Math 486/522 - Homework 7

Fall 2024 **Len Washington III**

1. Consider the irreversible chemical reaction: $A \to^{k_1} B \to^{k_2} C$.

- **(a)** Derive the system of differential equations for the concentrations $A = A(t)$, $B = B(t)$, and $C = C(t)$ with initial conditions $A(0) = A_0$, $B(0) = 0$, and $C(0) = 0$.
- **(b)** Find a conservation law that replaces the need for the dC/dt equation.
- **(c)** Solve the equations in **(a)** for A and B then use the conservation law to find C.
- **(d)** If $k_1 = k_2 = k$, solve for A, B, and C.
- **(e)** If $k_1 = k_2 = k$, find the maximum amount of B that is produced.

2. Consider the dimerization to two monomers example from class

$$A + A \leftrightarrows_{k_1}^{k_{-1}} C$$

- **(a)** Derive the system of differential equations for the concentrations $A = A(t)$ and $C = C(t)$ with initial conditions $A(0) = A_0$ and $C(0) = 0$.
- **(b)** Find a conservation law that replaces the need for the dC/dt equation and derive the equation for $A(t)$.
- **(c)** If $k_1 = k_2 = k$ and $A_0 = 1$, find the steady-state values for $A(t)$ and $C(t)$, i.e. limits as $t \to \infty$.

3.