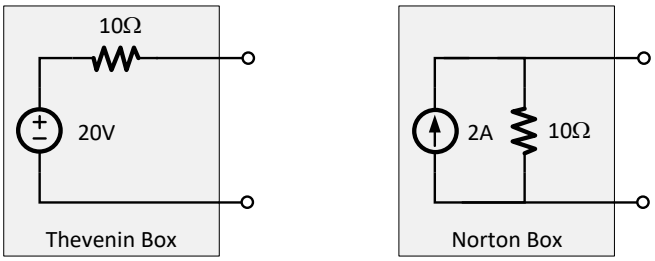
BMES CELL TEAM
SPRING 2021

Module 10 Worksheet

Problem 1. The following figure shows two circuits contained inside a black box, with an equivalent voltage output. Assume you do not know what is inside of these two boxes. Propose a way to identify which one is the Thevenin Equivalent and which one is the Norton Equivalent. *Hint*: You do not have to do any math to find the answer, and you do not have to know about the Thevenin-Norton Theorem.



Problem 2. What is the solution to the following differential equation? Let $y = 1$ at $t = 0$.

$$\frac{dy}{dt} + 2y = 0$$

Problem 3. What is the solution to the following differential equation? Let $y = 0$ and $\frac{dy}{dt} = -1$ at $t = 0$.

$$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = 0$$

Problem 4. Assume you have a series RLC circuit with a sinusoidal current source described by the following function.

$$i(t) = \alpha \cos(\gamma t + \phi)$$

Derive expressions for v_L, v_c, and v_R as a function of time. Also, please explain the behavior of the capacitor and inductor at steady state ($t \to \infty$).

Problem 5. Your team is building a small scale bioreactor to support your bacterial cell colony. An image of the bioreactor is shown below.

The bacteria you are harvesting converts glucose (G) into drug (D) through a first order reaction at a rate of k. Every few hours, a researcher adds media at a rate of Q_{in} with a glucose concentration of $C_{G,in}$. At $t = 0$, there is a volume V_0 of media in the bioreactor and the glucose concentration is C_G0.
What type of bioreactor is this? Write an expression for the rate of change of moles of glucose in your bioreactor at $t = t_1$.