Q1

Warrick Ma

$\gamma_i = k_{ei}[G_j:R_x]_0$

Assume $[G_j:R_x]_0$ steady state

$$[G_j:R_x]_0 = \frac{k_{I,j}[G_j:R_x]_c}{k_{A,j}+k_{E,j}} \rightarrow [G_j:R_x]_c = \gamma_{x,j}[G_j:R_x]_0$$

Assume $[G_j:R_x]_c$ steady state

$$k_{I,j}\cdot[G_j:R_x]_c + k_{-j}\cdot[G_j:R_x]_c = k_{+j}[G_j][R_x]^0$$

$$[G_j:R_x]_c = K_{x,j}^{-1}\cdot[G_j][R_x]^0 \Rightarrow (\gamma_{x,j}[G_j:R_x]_0 = K_{x,j}^{-1}[G_j][R_x]^0)$$

$$R_{x,T} = R_x^0 + [G_j:R_x]_c + [G_j:R_x]_0 + \sum_{i=1,i\neq j}^{N}[[G_i:R_x]_c + [G_i:R_x]_0]$$

$$= R_x^0 + (1+\gamma_{x,j})[G_j:R_x]_0 + \sum_{i=1,i\neq j}^{N}[(1+\gamma_{x,i})[G_i:R_x]_0]$$

$$[G_j:R_x]_0 = \frac{G_j(R_{xT} - \sum[(1+\gamma_{x,i})[G_i:R_x]_0])}{(1+\gamma_{x,j})G_j + \gamma_{x,j}K_{x,j}}$$

$$[R_x]^0 = \frac{\gamma_{x,j}[G_j:R_x]_0}{K_{x,j}^{-1}[G_j]}$$

~~$G_j\cdot\sum([G_i:R_x]_c + [G_i:R_x]_0)$~~ $G_j\sum[(1+\gamma_{x,i})[G_i:R_x]_0]$

$$[G_i:R_x]_0 = \frac{[R_x]^0[G_i]}{\gamma_{x,i}K_{x,i}} = \frac{\gamma_{x,j}k_{x,j}[G_j:R_x]_0[G_i]}{[G_j]\gamma_{x,i}\cdot K_{x,i}}$$

$$\sum(1+\gamma_{x,i})\frac{\gamma_{x,j}K_{x,j}[G_j:R_x]_0[G_i]}{\gamma_{x,i}K_{x,i}}$$

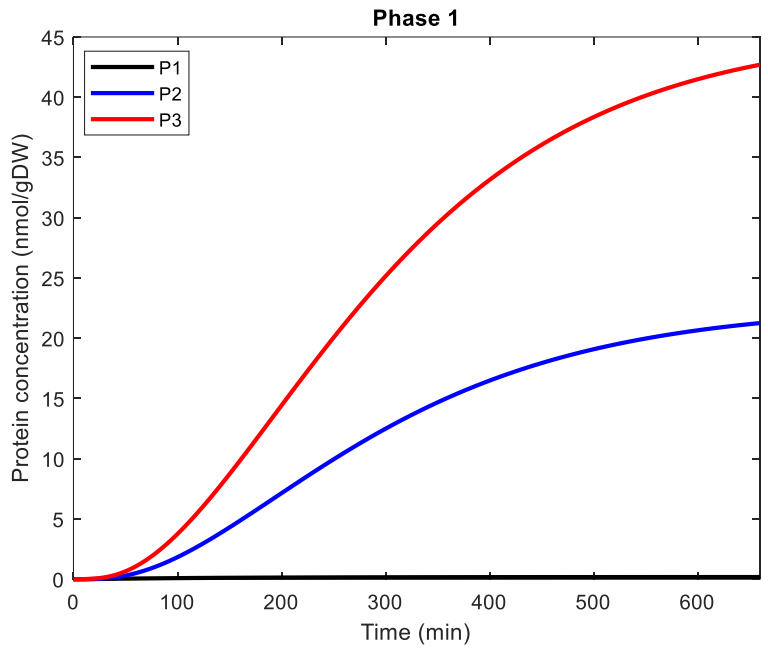
$$\therefore [G_j:R_x]_0 = \frac{G_j\cdot R_{xT} - [G_j:R_x]_0 \sum(1+\gamma_{x,i})\cdot}{(1+\gamma_{x,j})G_j + \gamma_{x,j}K_{x,j}}$$ ϵ_j

