Math 141 Name: ______________________

MIDTERM 2 – PART 1

(CHAPTERS 2 AND 3: POLYNOMIAL, RATIONAL, EXP'L, LOG FUNCTIONS)
MATH 141 – FALL 2019 – KUNIYUKI
150 POINTS TOTAL: 49 FOR PART 1, AND 101 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 (49 PTS.)

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

   a) 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.

   b) What is the maximum height achieved by the ball?

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

   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.

2) 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)

3) 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)

4) Approximate $\log_5(1684)$ to four decimal places. Show work by using a change-of-base formula we have discussed in class. (4 points)

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Show all work, simplify as appropriate, and use "good form and procedure" (as in class).
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Unless otherwise specified, give exact answers.
Graphs are assumed to be in the usual *xy*-plane.

PART 2: NO CALCULATORS ALLOWED! (101 POINTS)

5) The equation of a parabola is given by: $y = -7(x-4)^2 + 5$. (4 points total)

   a) Which way does the parabola open? Box in one: Upward Downward

   b) What is the vertex of the parabola?

6) 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. (8 points)

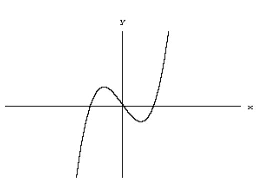
   The graph of $y = x^4 + 3x^2 - x + 1$ is Graph _____.

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

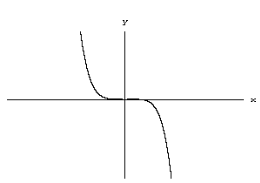
   The graph of $y = x^5 - 10x^3 + 9x + 1$ is Graph _____.

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

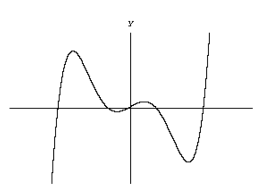
Graph A



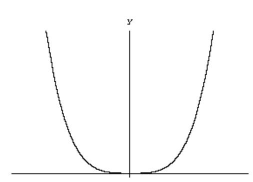
Graph B



Graph C



Graph D



7) Write the list of the possible rational zeros of f, where $f(x) = 2x^5 + 3x^3 - 6x^2 + 7$, 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)

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

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

9) Simplify $\dfrac{1}{3-7i}$ by writing the quotient in standard form. (5 points)

10) Consider $f(x)=9x^6+3x^4+x^3+4$. According to Descartes's Rule of Signs, how many **positive** real zeros does f have? (2 points)

11) Factor $3x^4 - 75$ as a product of a constant and four linear factors over $\mathbb{C}$, the set of complex numbers. We basically want the Linear Factorization Theorem (LFT) Form of the factorization. (8 points)

12) Consider the graph of $y = f(x)$, where $f(x) = \dfrac{3x^2 + 2x - 1}{9x^2 - 4}$. If an answer to a part below is none, write "NONE." Box in the answers! (20 points total)

a) Factor the numerator and the denominator of $\dfrac{3x^2 + 2x - 1}{9x^2 - 4}$. (4 points)

b) Yes or No: Does the graph of $y = f(x)$ have any holes? (Holes correspond to "removable discontinuities.") Box in one: (2 points)

Yes   No

c) Find the equation(s) of the vertical asymptote(s) (VAs), if any. (4 points)

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

e) Find the x-intercept(s), if any. (4 points)

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

13) 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)

14) Simplify the following; box in your final answers: (6 points total; 2 each)

a) $\log_{16}(2)$

b) $\log(1000)$

c) $\log_2\left(\frac{1}{8}\right)$

15) Expand and evaluate where appropriate: $\ln\left[\frac{e^4 x^5}{(y^3)(\sqrt{z})}\right]$.

Assume $x, y, z > 0$. (10 points)

16) 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)

17) 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)