A19	A20			

1:30 Section

WTHR 200
480 stations (41 LH)
Exam Capacity 260 stations (shown shaded)

2:30 Section

SEE IMPORTANT MARKING INSTRUCTIONS ON SIDE 2

LAST NAME Zachariah FIRST NAME Pence MI A

PURDUE UNIVERSITY 10-9-0

COMPLETE ALL INFORMATION AS DIRECTED

SECTION NUMBER 027

TEST/QUIZ NUMBER 1234

STUDENT IDENTIFICATION NUMBER 00##

USE A #2 PENCIL ONLY

1 (A) (B) (C) (D) (E) (F)

2 (A) (B) (C) (D) (E) (F)

3 (A) (B) (C) (D) (E) (F)

4 (A) (B) (C) (D) (E) (F)

5 (A) (B) (C) (D) (E) (F)

6 (A) (B) (C) (D) (E) (F)

7 (A) (B) (C) (D) (E) (F)

8 (A) (B) (C) (D) (E) (F)

9 (A) (B) (C) (D) (E) (F)

10 (A) (B) (C) (D) (E) (F)

11 (A) (B) (C) (D) (E) (F)

12 (A) (B) (C) (D) (E) (F)

13 (A) (B) (C) (D) (E) (F)

14 (A) (B) (C) (D) (E) (F)

15 (A) (B) (C) (D) (E) (F)

on the exam cover page

SIGNATURE

DATE

COURSE

INSTRUCTOR

Fill out

Do not need to

Sign your name

Should start with two zeros

MA 16010 Alternate Exam 1 Fall 2026 Test Number:

Student's Name: _____ Section Number: _____

(Without your name and section number, we will NOT be able to locate your exam booklet.)

- Fill out your name and section number in the space provided above. On the scantron, fill in your name, section number, test number and student ID. Sign your name.
- You can write on this exam booklet. Turn in both your scantron and your exam booklet when you are done. Note: you will be graded ONLY based on your scantron answer sheet. Your exam booklet will be looked at to check for sufficient work to support your answers on the scantron.
- Only a TI-30Xa calculator is allowed. No exceptions. No other electronic devices are allowed. No books or notes are allowed.
- There are 12 questions with 8 points each for a total of 96 points. You will have 60 minutes to complete the exam. Good luck!

Instructor	Time and Section	Time and Section
Anderson, Sarah	9:30am 021	10:30am 022
Ashton, Liam	1:30pm 026	2:30pm 025
B Ramakrishna, Barath	7:30am 034	8:30am 033
Bouw, Hudson	12:30pm 030	1:30pm 029
Chan, Mei Lam	9:30am 032	10:30am 031
Chuah, Howen	11:30am 013	12:30pm 014
Delgado, Huimei	1:30pm 300	2:30pm 890
Fessler, Austin	7:30am 002	8:30am 001
Gutwein, Linda	7:30am 035	8:30am 036
Hilmer, Kieran	9:30am 006	10:30am 005
Kapsin, Nathan	3:30pm 016	4:30pm 015
Karunaratne, Susitha	8:30am 891	
Keith, Ashton	11:30am 008	12:30pm 007
Liu, Zijin	3:30pm 003	4:30pm 004
Melo, Anthony	3:30pm 019	4:30pm 020
Polak, Raechel	7:30am 010	8:30am 009
Pence, Zach	1:30pm 028	2:30pm 027
Vu, Thi Huong Thu	3:30pm 023	4:30pm 024
Wachefuss, Matthew	1:30pm 012	2:30pm 011
Wong, Katherine	9:30am 018	10:30am 017

Problem 1. Use the table below to compute numerically $\lim_{x \rightarrow 0} \frac{e^{3x} - 1}{x}$:

x	-0.1	-0.01	-0.001	0	0.001	0.01	0.1
$f(x)$				—			

$$\lim_{x \rightarrow 0} \frac{e^{3x} - 1}{x}$$

Problem 2. Evaluate:

$$\lim_{x \rightarrow 0} \frac{\sin(x) - x}{4x}$$

$$\begin{aligned}
 \lim_{x \rightarrow 0} \frac{\sin(x) - x}{4x} &= \frac{1}{4} \lim_{x \rightarrow 0} \frac{\sin(x) - x}{x} \\
 &= \frac{1}{4} \lim_{x \rightarrow 0} \left(\frac{\sin(x)}{x} - \frac{x}{x} \right) \\
 &= \frac{1}{4} \left[\lim_{x \rightarrow 0} \frac{\sin(x)}{x} - \lim_{x \rightarrow 0} 1 \right] \\
 &= \frac{1}{4} \lim_{x \rightarrow 0} \frac{\sin x}{x} - \frac{1}{4} \lim_{x \rightarrow 0} 1 \\
 &= \frac{1}{4} \underbrace{1} - \frac{1}{4} \underbrace{1} = \boxed{0}
 \end{aligned}$$

