

Homework #1 – ECEN 667 Fall 2025

Due September 11, 2025 at 8 AM

Problem 1. Consider the following set of two differential equations

$$\begin{aligned}\dot{x}_1 &= \frac{3}{5}x_1 - \frac{8}{5}x_1x_2 \\ \dot{x}_2 &= x_1x_2 - 4x_2\end{aligned}$$

- Find all equilibrium points for the system.
- With a step size of $\Delta t = 0.1$ seconds, use Euler's method to determine the values of x_1 and x_2 at $t = 0.4$ seconds, with initial conditions $x_1(0) = x_2(0) = 1$.
- Repeat 1.b with the Second Order Runge-Kutta Method.
- Repeat 1.c with the Second Order Adams-Bashforth method. Use your solution from 1.c for the value at $t = 0.1$, then start your integration at $t = 0.2$.

Problem 2. Consider the following set of three differential equations

$$\begin{aligned}\dot{x}_1 &= 8(x_2 - x_1) \\ \dot{x}_2 &= x_1(28 - x_3) - x_2 \\ \dot{x}_3 &= x_1x_2 - \frac{4}{3}x_3\end{aligned}$$

- Find all equilibrium points for this system.
- Write a computer program using either Python or Matlab to solve the above set of three differential equations using the Second-Order Runge-Kutta method. Use $\Delta t = 0.01$ seconds. Initial conditions are $x_1 = x_2 = x_3 = 5$. Turn in your source code listing. You must code the method yourself. Do not use any packages such as built-in or third party differential equation solvers, symbolic algebra libraries, etc. You may use a package to plot the results.
- Using your program, integrate the equations long enough that you can describe the system behavior, including whether it converges to the equilibrium point.

Problem 3. Consider a two-bus, two-generator power system. Each of the two generators is modeled with a classical generator as discussed in class. For the first generator, $H = 3$ and $X'_d = 0.1$. For the second generator, $H = 5$ and $X'_d = 0.1$. There is a transmission line connecting the two lines which has $X = 0.22$, $R = 0.07$, $B = 0$. Assume that in the initial steady-state conditions the generator at bus 2 is producing 50 MW and the voltage magnitude at both buses is 1.0 per-unit. Then assume a 3 cycle solid three-phase fault at the first bus occurs at $t = 1$.

- Build this case in PowerWorld and solve the power flow to find the initial voltage magnitudes and angles at each bus.
- Write the set of differential and algebraic equations that represent this system before the fault occurs.
- Solve for the initial steady-state values of each variable in your equations.
- Add the generator stability models to PowerWorld and add the fault event in the Transient Stability dialog. Run the simulation for 30 seconds and create a plot of the two machines' speeds during the simulation. Turn in a plot of the speeds along with a brief description, including whether the response is stable or unstable.
- Why is the solution to this system different from Example 1 as given in class?