Math 141 Name: ________________________

MIDTERM 2 – PART 1

(CHAPTERS 2 AND 3: POLYNOMIAL, RATIONAL, EXP'L, LOG FUNCTIONS)
MATH 141 – SPRING 2019 – KUNIYUKI
150 POINTS TOTAL: 47 FOR PART 1, AND 103 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 (47 PTS.)

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

2) A projectile is fired over a flat desert. The height of the projectile is given by $h(t) = -16t^2 + 40t + 5$, where t is time measured in seconds since the moment the projectile is fired. (The height formula is relevant up until the moment the projectile hits the ground.) Height is measured in feet. Write appropriate units in your answers! (10 points total)

   a) What is the height of the projectile at the moment that it is fired?

   b) Use a formula we used in class to find the length of time it takes (since it was fired) for the projectile to reach its maximum height.

   c) What is the corresponding maximum height?

3) Consider $f(x) = 3x^3 - 10x^2 + 7x - 12$ in parts a) and b) below.
Hint: One of the zeros is 3. (17 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 $f(x)$ as a product of a constant and three linear factors over $\mathbb{C}$, the set of complex numbers. We basically want the Linear Factorization Theorem (LFT) Form of the factorization. (4 points)

4) An exponential growth model for the population of Fredonia is given by: $P(t) = P_0 e^{0.0471t}$, where $P(t)$ is the population t years after January 1, 2010. The population of Fredonia was 64,000 people on January 1, 2010. (9 points total)

   a) In how many years after January 1, 2010 will the population of Fredonia be 750,000 people? 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! (8 points)

   b) In what year will the population of Fredonia be 750,000 people? You may use part a). (1 point)

5) Approximate $\log_4(9753)$ to four decimal places. Show work by using a change-of-base formula we have discussed in class. (4 points)

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Graphs are assumed to be in the usual *xy*-plane.

PART 2: NO CALCULATORS ALLOWED! (103 POINTS)

6) Use Long Division to perform the division: $\dfrac{6x^5 + 2x^3 - 12x^2 + 4x - 5}{3x^2 + 1}$.

   Write your answer in the form: $(\text{polynomial}) + (\text{proper rational expression})$.
   (11 points)

7) Fill in each blank below with ∞ or $-\infty$. (4 points total; 2 points each)

   a) If $f(x) = 4x^5 - 2x^4 + 3$, then $\lim\limits_{x \to -\infty} f(x) =$ _______

   b) If $g(x) = 5x^4 + x^2 - \dfrac{1}{x}$, then $\lim\limits_{x \to \infty} g(x) =$ _______

8) Write the list of the possible rational zeros of f, where $f(x) = 2x^4 - 11x^2 + x - 3$, based on the Rational Zero Test (Rational Roots Theorem). You do <u>not</u> have to determine which of these candidates are, in fact, zeros. (6 points)

9) Simplify i^{502}. (2 points)

10) Simplify $\frac{1}{2+i}$ by writing the quotient in standard form. (4 points)

11) Let $f(x) = x^5 + 9x^3$. Write the three distinct complex zeros of f and their multiplicities in the table below. (8 points)

Zero	Multiplicity

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) Write the equation of the **horizontal** asymptote (HA) for the graph of $y = \frac{5x^4 + 3x}{9x^4 - x^2 + 1}$ in the usual *xy*-plane. (3 points)

14) Yes or No: Does the graph of $y=\frac{x^2-36}{x-6}$ have a vertical asymptote (VA) with equation $x=6$ in the usual xy-plane? Box in one: (2 points)

Yes No

15) Consider the graph of $y=\frac{x-4}{x^2-2x-3}$ 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 equation(s) of the vertical asymptote(s) (VAs), if any. (5 points)

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

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

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

16) Write the domain of f, where $f(x)=\sqrt{x^2-4x+3}$ using interval form (the form using parentheses and/or brackets). (5 points)

17) Let $f(x) = e^x \ln(x+5)$. Write the **domain** of f using interval form (the form using parentheses and/or brackets). (3 points)

18) Simplify the following: (4 points total; 2 points each)

a) $4^{\log_4(20)}$

b) $\log_3\left(\frac{1}{27}\right)$

19) Expand and evaluate where appropriate: $\log\left[\frac{x^2\left(\sqrt[3]{y}\right)}{1000z^3}\right]$. Assume $x, y, z > 0$.

(10 points)

20) Find all real solution(s) of the equation: $\log_2(x) + \log_2(x+2) = 3$.
Write the solution set. Show all work, as in class; do <u>not</u> use trial-and-error!
(12 points)

21) Find the real solution of the equation: $e^{2x} - 11e^x = 0$.
Write the solution set. Show all work! Hint: Factor. (7 points)