EECE 360 Homework - Natural Response (2^{nd} Order Systems)

1) For the transfer functions in the following questions:
   - Determine ζ and ω_n (if it exists).
   - Is the system underdamped, overdamped, critically damped, undamped or unstable.
   - Determine the DC gain.
   - Determine the final value of the natural response.
   - Determine the final value of the step response.
   - Sketch the pole/zero plot of the system.
   - Sketch the natural response of the system.

   a) E2.4
   b) E2.18
   c) E2.29
   d) E2.30
   e) P2.50 (open loop TF)
   f) $$G(s) = \frac{s+2}{s^2 + 14s + 49}$$
   g) $$G(s) = \frac{s+2}{2s^2 + 12s + 36}$$
   h) $$G(s) = \frac{s-3}{s^2(s+4)^2}$$
   i) $$G(s) = \frac{s+1}{s^3 + 7s^2 + 10s}$$
   j) $$G(s) = \frac{4s-20}{s^2 + s - 30}$$
   k) $$G(s) = \frac{s+2}{s^3 + 64s}$$

2) Use Simulink to implement the Steel Mill example presented in class.
   - Verify that you get the same step response as shown on the handouts
   - Draw the pole/zero plot of the system

   a) Predict how the step response will change if the rotor inertia (J) is increased.
      - step response
      - pole/zero plot
      - DC gain
      - Final value
      - Natural frequency
      - Damping coefficient
   b) Use your Simulink model to check your prediction.
   c) Repeat part a) and b) for J=0.
   d) Repeat parts a) through c) for all other parameters:
      - Armature resistance (R)

- Motor constant (K_m)
- Motor friction (B)
- Back-EMF constant (K_b)