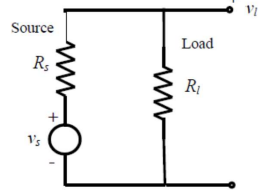
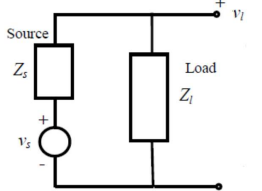
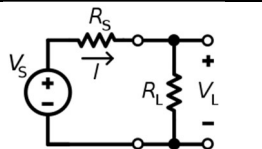


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- > What if an analytical model is not possible? A linear system is one that can be expressed by a linear analytical model; if error or non-linear phenomena cause the system to be non-linear, linearize (according to the textbook)
 - Also: analyze system, create model, simulate system, design, test
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- Sensor = measures unknown signals and parameters of a plant and its environment
- Sensor system = 1) many sensors, sensor fusion, 2) sensor + accessories (signal processing, DAQ, display,...)
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 - Electromechanical
 - Has sensors, actuators, controllers
 - Multiphysics, multidomain, and designed with all domains/components considered simultaneously
 - Optimized and designed through the mechatronics approach
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Note: at max power, efficiency=50%

<p>DC (pure resistance)</p> $i = \frac{v_s}{R_l + R_s}$ $v_l = iR_l = \frac{v_s R_l}{R_l + R_s}$ <p>Power absorbed by load:</p> $p_l = i v_l = \frac{v_s^2 R_l}{[R_l + R_s]^2}$ <p>Max power if: $\frac{dp_l}{dR_l} = 0$</p> <p>Occurs when $R_l = R_s$</p>	
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Impedance matching to prevent signal reflection

- Abrupt change in impedance reflects signals
- Reflection deteriorates signal (magnitude and phase), and dissipates power
- Match impedance on transmission lines to prevent reflection

Reflection coefficient:

$$\Gamma = \frac{v_r}{v_i} = \left| \frac{Z_L - Z_c}{Z_L + Z_c} \right|, \text{ want } = 0$$

Incident v_i , reflected v_r

Impedance Matching for Loading Reduction

- Sensor should not significantly change system behavior; loading error is one of the biggest errors

Input Impedance

$$Z_i = \frac{v_s}{i_i} = Z_s + Z_1 + Z_2$$

rated input voltage/input current (open circuit output)

Output Impedance

$$Z_o = \frac{v_o}{i_{sc}} = \frac{Z_2(Z_s + Z_1)}{Z_s + Z_1 + Z_2}$$

open circuit output voltage/s.circuit output current

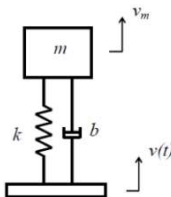
- Ex. Force or motion isolation for stuff sensitive to vibration

Element	Time Domain	Impedance	Mobility
Mass m	$m \frac{dv}{dt} = f$	$Z_m = ms$	$M_m = \frac{1}{ms}$
Spring k	$\frac{df}{dt} = kv$	$Z_k = \frac{k}{s}$	$M_k = \frac{s}{k}$
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- Force transmissibility=velocity of mass under investigation/driving velocity = force

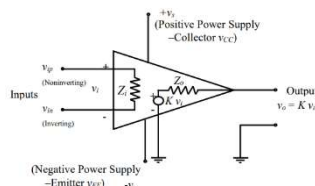
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 - Percent isolation $I = [1 - |T|] \times 100\%$



Part 4: Op-amps (s6)

- ideally, $K=\infty$, $Z_i=\infty$, low Z_o
- With negative feedback, inputs to op-amp are ~equal

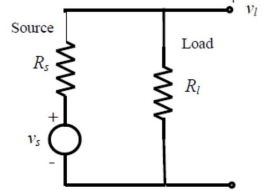
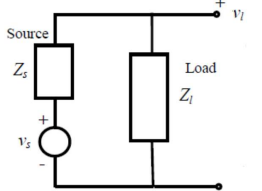
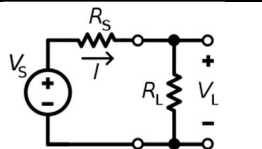


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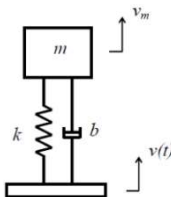
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