UNIVERSITY OF VICTORIA
MIDTERM EXAM 1 JANUARY 30 2020
COMPUTER SCIENCE 349A

NAME: _____ STUDENT NO. _____

INSTRUCTOR: Rich Little

. DURATION: 50 minutes

TO BE ANSWERED ON THE PAPER

STUDENTS MUST COUNT THE NUMBER OF PAGES IN THIS EXAMINATION PAPER BEFORE BEGINNING TO WRITE, AND REPORT ANY DISCREPANCY IMMEDIATELY TO ME.

PLEASE PUT YOUR NAME ON THE VERY BACK SHEET AS WELL.

THIS QUESTION PAPER HAS 4, SINGLE-SIDED PAGES. YOU MAY USE THE BACK PAGES.

NOTES: (0) CLOSED BOOK EXAM; ONLY BASIC CALCULATORS ARE ALLOWED, (1) ANSWER ALL QUESTIONS, (2) THERE ARE A TOTAL OF 18 MARKS, (3) THE BACK PAGE OF EACH QUESTION MAY BE USED FOR YOUR ANSWERS. (4) STUDENTS ARE ALLOWED ONE 8.5-by-11 INCH SHEET CONTAINING ANY INFORMATION — BOTH SIDES CAN BE USED.

Question	Possible marks	Actual marks
1	6	
2	6	
3	6	
Total	18	

1. The amount of a uniformly distributed radioactive contaminant contained in a closed reactor is measured by its concentration c in becquerels/litre (Bq/L). The contaminant decreases at a decay rate proportional to its concentration, given by differential equation,

$$\frac{dc}{dt} = -kc$$

where t is time in days (d) and k is a constant with units of inverse days (d^{-1}).

   (a) [4 points] Use Euler's method to derive a numeric approximation to the concentration of a radiactive contaminant at time t_{i+1} days, $c(t_{i+1})$, given the concentration at time t_i days, $c(t_i)$.

   (b) [2 points] Let $k = 0.175d^{-1}$ and suppose that $c(0) = 100$ Bq/L. Approximate the concentration at time $0.1d$ using your method from (a).

2. (a) [4 points] Evaluate

$$f(x, y) = \frac{y}{\sqrt{x^2 + y^2} + x}$$

using $b = 10$, $k = 4$ floating-point arithmetic with *chopping* where $x = -12.34$ and $y = 0.9555$.

(b) [2 points] Given that the actual value is $f(-12.34, 0.9555) = 25.868066...$, what is the relative error of your approxiamtion in (a)?

3. Consider a base-3, ternary, normalized floating-point number system. Analogous to a bit, a ternary digit is a trit. Assume that a hypothetical ternary computer uses the following floating-point representation:

s_m	s_e	t_1	t_2	t_3	t_4	e_1	e_2

where s_m is the sign of the mantissa and s_e is the sign of the exponent (0 for positive, 1 for negative), t_i are the trits of the mantissa, and e_j are the trits of the exponent.

(a) [2 points] What is the computer representation of $3_{(10)} + \left(\frac{1}{9}\right)_{(10)}$ in this system?

(b) [2 points] What is the smallest positive non-zero number that can be represented in this system in decimal?

(c) [2 points] What is the size of the gap between any two consecutive numbers in the interval $9_{(10)}$ and $27_{(10)}$ in this ternary floating-point system? Your answer should be in decimal.