

**MIDTERM 2 – PART 1****(CHAPTERS 2 AND 3: POLYNOMIAL, RATIONAL, EXP'L, LOG FUNCTIONS)****MATH 141 – SPRING 2026 – KUNIYUKI****150 POINTS TOTAL: 56 FOR PART 1, AND 94 FOR PART 2****Show all work, simplify as appropriate, and use “good form and procedure” (as in class).****Box in your final answers!****No notes or books allowed.**

Unless otherwise specified, give exact answers.

**Write units where appropriate in your answers.****PART 1: USING SCIENTIFIC CALCULATORS (56 PTS.)**

- 1) Write the “Vertex Form” of the equation of the parabola in the usual  $xy$ -plane that opens downward, that has  $(-1, 4)$  as its vertex, and that passes through the point  $(1, -16)$ . (7 points)

2) An astronaut kicks a ball over a flat region of a (very) distant moon. The height of the ball in feet is given by:  $h(t) = -3t^2 + 18t + 2$  (if  $t \geq 0$ ), where  $t$  is the amount of time in seconds since the ball was kicked. (The formula is relevant up until the moment the ball hits the ground.) Write units in your answers! (19 points total)

a) Write and use a formula we used in class to find how much time it takes (since the ball was kicked) for the ball to reach its maximum height. (4 points)

b) What is the maximum height achieved by the ball? (4 points)

c) What was the height of the ball at the time it was kicked? (3 points)

d) How much time does it take (since the ball was kicked) for the ball to hit the ground? Give an exact answer and also round it off to three significant digits. (8 points)

3) Consider  $f(t) = t^3 - 7t^2 + 17t - 14$  in parts a) and b) below.

Hint: One of the zeros is 2. (16 points total)

a) Write the two other complex zeros of  $f$  in simplest, standard form. Show all work, as in class. Box in your answers! (13 points)

b) Write the polynomial  $f(t)$  as a product of three linear factors over  $\mathbb{C}$ , the set of complex numbers. We basically want the Linear Factorization Theorem (LFT) Form of the factorization. (3 points)

4) On the day of a child's birth, a deposit of \$2000 is made in a trust fund that pays 5.5% annual interest compounded continuously. Assuming there are no further deposits or withdrawals, how old will the child be when there is \$15,000 in the account? Give **both** an **exact** answer (which may look ugly; you don't have to simplify it) and an **approximate** answer rounded off to three significant digits. Write units! (10 points)

5) Approximate  $\log_5(1234)$  to four decimal places. Show work by using a change-of-base formula we have discussed in class. (4 points)

**MIDTERM 2 – PART 2****(CHAPTERS 2 AND 3: POLYNOMIAL, RATIONAL, EXP'L, LOG FUNCTIONS)****MATH 141 – SPRING 2026 – KUNIYUKI****150 POINTS TOTAL: 56 FOR PART 1, AND 94 FOR PART 2****Show all work, simplify as appropriate, and use “good form and procedure” (as in class).****Box in your final answers!****No notes or books allowed.**

Unless otherwise specified, give exact answers.

Graphs are assumed to be in the usual  $xy$ -plane.**PART 2: NO CALCULATORS ALLOWED! (94 POINTS)**

- 6) Use Long Division to perform the division:  $\frac{6x^5 + 4x^4 - 15x^2 - 14x}{2x^3 - 5}$ .

Write your answer in the form: (polynomial) + (proper rational expression).

(11 points)

- 7) Match the equations with their corresponding graphs by writing the appropriate letters in the blanks. Assume that there are no other turning (turnaround) points outside the “scope” of the figures below. The  $x$ - and  $y$ -axes are not necessarily scaled the same way within and between graphs. (4 points)

The graph of  $y = x^4 + 3x^2 - x + 1$  is Graph \_\_\_\_\_.

The graph of  $y = -x^5 + 2x^2 + 1$  is Graph \_\_\_\_\_.

The graph of  $y = x^5 - 10x^3 + 9x + 1$  is Graph \_\_\_\_\_.

