Home Work #4

Ali BaniAsad 96108378

November 12, 2021

1 Question 1

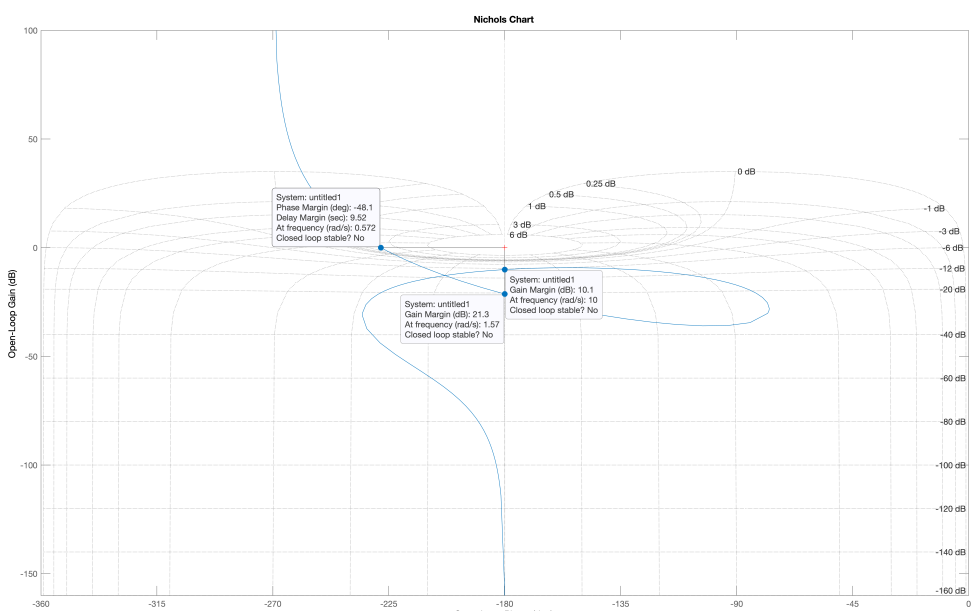
System:

