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Math 118 - Fall 2025 - Common Final Exam

Print name:______________________________________

Section number:__________ **Instructor's name:**____________________________

Directions:

- **Do not open your exam until you are instructed to do so by your instructor.**
- Fill in your name, your instructor's name, and section number. If you don't know your section number, write the day and time that your class normally meets (example: MWF 8:15-9:05).
- This exam has 14 questions. Once the exam has begun, please check to make sure that your exam is complete.
- It will be graded out of 100 points.
- Show your work. Answers (even correct ones) without the corresponding work will receive no credit.
- A formula sheet has been provided with this exam. You may not refer to any other notes during the exam.
- You may use a calculator which does not allow internet access. The use of any notes or electronic devices other than a calculator is prohibited.
- **Unless otherwise stated, round any constants to two decimal places if necessary.**

Good luck!

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

Question:	9	10	11	12	13	14		Total
Points:	8	6	5	10	6	5		100
Score:								

1. (8 points) A social media influencer starts with 800 followers on her platform in January 2024. Recall that a linear function has a general form of $f(t) = a + bt$ and an exponential function has a general form of $f(t) = a \cdot b^t$.

   (a) If the influencer gains followers at a steady rate of 75 followers per month, find a formula for the function $f(t)$, the number of followers t months after January 2024.

   (b) If her follower count is growing by 8% per month, find a formula for the function $f(t)$, the number of followers t months after January 2024.

   (c) Under the assumptions stated in part (b), find how many months it will take for her follower count to reach 3000. Round to the nearest whole number.

2. (7 points) A startup's revenue grows by a factor of 1.15 each year. Find the doubling time for the revenue (in years). Give your answer to two decimal places.

3. (10 points) Jordan deposits \$8,000 into a savings account that offers a nominal annual rate of 3.6%.

   (a) Find the account balance after 4 years for the following compounding options. Round your answers to the nearest dollar.

      i. Compounded annually.

      ii. Compounded monthly (12 times per year).

      iii. Compounded continuously.

   (b) If Jordan plans to keep the money in the account for 30 years, by what percent does the investment increase over the 30-year period if compounded annually? Round your answer to the nearest hundredth of a percent.

4. (7 points) Consider the function $P(t) = 120e^{-0.09t}$, $t \geq 0$.

   (a) Does $P(t)$ model exponential growth or decay? Explain briefly.

   (b) What is the initial value $P(0)$?

   (c) What is the continuous growth/decay rate as a percentage?

   (d) Rewrite $P(t)$ in the form $P(t) = ab^t$ with $b > 0$.

5. (8 points) On March 1 at midnight low tide at a harbor is at 0.5 ft and the first high tide that day occurs at 6 a.m. with height 8.5 ft.

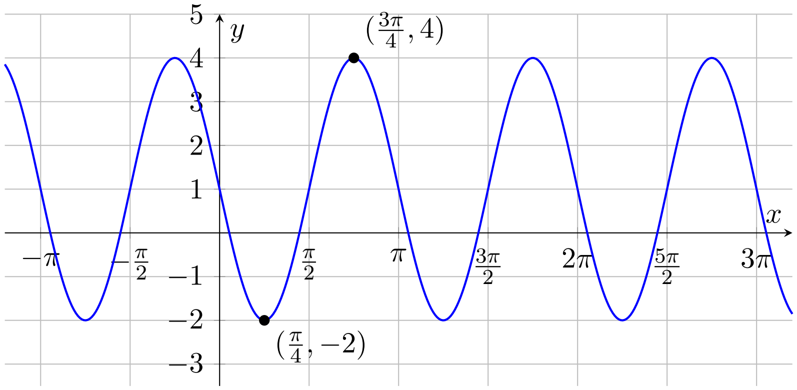
   (a) Find a sinusoidal model for the height at time t hours since midnight that fits the data, where t is hours after midnight. Show how you determine amplitude, period, and midline.

   (b) Write an equation to solve for the first time after midnight that the tide reaches 3 ft, and give the solution by using an inverse trig function. Then evaluate the time to the nearest hour.

6. (6 points) The graph of a trigonometric function is shown below. Write an equation of the form

$$y = A\sin(Bx + C) + D \quad \text{or} \quad y = A\cos(Bx + C) + D$$

that represents the graph. State the amplitude, period and midline. Show your work.



Amplitude = ________________

Period = ________________

Midline = ________________

Equation = ___________________________

7. (8 points) Let α be an angle in quadrant II with $\cos\alpha = -\dfrac{4}{5}$.

   (a) Find $\sin\alpha$ and $\tan\alpha$. Provide an exact answer.

   (b) Compute $\sin(\alpha - \frac{\pi}{6})$ using sum/difference identities. Provide an exact answer.

8. (6 points) Evaluate each of the following exactly. Show all work and include a right triangle diagram when helpful.

   (a) $\sin^{-1}\left(\frac{\sqrt{2}}{2}\right)$

   (b) $\cos^{-1}\left(-\frac{\sqrt{3}}{2}\right)$

   (c) $\tan^{-1}(\sqrt{3})$

9. (8 points) A radio tower of height 480 ft is secured by a cable attached to the top and anchored to the ground. The cable makes an angle of 50° with the ground.

   (a) How long must the cable be? Give your answer to two decimal places.

   (b) How far from the base should the anchor be placed? (Distance from tower base to anchor point.)

10. (6 points) Let $f(x) = 4x + 1$, $g(x) = 2^x$, and $h(x) = \ln(x)$.

