1. The following are transfer function models for various chemical processes. Find the ultimate gain and period for Z-N tuning (also obtain the PID settings):

   i. \[ \frac{-3s + 1}{(s + 1)(5s + 1)} \]
   
   ii. \[ \frac{e^{-s}}{s + 1} \] (Use Pade approximation for the dead time)

   iii. \[ \frac{2}{(s + 1)(2s + 1)(3s + 1)} \]

2. Can you obtain Z-N controller settings using the following transfer function models? If not why not? Explain qualitatively and quantitatively.

   i. \[ \frac{1}{s + 1} \]
   
   ii. \[ \frac{1}{(s + 1)(2s + 1)} \]

   iii. \[ \frac{1}{(-s + 1)(s + 3)} \]

3. Reconsider the process model \[ \frac{e^{-s}}{s + 1} \] and obtain the IMC approach to find the controller settings for a PID controller (take the filter constant to be equal to the process time constant and Pade approximation for the time delay). Now use P-only controller and find the closed loop damping coefficient under this \( K_c \) value. What is the Z-N method \( K_c \) value (use again Pade approximation)

4. For the following process model find the IMC controller (Use both IAE and ISE criterion)

   \[ G(s) = \frac{-s + 1}{(s + 1)(2s + 1)} \]

   What is the equivalent conventional F.B. controller?

5. A process with a true transfer function \[ G(s) = \frac{1}{(s + 1)^2} \] is inadvertently modeled as \( G(s) = \frac{1}{(s + 1)} \). Firstly, find the IMC controller based on this model then check whether the closed loop system will be stable.