Q1. The transfer function model of a process is

$$y(s) = g_p(s)m(s) + g_{d1}(s)d_1(s)$$

$$m(s) = g_v(s)u(s) + g_{d2}(s)d_2(s)$$

A cascade control strategy will be employed to control the process to take care of the disturbances in the manipulated variable.

a) Draw block diagram for the cascade control strategy
b) Derive the closed loop equation relating $y(s), y_{sp}(s), d_2(s), d_1(s)$.
c) Draw block diagram for cascade-feedforward control strategy
d) Derive the closed loop equation relating $y(s), y_{sp}(s), d_2(s), d_1(s)$.
e) Derive the equation for Feedforward controller.

Q2. The transfer function model of the process is given below:

$y(s) = \frac{0.2}{(2s+1)(4s+1)}m(s) + \frac{0.05}{3s+1}d_1(s)$ and $m(s) = \frac{1}{s+1}u(s) + d_2(s)$

1. Draw a cascade control block diagram
2. Find the relationship of ultimate controller gain of master controller (K_{C1u}) $with$ the slave proportional controller (K_{c2}) [Hint: use method of direct substitution]

Q3. Consider a process transfer function as given below:

$$y(s) = \frac{-2(-6s+1)}{(10s+1)(3s+1)}u(s) + \frac{3}{5s+1}d(s)$$

Where y is output, u is manipulated input and d disturbance. The objective is to control the process using Feedback-Feedforward scheme.

a) Design the feedback controller using IMC-PID approach with filter time constant is 40% of dominant time constant.
b) Design a feedforward controller and make it feasible with proper explanations.

Q4. Consider the cascade control system below where $G_p(s) = \frac{s+1}{s-3}$.

a) Determine the maximum range of K_{c2} values for which the inner loop will be stable.
b) Assume $K_{c2} = 6$ and G_{c1} is PI controller, find the values of controller parameters such that the closed loop poles are at $-0.5 \pm 0.2j$.