$$G(s) = \frac{(s+1)(s+4)(s+8)}{s^3(s^2+0.2s+100)}$$

1.1 part a

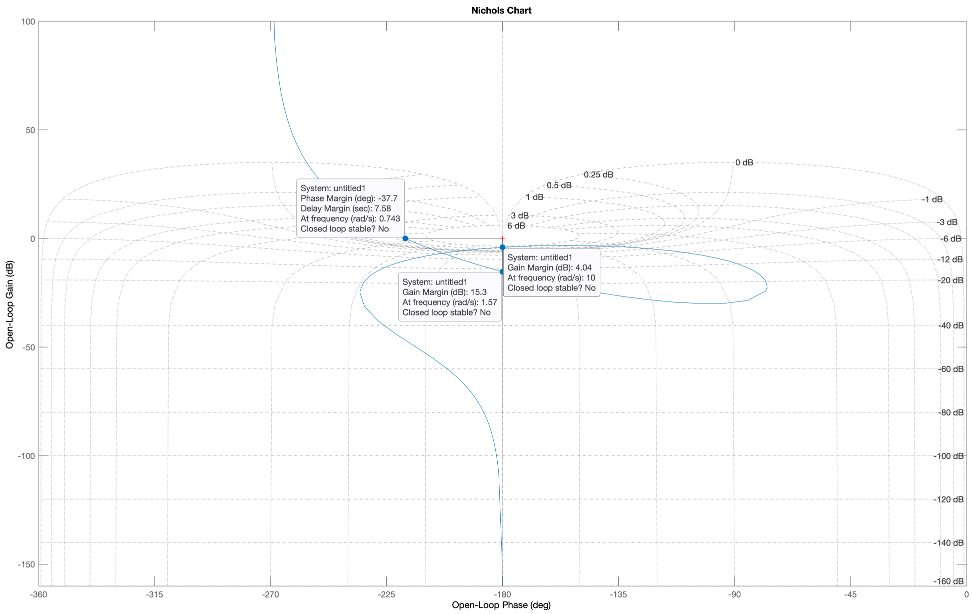
- $K = 0.5$

Figure 1: Nichols chart for $KG, (K = 0.5)$



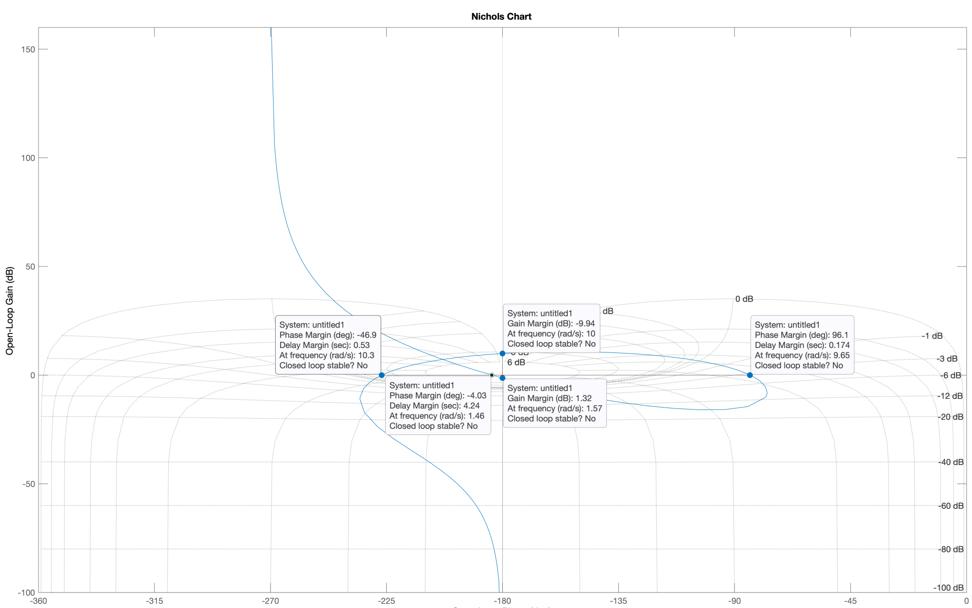
- $K = 1$

Figure 2: Nichols chart for $KG, (K = 1)$



- $K = 5$

Figure 3: Nichols chart for $KG, (K = 5)$



Phase margin and gain margin are shown in above figures and all closed loop systems are unstable with K form 1 to 5. In all of them phase margin is negetive.

1.2 part b

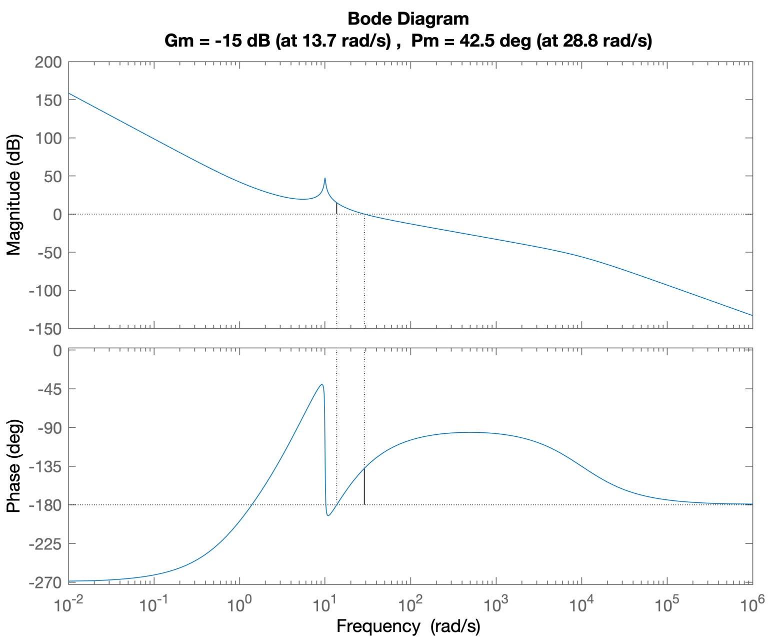
I use a zero and a far pole to make controller feasible.

