APPM 1345 & 1350
Final Exam
Spring 2026

Name	
Instructor	**Lecture Section**

This exam is worth 150 points and has **6 problems**.

Make sure all of your work is written in the blank spaces provided. If your solutions do not fit, you may ask one of your proctors for a piece of scratch paper. Do NOT use any paper that you have brought with you.

Show all work and *simplify* your answers. Name any theorem that you use. Answers with no justification will receive no points unless the problem explicitly states otherwise.

Notes, papers, calculators, cell phones, and other electronic devices are not permitted.

End of Exam Check List

1. If you finish the exam before 12:45 PM:
   - Go to the designated area to scan and upload your exam to Gradescope.
   - Verify that your exam has been correctly uploaded and all problems have been labeled.
   - Leave the physical copy of the exam with your proctors in the correct pile for your Lecture Section.
2. If you finish the exam after 12:45 PM:
   - Please wait in your seat until 1:00 PM.
   - When instructed to do so, scan and upload your exam to Gradescope at your seat.
   - Verify that your exam has been correctly uploaded and all problems have been labeled.
   - Leave the physical copy of the exam with your proctors in the correct pile for your Lecture Section.

Formulas

$$\sin(2\theta) = 2\sin\theta\cos\theta \qquad \cos(2\theta) = 2\cos^2\theta - 1 = 1 - 2\sin^2\theta$$

$$\sum_{i=1}^{n} i = \frac{n(n+1)}{2} \qquad \sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6} \qquad \sum_{i=1}^{n} i^3 = \left(\frac{n(n+1)}{2}\right)^2$$

$$\int \frac{1}{\sqrt{1-x^2}}dx = \arcsin x + C \qquad \int \frac{1}{1+x^2}dx = \arctan x + C$$

1. (28 points) The following parts are not related. You may use any method to find the derivatives. Show all supporting work and box your answer.

   (a) Find $f'(x)$ when $f(x) = \frac{\sin(\tan(x))}{x}$.

   (b) Use logarithmic differentiation to find the derivative of $y = (x^2 + 7)^x$. Write your answer in terms of x. *You do not need to simplify your answer.*

   (c) Find $g'(x)$ when $g(x) = xe^{5x} + \sinh(x)$.

   (d) Find dy/dx if $\ln(xy) = e^{x-y}$

2. (40 points) The following parts are unrelated. Show all supporting work and box your answers.

   (a) Evaluate the limit: $\lim_{x\to\infty} x^3 e^{-x}$.

   (b) Evaluate the limit: $\lim_{x\to 3} \dfrac{x^2-9}{x-3}$.

   (c) Evaluate the indefinite integral: $\displaystyle\int \sec^3 x \tan x dx$.

   (d) Evaluate the definite integral: $\displaystyle\int_1^2 \frac{x^2}{x^3+1} dx$

3. (15 points) For what values of a and b is the following function $f(x)$ continuous at $x = 0$? Fully support your answer using the definition of continuity, which includes evaluating the appropriate limits. Box your answers.

$$f(x) = \begin{cases} \dfrac{\sin(5x)}{x} & , \quad x < 0 \\ a & , \quad x = 0 \\ b(x-2)^2 & , \quad x > 0 \end{cases}$$

4. (15 points) Suppose the Artemis II rocket is traveling directly upward from a launch pad, and a point P is located on the ground 3 km from the launch pad. Assume the ground between the launch pad and point P is flat and horizontal.

   If the rocket is traveling at 20 km per minute when it is 4 km directly above the launch pad, how fast is the straight-line distance between the rocket and point P changing at that moment? Show all work and include the correct unit of measurement in your final answer.

5. (28 points) Parts (a), (b), and (c) are unrelated. Clearly show your supporting work and box your answer.

(a) For $f(x) = \int_0^{3x} \sin^{-1}(t)dt$, find $f'(x)$.

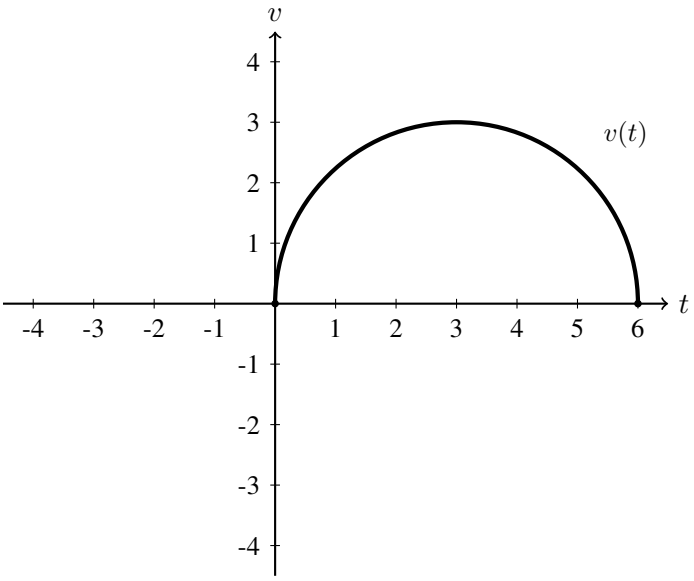
(b) For $g(x) = \tan^{-1}(x^2)$, find $g'(x)$.

(c) Suppose $h(x)$ is such that $h'(x) = \frac{1}{(1-x)^2}$ and $h''(x) = \frac{2}{(1-x)^3}$

(i) On what interval(s) is $h(x)$ increasing?

(ii) On what interval(s) is $h(x)$ concave down?

6. (24 points) The airspeed velocity (m/s) of an unladen European swallow is given by the function graphed below. You may assume that the swallow is traveling in a straight horizontal line. You may assume that the graph below is a half-circle. Answer the following questions. No justification is required for the following questions. Include relevant units in your answers.



(a) What is the distance that the swallow travels from time $t = 0$ to $t = 6$?

(b) What is the maximum velocity of the swallow on the given time interval: $[0, 6]$?

(c) Over which open interval is the swallow accelerating?

(d) At what point(s) in time is the swallow moving at a constant speed? (i.e. $a(t) = 0$)

(e) At what point(s) in time is the swallow at rest?

END OF TEST