Problem 3. Locate and classify all discontinuities of the function $f(x)$ below:

$$f(x) = \begin{cases} -1 & x < -1 \\ \frac{x^2+x}{2x} & -1 \leq x \leq 1 \\ -\cos(\pi x) & x > 1 \end{cases}$$

Check every value except for $x = -1, 1$
 -1 that's cont $\Rightarrow f$ is cont. on $(-\infty, -1)$
 $-\cos(\pi x)$ is cont. $\Rightarrow f$ is cont. on $(1, \infty)$

$\frac{x^2+x}{2x} \leftarrow f(0)$ is undefined $\Rightarrow f$ is dis cont at $x=0$

$$\lim_{x \rightarrow 0} \frac{x^2+x}{2x} = \lim_{x \rightarrow 0} \frac{x(x+1)}{x \cdot 2} = \lim_{x \rightarrow 0} \frac{x+1}{2} = \frac{1}{2}$$

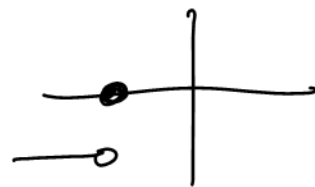
Yes, f is cont. on $(-1, 0) \cup (0, 1)$, but f
has a hole at $x=0$

Check at $x = -1$:

$$\lim_{x \rightarrow -1^-} f(x) = \lim_{x \rightarrow -1^-} -1 = -1$$

$$\lim_{x \rightarrow -1^+} f(x) = \lim_{x \rightarrow -1^+} \frac{x^2+x}{2x} = \frac{(-1)^2+(-1)}{2(-1)} = \frac{0}{-2} = 0$$

$\Rightarrow f$ has a jump discontinuity at $x = -1$



Check $x=1$:

$$\lim_{x \rightarrow 1^-} f = \lim_{x \rightarrow 1^-} \frac{x^2 + x}{2x} = 1$$

$$\lim_{x \rightarrow 1^+} f = \lim_{x \rightarrow 1^+} -\cos(\pi x) = -(-1) = 1$$

$$f(1) = \frac{(1)^2 + 1}{2(1)} = 1$$

$\Rightarrow f$ is cont. at 1.

Problem 4. Use the definition of the derivative to compute $f'(x)$ if $f(x) = x^2 - x$.

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$f(x) = x^2 - x$$

$$\begin{aligned} f'(x) &= \lim_{h \rightarrow 0} \frac{(x+h)^2 - (x+h) - (x^2 - x)}{h} \\ &= \lim_{h \rightarrow 0} \frac{\cancel{x^2} + 2xh + h^2 - \cancel{x} - h - \cancel{x^2} + \cancel{x}}{h} \\ &= \lim_{h \rightarrow 0} \frac{2xh + h^2 - h}{h} \\ &= \lim_{h \rightarrow 0} (\underbrace{2x + h - 1}) = 2x - 1 \end{aligned}$$

Problem 5. Find the equation of the line tangent to $f(x) = \sqrt{x}$ at $x = 4$

$$f(x) = \sqrt{x}$$

$$x = 4$$

Slope: Need to find $f'(4)$

$$f'(x) = [\sqrt{x}]' = [x^{\frac{1}{2}}]'$$

$$[x^p]' = p \cdot x^{p-1}$$

$$= \frac{1}{2} x^{-\frac{1}{2}} = \frac{1}{2\sqrt{x}}$$

$$f'(4) = \frac{1}{2 \cdot 2} = \frac{1}{4}$$

Point: $(4, f(4))$

$$f(4) = \sqrt{4} = 2$$

Eq:

$$y - f(4) = f'(4)(x - 4)$$

$$y - 2 = \frac{1}{4}(x - 4)$$

$$y - 2 = \frac{1}{4}x - 1$$

$$y = \frac{1}{4}x + 1$$

Problem 6. Differentiate the following functions:

$$(i) f(x) = 3x^4 + 7\sqrt[4]{x^3} - 5x^{-\frac{2}{5}} + 9x + 1$$

$$[f \pm g]' = f' \pm g'$$

$$[k \cdot f]' = k \cdot f'$$

$$f'(x) = 3(4x^3) + 7\left(\frac{3}{4}x^{-\frac{1}{4}}\right) - 5\left(-\frac{2}{5}x^{-\frac{7}{5}}\right) + 9 \cdot 1 + 0$$

$$(ii) g(x) = e^x \csc(x)$$

$$g(x) = e^x \csc x \quad [fg]' = f'g + fg'$$

$$g'(x) = [e^x]' \csc x + e^x [\csc x]'$$

$$= e^x \csc x + e^x [-\csc x \cot x]$$

$$= e^x \csc x (1 - \cot x)$$

$$(iii) h(x) = \frac{\sec(x)}{\sin(x)}$$

$$h(x) = \frac{\sec x}{\sin x} \quad \left[\frac{f}{g}\right]' = \frac{f'g - fg'}{g^2}$$

$$h'(x) = \frac{[\sec x]' \sin x - \sec x [\sin x]'}{\sin^2 x} = \frac{\sec x \tan x \sin x - \sec x \cos x}{\sin^2 x}$$

$$= \sec^2 x - \csc^2 x$$

$$(iv) s(x) = \tan(x^2 + 3x)$$

$$[f(g(x))]' = f'(g(x)) \cdot g'(x)$$

$$s'(x) = \sec^2(x^2 + 3x) \cdot [x^2 + 3x]'$$

$$= \sec^2(x^2 + 3x) \cdot (2x + 3)$$

Problem 7. The position of a damped pendulum is measured from the angle (in radians) from its resting point. Its position after t seconds is given by the equation:

$$s(t) = e^{-t} \cos\left(\frac{\pi}{2}t\right)$$

(i) What is the velocity function $v(t)$ (in radians per second)?



Velocity is the derivative of position

$$v(t) \stackrel{\text{def}}{=} s'(t) = \left[e^{-t} \cos\left(\frac{\pi}{2}t\right) \right]'$$

$$= -e^{-t} \cos\left(\frac{\pi}{2}t\right) + e^{-t} \left(-\sin\left(\frac{\pi}{2}t\right) \cdot \frac{\pi}{2} \right)$$

$$= -e^{-t} \left[\cos\left(\frac{\pi}{2}t\right) + \frac{\pi}{2} \sin\left(\frac{\pi}{2}t\right) \right]$$

(ii) What is the velocity after 1 second?

$$v(1) = -e^{-1} \left[0 + \frac{\pi}{2} \right] = -\frac{\pi}{2e} \frac{\text{rad}}{\text{s}}$$

Problem 8. The limit below represents the derivative of some function $f(x)$ at a point a :

$$\lim_{h \rightarrow 0} \frac{\sqrt[3]{\frac{1}{64+h}} - \frac{1}{4}}{h}$$

$$\frac{f(x+h) - f(x)}{h}$$

(i) Find the function $f(x)$ and the point a .

$$\begin{aligned} \lim_{h \rightarrow 0} \frac{\sqrt[3]{\frac{1}{64+h}} - \frac{1}{4}}{h} &= \lim_{h \rightarrow 0} \frac{\sqrt[3]{(64+h)^{-1}} - \frac{1}{4}}{h} \\ &= \lim_{h \rightarrow 0} \frac{(64+h)^{-\frac{1}{3}} - (64)^{-\frac{1}{3}}}{h} \end{aligned}$$

$$\begin{aligned} f(x) &= x^{-\frac{1}{3}} \\ a &= 64 \end{aligned}$$

(ii) Compute the limit.

$$\begin{aligned} \text{Limit} &= \left. \frac{d}{dx} (x^{-\frac{1}{3}}) \right|_{x=64} = -\frac{1}{3} \cdot x^{-\frac{4}{3}} \Big|_{x=64} \\ &= -\frac{1}{768} \end{aligned}$$