Controller:

$$C(s) = \frac{2.2368 \times 10^5 (s + 11.91)}{s + 10^4}$$

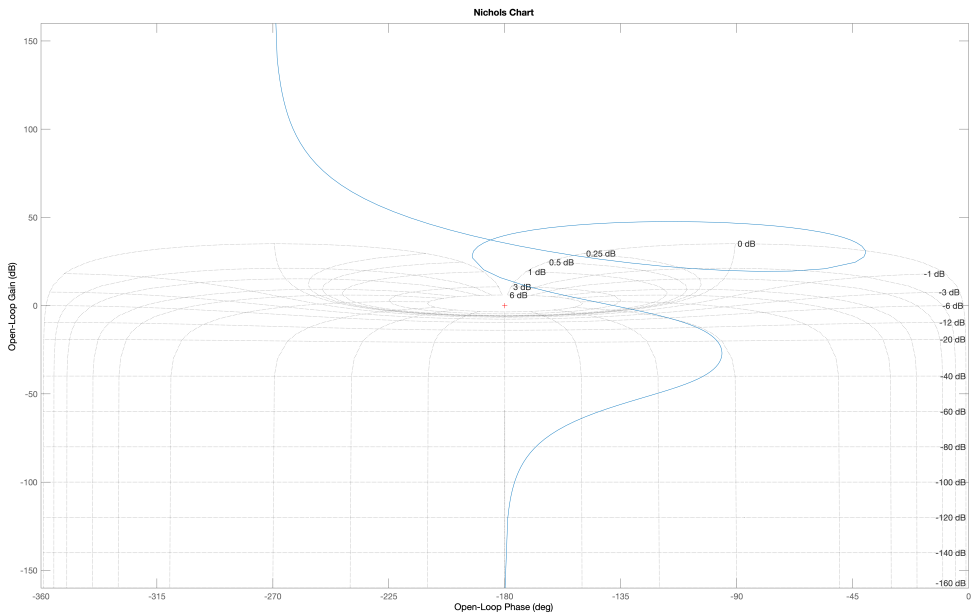
Phase margin is above 40 degree.

Figure 4: Phase margin with controller



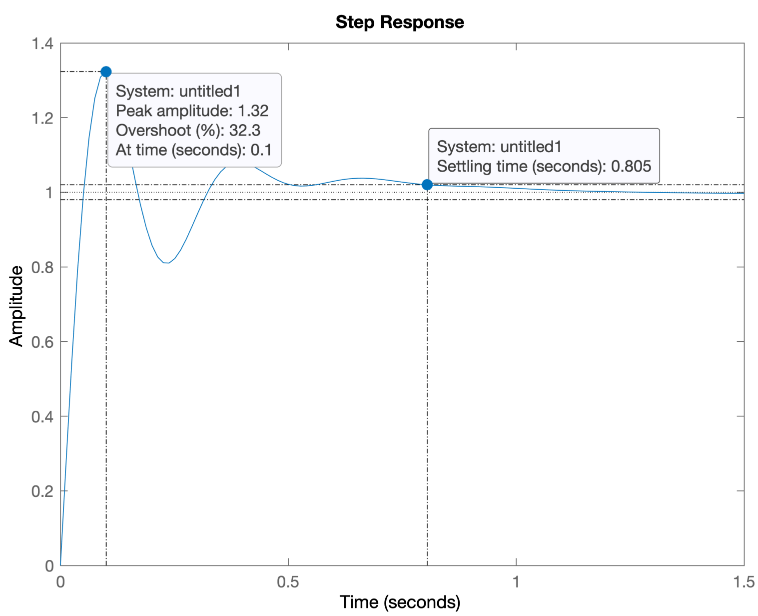
Maximum closed loop is below than 3 decibels.

Figure 5: Nichols chart with controller



Setteing time and overshoot for step responde in closed loop system are shown in figure.

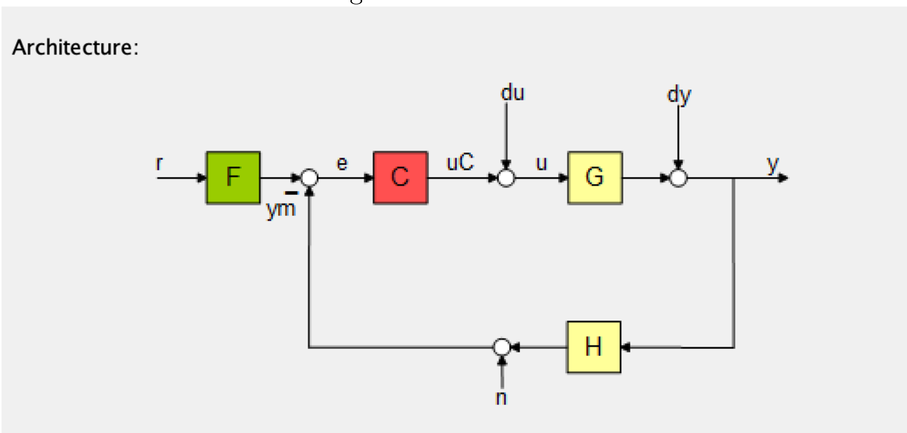
Figure 6: Step responde



1.3 part c

For transfer function we use common architecture.

