1. For each of the following systems state if they are linear/nonlinear, time invariant/time varying, dynamic or instantaneous ($x$, $y$, and $z$ are functions of time).

(a) $y = 3x$
(b) $y = zx$
(c) $y' + zy = 3x$
(d) $y'' + 12y' - 4y = x' + 4x - 2$
(e) $y' = 3x'$

2. Given the following circuit,

(a) determine the differential equation describing the input-output relationship
(b) determine its impulse response in terms of $R_1$ and $L_1$.
(c) determine the zero-state response for $x(t) = u(t)$.
(d) show that the system is BIBO stable

3. Given the following circuit,

(a) determine the differential equation describing the input-output relationship
(b) determine its impulse response in terms of $R_1$ and $L_1$.
(c) determine the zero-state response for $x(t) = u(t)$.
(d) show that the system is BIBO stable
4. Suppose the circuits from problems 2 and 3 above are connected by an op-amp with gain $G = 1$ and infinite input impedance to give the circuit below where $R_1 = R_2 = R$ and $L_1 = L_2 = L$ and $x(t)$ is the input and $z(t)$ the output,

(a) determine the differential equation describing the input-output relationship
(b) determine the impulse response in terms of $R$ and $L$.
(c) show that the impulse response of the combined circuit is the convolution of their individual impulse responses from problems 2 and 3.

![Circuit Diagram](image)

5. Given the following circuit,

(a) determine the differential equation describing the input-output relationship
(b) determine its impulse response in terms of $R_1, R_2, \text{ and } L_1$
(c) determine the zero-state response for $x(t) = u(t)$, assuming $R_1 = 1, R_2 = 1, \text{ and } L_1 = \frac{1}{2}$.

![Circuit Diagram](image)

6. Given the following circuit, derive the total response assuming the input current is $x(t) = -4 + 10u(t)$. The response should be written as a zero-input plus a zero-state component.
7. Given the following mechanical system consisting of a mass $M = 5$ kg connected to one end of a spring with constant $k = 1$ immersed in water (Stokes drag = $2\dot{x}$). The other end of the spring is attached to a fixed support (shown at rest with $x = 49$). The output of interest is the position of the mass at time $t$. Convert this system to a differential equation, then derive its zero-input, zero-state, and total response assuming the initial conditions are $x(0^-) = 48$, $x'(0^-) = 0$ and the applied force is $f(t) = 5u(t)$. Be sure to clearly describe what you consider to be the input in your analysis.