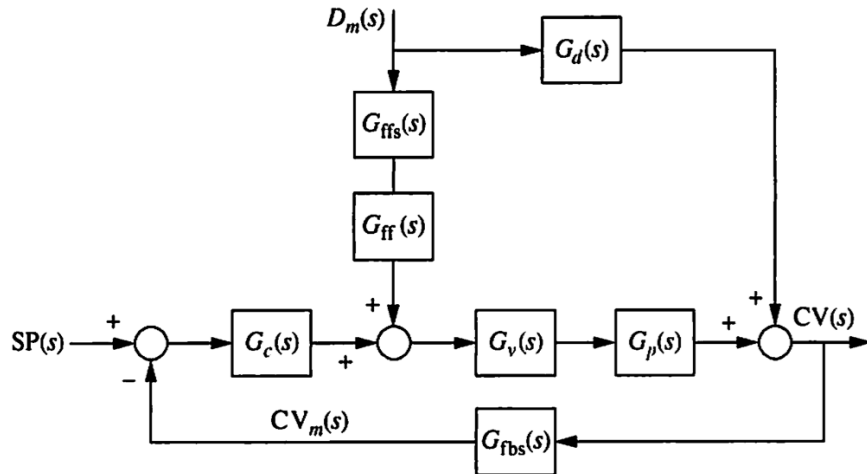


This tutorial provides some practice for feedforward control systems.

**Question 1**

The general feedforward and feedback block diagram is shown here. Let the two transfer functions:  $G_{ffs}(s)$ ,  $G_{fbs}(s)$  be unity (i.e. no dynamics or change to the signal).



1. Derive the single transfer function from input  $SP(s)$  to output  $CV(s)$ .  
Which systems in the transfer function affect the stability of the closed loop system.
2. Derive the single transfer function from input  $D_m(s)$  to output  $CV(s)$ .  
Which systems in the transfer function affect the stability of the closed loop system.
3. Compare your two answers above.  
Discuss the interesting and important features you notice in your results.  
What does this result mean from a practical point of view?

## Question 2

Refer back to the diagram in the previous question. Design a feedforward controller using the notation on the diagram, assuming there are transfer functions in each block (i.e. none of the blocks are unity).

## Question 3

A primary controlled variable, temperature in the bottom tray of a distillation column, has a transfer function of  $\frac{T(s)}{P(s)} = \frac{2e^{-s}}{5s + 1}$ , when adjusting the steam flow to the reboiler (*does this transfer function make sense?*).

This temperature is also affected by the bottom's stream outlet valve position (we don't control that, the next unit operation after the distillation column will periodically adjust this up or down, depending on their demand). This transfer function is  $\frac{T(s)}{v(s)} = \frac{-0.10e^{-3s}}{5s + 1}$

1. Draw a block flow diagram of these systems (I strongly recommend you also draw a Piping and Instrumentation Diagram).
2. Design the feedforward controller for the system in transfer function form.
3. Write out the piece of computer code (pseudo-code) in the *time-domain* to implement the feedforward controller. Your computer code should have one input (what is that?) and one output (what is that?).

Draw on your P&ID diagram where the computer code should be.