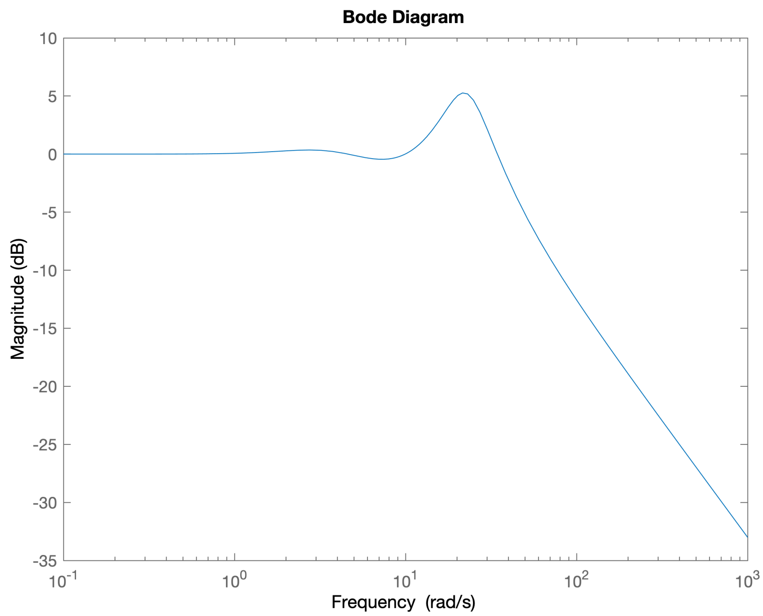
Figure 7: Architecture



- r to y refrence

$$\frac{y}{r} = \frac{C(s)G(s)}{1 + C(s)G(s)}$$

Figure 8: r to y bode magnitude

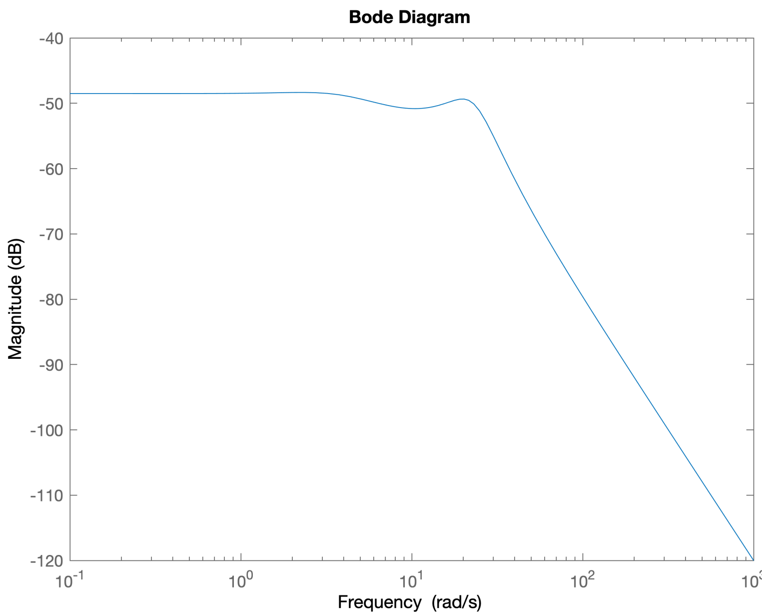


System has a good performance at high frequency but not good performance at low frequency.