(a) Compute $f(g(3))$.

(b) Write an expression for $h(g(f(x)))$. Do not simplify.

11. (5 points) Let $G(x) = \dfrac{3}{\ln(2x+5)}$. Decompose G as $G(x) = f(u(x))$ with u the inside function.

12. (10 points) A town has population modeled by $P(t) = 900(1.04)^t$, where t is years since 2022.

(a) Evaluate $P(5)$ and round to the nearest whole number. Explain what this number represents in a sentence.

(b) Find the inverse function $P^{-1}(y)$ in terms of y (exact form).

(c) Use part (b) to find how many years after 2022 the population will reach 1200. Round to the nearest whole year.

13. (6 points) Perform the following coordinate conversions and give exact answers when possible.

    (a) Convert Cartesian $(x, y) = \left(-\sqrt{3}, 1\right)$ to polar coordinates (r, θ) with $0 \leq \theta < 2\pi$.

    (b) Convert polar coordinates $(r, \theta) = (6, -\frac{\pi}{3})$ to Cartesian (x, y).

14. (5 points) Oli and Nora run from the same point with an angle of $140°$ between their paths. Oli runs 40 m, and Nora runs 70 m.

    (a) Draw a clear diagram showing the situation.

    (b) How far apart are Oli and Nora after running? Round your answer to the nearest meter.

Rules of Exponents
$a^b a^c = a^{b+c}$
$(a^b)^c = a^{b \cdot c}$
$a^{m/n} = (\sqrt[n]{a})^m = \sqrt[n]{a^m}$
$a^{-b} = \dfrac{1}{a^b}$
$\dfrac{1}{a^{-b}} = a^b$

Exponential and Logarithm Formulas
Linear Function: $Q(t) = mt + b$
Exponential Function: $Q(t) = a \cdot b^t$
Continuous Exponential Function: $Q(t) = a \cdot e^{kt}$
Simple Interest: $B = P(1 + r)^t$
Compound Interest: $B = P\left(1 + \dfrac{r}{n}\right)^{nt}$
Logarithms: $b^y = x \leftrightarrow log_b(x) = y$

Trigonometry Formulas
1 radian $= \dfrac{180}{\pi}$ degrees and 1 degree $= \dfrac{\pi}{180}$ radians

$\sin(\theta) = \dfrac{opp}{hyp} = \dfrac{y}{r} \quad \cos(\theta) = \dfrac{adj}{hyp} = \dfrac{x}{r} \quad \tan(\theta) = \dfrac{opp}{adj} = \dfrac{y}{x} = \dfrac{\sin(\theta)}{\cos(\theta)}$

$\csc(\theta) = \dfrac{1}{\sin(\theta)} = \dfrac{r}{y} \quad \sec(\theta) = \dfrac{1}{\cos(\theta)} = \dfrac{r}{x} \quad \cot(\theta) = \dfrac{1}{\tan(\theta)} = \dfrac{x}{y} = \dfrac{\cos(\theta)}{\sin(\theta)}$

Sum and Difference Formulas:
$\sin(A + B) = \sin(A)\cos(B) + \cos(A)\sin(B)$
$\sin(A - B) = \sin(A)\cos(B) - \cos(A)\sin(B)$
$\cos(A + B) = \cos(A)\cos(B) - \sin(A)\sin(B)$
$\cos(A - B) = \cos(A)\cos(B) + \sin(A)\sin(B)$

Pythagorean Identities: $\sin^2(\theta) + \cos^2(\theta) = 1 \quad \tan^2(\theta) + 1 = \sec^2(\theta) \quad 1 + \cot^2(\theta) = \csc^2(\theta)$

Even-Odd Identities: $\sin(-x) = -\sin(x)$ and $\cos(-x) = \cos(x)$ and $\tan(-x) = -\tan(x)$

Other identities: $\sin(\theta) = \sin(\pi - \theta)$, $\cos(\theta) = \cos(2\pi - \theta)$

General form for sine and cosine: $f(t) = A\sin(Bt) + k$ and $f(t) = A\cos(Bt) + k$

General form with horizontal shift: $f(t) = A\sin(B(t - h)) + k$ and $f(t) = A\cos(B(t - h)) + k)$

Period for sine and cosine: $P = \dfrac{2\pi}{|B|}$ or $PB = 2\pi$. Amplitude $= |A| = \dfrac{max - min}{2}$. Midline: $y = k$, where $k = \dfrac{max + min}{2}$

Law of Sines: $\dfrac{\sin(A)}{a} = \dfrac{\sin(B)}{b} = \dfrac{\sin(C)}{c}$

Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos(C)$

Arc Length: $s = r\theta$

Inverse Trig Functions

$\theta = \cos^{-1}(y)$ provided that $y = \cos(\theta)$ and $0 \leq \theta \leq \pi$

$\theta = \sin^{-1}(y)$ provided that $y = \sin(\theta)$ and $-\dfrac{\pi}{2} \leq \theta \leq \dfrac{\pi}{2}$

$\theta = \tan^{-1}(y)$ provided that $y = \tan(\theta)$ and $-\dfrac{\pi}{2} < \theta < \dfrac{\pi}{2}$

Polar coordinates conversions

$r^2 = x^2 + y^2$, $\tan(\theta) = \dfrac{y}{x}$, $x = r\cos(\theta)$, $y = r\sin(\theta)$

The Unit Circle