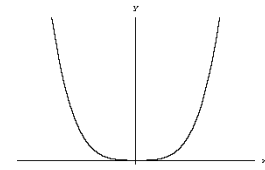
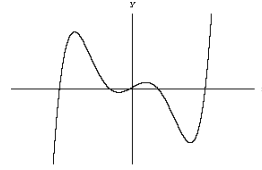
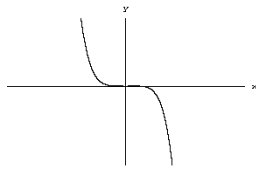
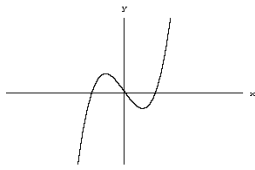
The graph of  $y = x^3 - 8x + 1$  is Graph \_\_\_\_\_.

Graph A

Graph B

Graph C

Graph D



- 8) If  $f(x)$  is a nonzero polynomial with real coefficients such that one of its zeros is  $3 + 5i$ , what other complex number must also be a zero of  $f(x)$ ? (1 point)

- 9) Fill in the blank:

If  $f(x) = (x - 4)^3$ , then 4 is a zero of  $f$  with multiplicity \_\_\_\_\_. (1 point)

- 10) Write the list of the possible rational zeros of  $f$ , where

$$f(x) = 7x^5 + 12x^3 - 4x^2 + 2, \text{ based on the Rational Zero Test (Rational}$$

Roots Theorem). You do not have to determine which of these candidates are, in fact, zeros. (6 points)

- 11) Simplify  $i^{447}$ . (2 points)

12) Consider  $f(x) = 7x^5 - 3x^4 - 2x + 5$ . Using only Descartes's Rule of Signs, ... (8 points total)

a) List the possible numbers of **positive** real zeros of  $f$  (accounting for multiplicity: double roots are counted twice, for example). (3 points)

b) List the possible numbers of **negative** real zeros of  $f$  (accounting for multiplicity: double roots are counted twice, for example). Show work, as in class. (5 points)

13) Consider the graph of  $y = \frac{(x+1)^2(x+2)}{(x+1)(x+2)^4}$  in the usual  $xy$ -plane.

If an answer to a part below is none, write "NONE." Box in the answers! (6 points total; 2 each)

a) Give the  $x$ -coordinate(s) of the hole(s), if any.  
(Holes correspond to "removable discontinuities.")

b) Find the equation(s) of the vertical asymptote(s) (VAs), if any.

c) Find the equation of the horizontal asymptote (HA), if any.

14) Consider the graph of  $y = \frac{3x^2 + 1}{6x^2 - 6}$  in the usual  $xy$ -plane. If an answer to a part below is none, write "NONE." Box in the answers! (14 points total)

a) Find the  $x$ -intercept(s), if any. (3 points)

b) Find the  $y$ -intercept, if any. (3 points)

c) Find the equation(s) of the vertical asymptote(s) (VAs), if any. (5 points)

d) Find the equation of the horizontal asymptote (HA), if any. (3 points)

15) Write the domain of  $f$ , where  $f(x) = \sqrt[4]{x^2 - 16}$  using interval form (the form using parentheses and/or brackets). (5 points)

- 16) Write the **domain** of  $f$ , where  $f(x) = 10^x$ , in interval form (the form using parentheses and/or brackets). (1 point)
- 17) Write the **range** of  $f$ , where  $f(x) = 10^x$ , in interval form (the form using parentheses and/or brackets). (1 point)
- 18) Write the **domain** of  $f$ , where  $f(x) = \ln(x)$ , in interval form (the form using parentheses and/or brackets). (1 point)
- 19) Write the **range** of  $f$ , where  $f(x) = \ln(x)$ , in interval form (the form using parentheses and/or brackets). (1 point)
- 20) Simplify the following: (6 points total; 2 points each)
- a)  $\log_{16}(2)$
- b)  $\log_8(8^{12})$
- c)  $\log_3\left(\frac{1}{27}\right)$

21) Expand and evaluate where appropriate:  $\ln \left[ \frac{e^3(\sqrt{x})}{y^2 z^5} \right]$ . Assume  $x, y, z > 0$ .

(10 points)

22) Find all real solution(s) (in simplified form) of the equation:  $4^{x-1} = 16^{2x}$ .  
Write the solution set. Show all work, as in class; do not use trial-and-error!  
(7 points)

23) Find all real solution(s) of the equation:  $\log_5(x) - \log_5(x - 100) = 1$ .

Write the solution set. Show all work, as in class; do not use trial-and-error!  
(9 points)