- du to y distubance

$$\frac{y}{du} = \frac{G(s)}{1 + C(s)G(s)}$$

Figure 9: du to y bode magnitude

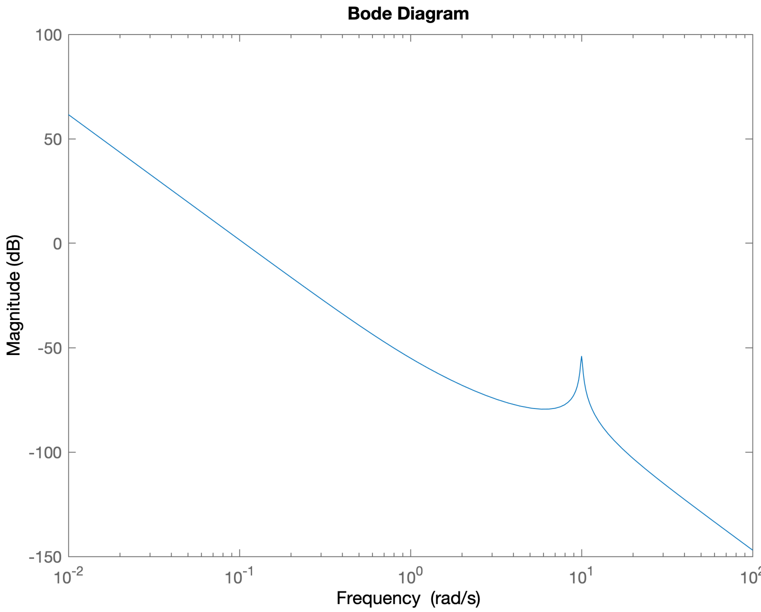


System has a better performance at high frequency but pretty good performance at low frequency.

- dy to y distubance

$$\frac{y}{dy} = \frac{1)}{C(s)G(s)}$$

Figure 10: dy to y bode magnitude

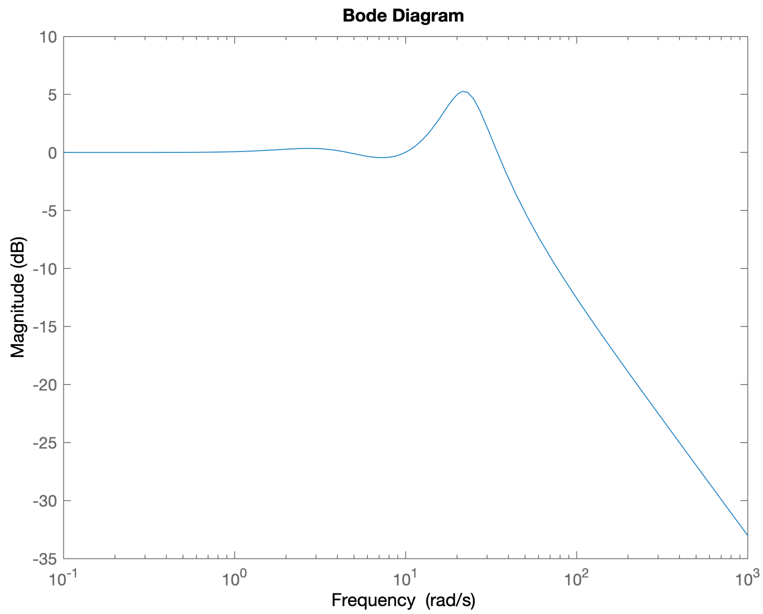


System has a good performance at high frequency but very bad performance at low frequency.

- n to y noise

$$\frac{y}{du} = \frac{-C(s)G(s)}{1 + C(s)G(s)}$$

Figure 11: n to y bode magnitude



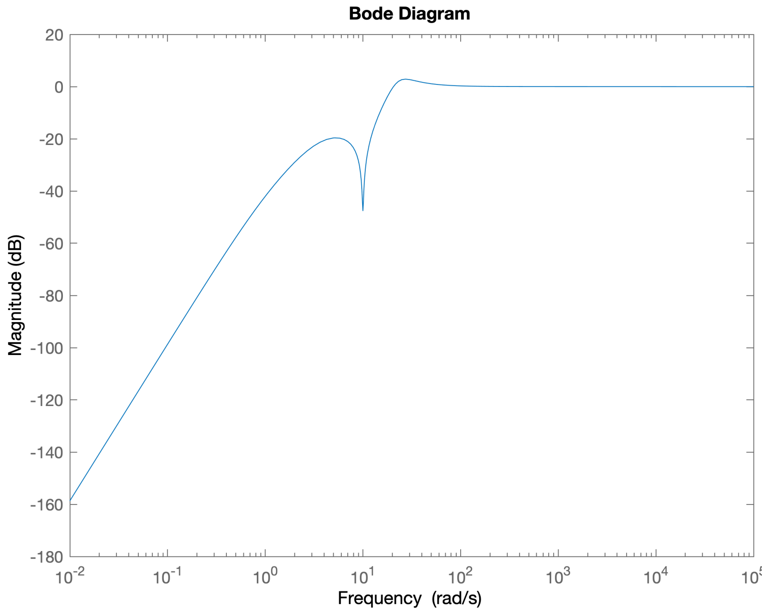
System has a good performance at high frequency but not good performance at low frequency.

