Assignment-3

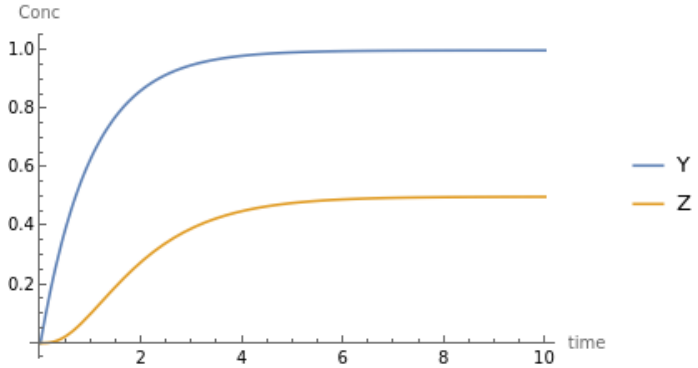
1)

X	Y	Z	W	OUTPUT
ON	ON	ON	ON	ON
ON	ON	OFF	OFF	OFF
OFF	ON	OFF	ON	OFF
ON	ON	OFF	ON	ON

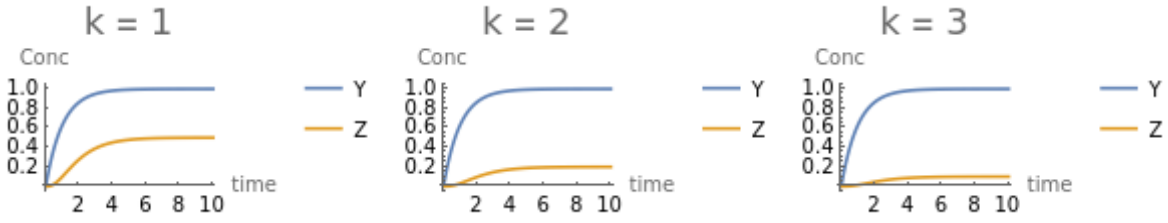
2)

a) To simulate the dynamics of C1-FFL we can use following lines of code:

- param = {β -> 1, Sx -> 1, α -> 1, n -> 2 , k -> 1}
  soly = DSolve[{y'[t] == Sx * β - α * y[t] , y[0] == 0}/.param ,y , {t , 0 , 10}]
  solz = NDSolve [{z '[t] == β * Sx * ((y[t] / k)^ n / (1 + (y[t] / k)^ n)) - α * z[t] , z[0] == 0} /. param /. soly , z , {t , 0 , 10}]
  Plot[{(y[t] /. soly), (z[t] /. solz)}, {t, 0, 10}, PlotRange → All, PlotLegends → {"Y", "Z"}, AxesLabel → {"time", "Conc"}]



b) The delay in response time of gene z increases with the increase in k.



c) With positive regulation on Y, the model equations will be:

$$y'[t] = S_x * \beta * \frac{(y[t]/k_y)^{n1}}{1 + (y[t]/k_y)^{n1}} - \alpha * y[t]$$

$$z'[t] = S_x * \beta * \frac{(y[t]/k_{yz})^{n2}}{1 + (y[t]/k_{yz})^{n2}} - \alpha * z[t]$$

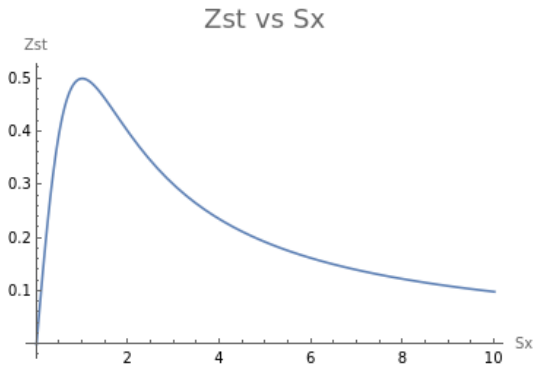
3)

a) At steady-state, $\frac{dy}{dt} = \frac{dz}{dt} = 0$.

$$\Longrightarrow y'[t] = S_x * \beta - \alpha * y_{st} = 0$$
$$\Longrightarrow y_{st} = \frac{S_x * \beta}{\alpha} = S_x \ (Note: \alpha = \beta = 1)$$

$$z'[t] = \frac{S_x * \beta}{1 + (y_{st}/k)^2} - \alpha * z_{st} = 0$$

$$z_{st} = \frac{S_x}{1 + {S_x}^2}$$



b) To calculate activation signal S_x at which z_{st} is maximum we need to find S_x at which $\frac{dz}{dS_x} = 0$.

$$\Rightarrow \frac{dz}{dS_x} = \frac{(1 + {S_x}^2 - 2 * {S_x}^2)}{(1 + {S_x}^2)^2} = 0$$
$$\Rightarrow \frac{dz}{dS_x} = \frac{(1 - {S_x}^2)}{(1 + {S_x}^2)^2} = 0$$
$$\Rightarrow S_x = 1$$