Problem 1. Determine the steady-state solution for mechanical vibrations with
\[ m = 1, \ k = 2, \ \gamma = 1, \ F_0(t) = 3 \cos t. \]

Problem 2. For a mechanical system with no damping, \( k = 2, \ m = 8, \) and the external force \( F_0(t) = -2 \sin(\omega t), \) find the value of \( \omega \) which causes the resonance. Find \( u(t) \) for this \( \omega, \) if the initial position \( u(0) = 1, \) and the initial speed is zero.

Problem 3. Let \( m = 1, \ k = 4. \) For which \( \gamma \) is there an overdamping? underdamping?

Problem 4. Consider a mechanical system without external force, with parameters
\[ m = 1, \ k = 2, \ \gamma = 1, \ u(0) = 1, \ u'(0) = -1. \]
Find the amplitude (dependent on \( t \)), and initial phase.

Problem 5. A circuit has a capacitor of 1, a resistor of 3, and an inductor of 2. The initial charge of the capacitor is \( -2 \) and there is no initial current. The battery gives \( E(t) = 3 \cos(2t). \) Find the charge \( Q \) on the capacitor at any time \( t. \) What is the steady-state solution?

Problem 6. A circuit has a capacitor \( C, \) an inductor \( L, \) and no resistor. The parameters \( C \) and \( L \) are given. The battery gives you \( E(t) = E_0 \cos(\omega t). \) Find \( \omega \) such that there is a resonance.

Problem 7. A circuit has \( R = 1, \ L = 1, \) and no capacitor. The battery gives the constant voltage: \( E(t) = 2. \) Suppose initially there were no charge and no current in the system. Find the current at time \( t. \) What is the limit of the current as \( t \to \infty? \)

Problem 8. A circuit has \( C = 2, \ L = 4, \) and no resistor. There is no battery. The initial charge of the capacitor is \( -1/2, \) and the initial current is \( -1. \) Find the amplitude, the phase and the initial phase.

Problem 9. Find the general solution of the equation
\[ y' = y^{5/2} t. \]
Find the solution to the following initial value problems: \( y(0) = 0; \ y(0) = 1; \ y(1) = 1. \)

Problem 10. Find the general solution of the equation
\[ y' = -t^2 y + 2t^5. \]

Problem 11. Analyze asymptotically the equation
\[ y' = y^3(y^2 - 1). \]