Due at 1700, Fri. Sept. 4 in homework box under stairs, first floor Cory .
Note: up to 2 students may turn in a single writeup.
Reading Nise 2.

1. (10 pts) Case study (Nise 1.4)
In a nuclear power plant, the rate of the fission reaction determines the amount of heat generated, and this rate is controlled by rods inserted into the radioactive core. The rods regulate the generation of neutrons. Inserting rods decreases rate of fission and removing rods increases fission rate. Draw a functional block diagram for the nuclear reactor control system shown in Fig. 1. Show all blocks and signals.

2. (10 pts) Partial fraction expansion (Nise 2.2)
Find the inverse Laplace transform of the following function using partial fraction expansion:

$$\frac{1}{(s+1)^2(s+4)^2}$$

3. (15 pts) Laplace transform review (Nise 2.2)
For each transfer function below determine $h(t)$.

i) $H_1(s) = \frac{1}{s^2+8s+16}$ ii) $H_2(s) = \frac{s}{s^2+8s+16}$ iii) $H_3(s) = \frac{s+3}{s^2+8s+16}$

iv) $H_4(s) = \frac{s^2}{s^2+8s+16}$ v) $H_5(s) = \frac{s^2+4}{s^2+8s+16}$

4. (15 pts) Initial value, final value (Nise 2.2)
For each of the following Laplace transforms $Y_i(s)$ determine $y_i(t=0^+)$ and if the limit exists, $\lim_{t\to\infty} y_i(t)$:

i) $Y_1(s) = \frac{s}{(s+4)}$ ii) $Y_2(s) = \frac{(s+1)^3}{s^3}$ iii) $Y_3(s) = \frac{(s+2)^3}{(s+1)^3}$

iv) $Y_4(s) = \frac{s+1}{(s+4)}$ v) $Y_5(s) = \frac{1}{(s+1)(s^2+7s+12)s}$

5. (15 pts) Electrical circuit example (Nise 2.4)
For the circuit in Fig. 2. below, using ideal op-amp assumptions, determine $H(s) = \frac{V_o(s)}{V_i(s)}$.

6. (15 pts) Equivalent models (Nise 2.5)
For the translational mechanical system in Fig. 3, write the transfer function relating input force $f(t)$ to output velocity $\dot{x}_2(t)$.

7. (20 pts) Equivalent electrical circuit (Nise 2.9)
Draw the equivalent electrical circuit for the system in Fig. 3, (with voltage corresponding to force, and current corresponding to velocity $\dot{x}_2(t)$, and re-derive the transfer function from voltage input to current output for the circuit to verify that it is equivalent to the transfer function found in problem 6 above.

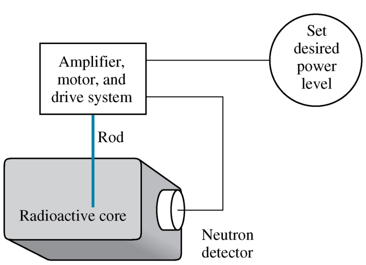

Fig. 1

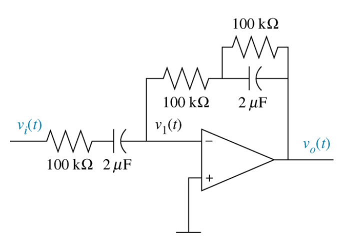

Fig. 2

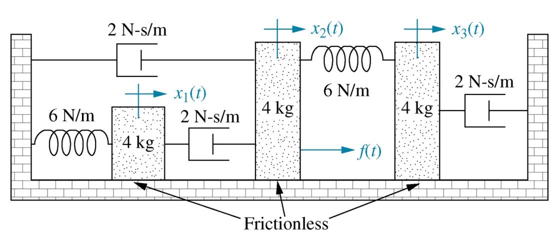

Fig. 3