ChEn 263, Practice Exam 1

Name_____

READ THE FOLLOWING BUT DON'T TURN THE PAGE UNTIL INSTRUCTED

In class exam (50 minutes)

Closed Book, Closed Notes, Closed Internet

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RULES—GUIDELINE—SUGGESTIONS

Show appropriate work, label cells, include intermediate formulas etc.

Be organized

Think before you type

More points are given if I can tell what you did

Be organized

Problem 1

We are simulating a reversible chemical reaction as follows:

A <--> 2 B

The rate of change of the concentrations A and B are given by

$dA/dt = -k_1 A + k_2 B^2$

$dB/dt = 2 k_1 A – 2 k_2 B^2$

(Here, symbols A and B denote the species concentrations in mol/L). The initial concentrations are **A_0=1 mol/L and B_0=0 mol/L**. Also, **k_1 = 0.2** 1/s and **k_2 = 0.1** L/mol-s (As initial guesses for part a).

a) **Solve** for the concentrations of A and B as functions of time. Use a timestep size of **dt=0.5 s** and solve to **t=10 s**. Hint: use Euler's equation applied to each d(Species)/dt above: dy/dt = f(y,z) --> $y_{n+1} = y_n + dt*f(y_n,z_n)$.
b) Measurement data for the concentration B is stored in column D of Worksheet “1-Reaction”. Adjust the values of **k_1** and **k_2** to best align the model predictions with the measured data by minimizing a sum of squared errors. Does the data suggest that the reaction is irreversible (is **k_2** = 0)?
c) **Plot** the predicted concentrations of A and B and the measured concentration of B as functions of time on the same plot. Label the axes as "time (s)" and “concentration (mol/L)”.

Problem 2

Your Excel workbook under worksheet "2-Population Data" has data for country populations from the year 1990 to 2010. For the 5 largest countries as of 1990, compute the growth each year as Growth = (Current Population in Year i+1 – Population in Year i) / (Population in Year i) for Years 1991-2010. Show the results in % in Worksheet “2-Population Analysis”.

a) Find the **min and max** of each country’s growth data over the 20 years (use functions for this).
b) **Create 5 bins** with evenly spaced values between 0.5% and 2.5%.
c) **Find the histogram** of the data using the FREQUENCY function to determine the number of points in each bin.
d) **Plot the data** using a column plot. The x-axis numbers should have the correct bin values.

Problem 3

Find a solution to the following set of equations and put the answer in the Worksheet named "3-Linear Solve".

$x_1 + 2x_2 = 5$

$x_3 + 5x_1 = x_2 + 10$

$x_4 - 3x_3 + 15 = 0$

$x_1 + x_2 + x_3 + x_4 = 0$

Hint: Use the MINVERSE and MMULT functions in Excel to find the solution. The solution to ***A x = b*** is ***x = A^{-1} b***. Use CTRL-SHIFT-Enter to fill in the matrix solution.