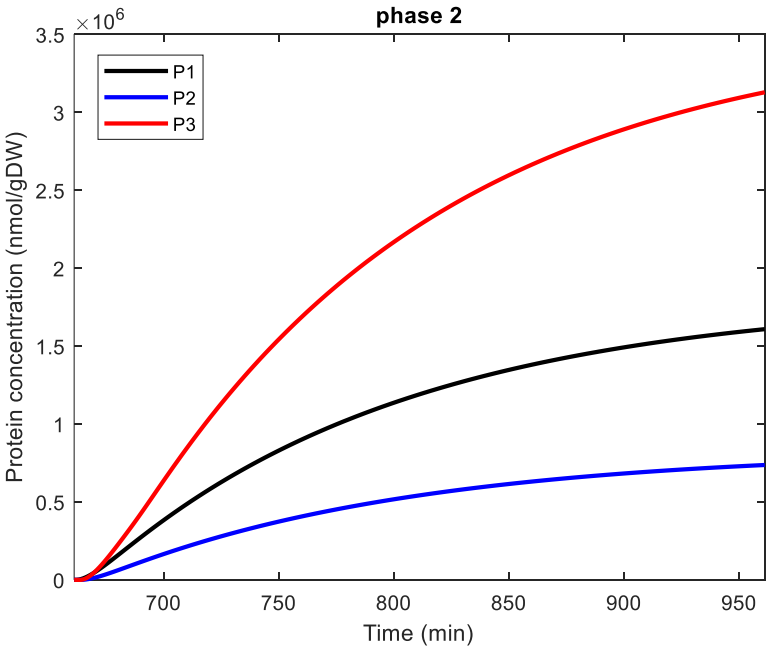
$$[G_j:R_x]_0 = \frac{G_j\cdot R_{xT}}{(1+\gamma_{x,j})G_j + \gamma_{x,j}\cdot K_{x,j} + \epsilon_j}$$

$$\therefore \gamma = \frac{k_{ej}\cdot G_j\cdot R_{xT}}{(1+\gamma_{x,j})G_j + \gamma_{x,j}\cdot K_{x,j} + \epsilon_j}$$

When $K_{x,i}\cdot\gamma_{x,i} \gg K_{x,j}\cdot\gamma_{x,j}$

Q2





Part b:

See Matlab output. S1 matrix for sensitivity array time function of phase 1

S2 matrix for sensitivity array time function of phase 2

Part c:

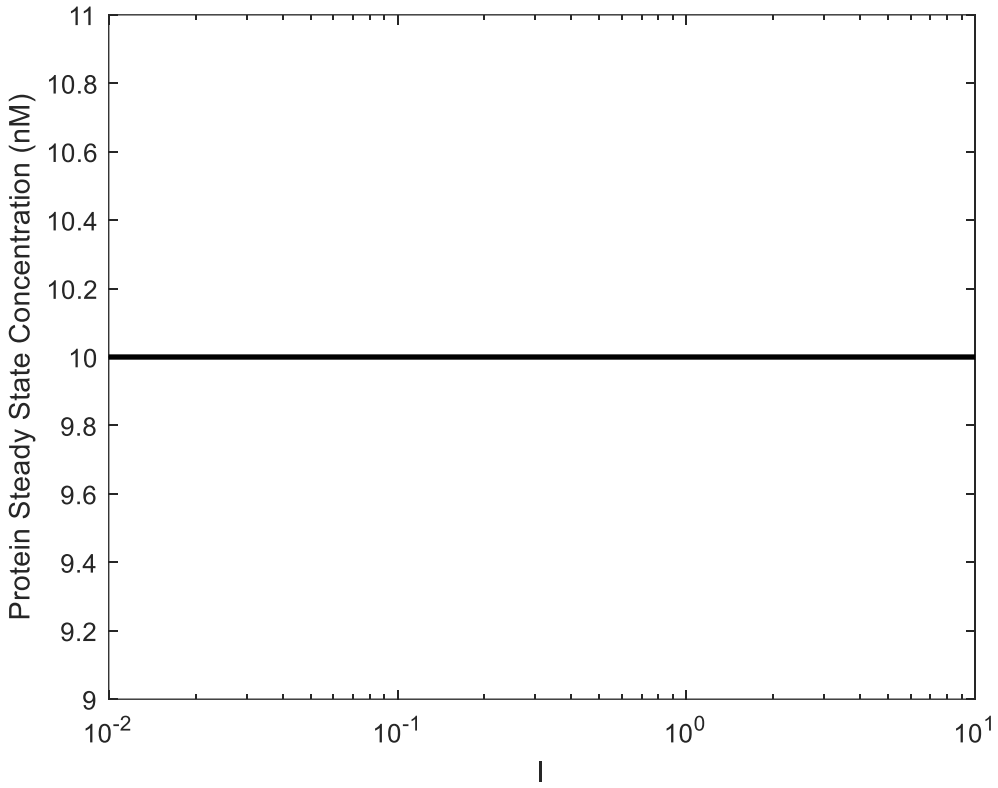
Importance of species in phase 1: P1>P3>P2

Importance of species in phase 2: P3>P2>P1

Q3

	v1	*v2*	*v3*	*v4*	*v5*	*v6*	*b1*	*b2*	*b3*	*b4*	*b5*	*b6*	*b7*	*b8*	*b9*
G	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
RNAP	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
*G**	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
NTP	0	-924	0	0	0	0	0	-1	0	0	0	0	0	0	0
Pi	0	1848	0	0	616	2	0	0	0	0	0	0	0	0	1
NMP	0	0	924	0	0	0	0	0	0	1	0	0	0	0	0
mRNA	0	1	-1	-1	1	0	0	0	0	0	0	0	0	0	0
rib	0	1	-1	-1	1	0	0	0	0	0	0	0	0	0	0
tRNA	0	0	0	0	308	-1	0	0	0	0	0	0	0	0	0
*rib**	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0
GTP	0	0	0	0	-616	0	0	0	0	0	0	0	-1	0	0
AAtRNA	0	0	0	0	-308	1	0	0	0	0	0	0	0	0	0
protein	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
GDP	0	0	0	0	616	0	0	0	0	0	0	0	0	1	0
ATP	0	0	0	0	0	-1	0	0	0	0	-1	0	0	0	0
AA	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0
AMP	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0

```
xd=8.35;% mRNA degradation rate constant based on 2.1 min half life unit h ^(-1)
pd=9.9*10^(-3); %h^(-1)
p_conc=5*10^(-3); % gene p concentration in microM
rnap_conc=0.15; % rnap concentration in microM
ribo_conc=1.6; % ribosome concentration in microM
e_x=60*3600;kel=e_x/924; % 60 nt/sec; compute for enlongation rate constant ke
taul=2.7;% time constant for transcription
tau2=0.8;%time constant for translation
K_x=0.3;%dissociation constant of RNAP in microM
K_L=57;%dissociation constant of ribosome in microM
n=1.5;Kd=0.3; % Kd (disocciation constant of inducer) is in mM
fl=I^n/(Kd^n+I^n);
ul=(0.26+300*fl)/(1+0.26+300*fl);
r_x=(rnap_conc*kel/taul*(p_conc/(p_conc+K_x)))*u;
r_L=mRNA*ribo_conc/K_L*(16.5*3600/308);
```



Don’t know how to answer part c