1.4 part d

- sensitivity function

$$S_G^{G_{cl}} = \frac{1}{1 + C(s)G(s)}$$

Figure 12: sensitivity function bode magnitude

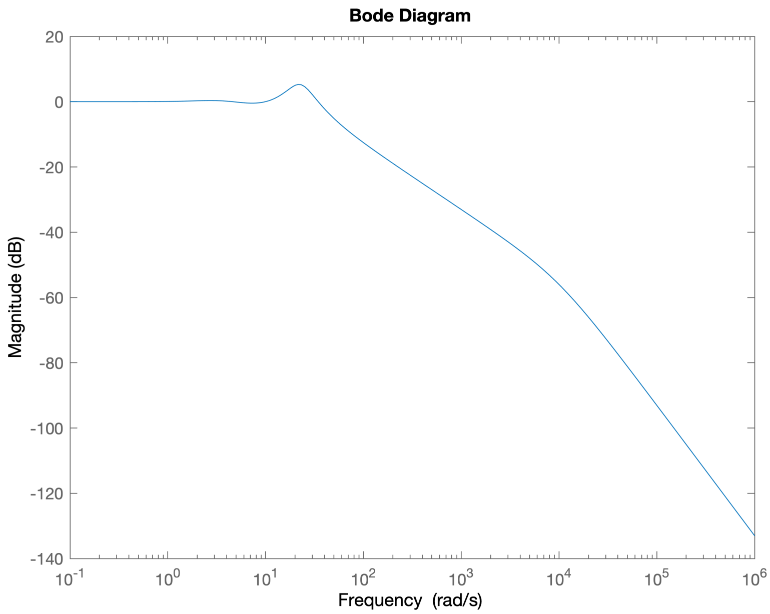


System sensitivity is very hight at high frequency but low at low frequency.

- complementary sensitivity function

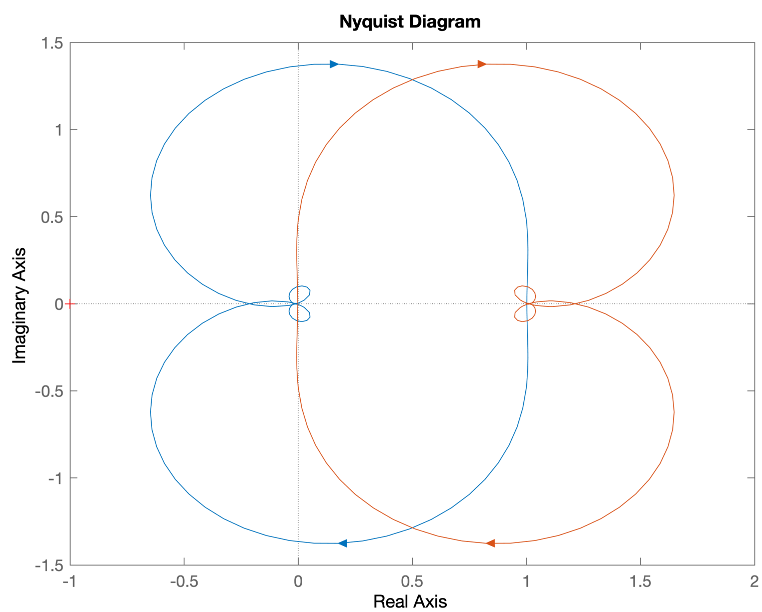
$$S_G^{G_{cl}} = \frac{C(s)G(s)}{1 + C(s)G(s)}$$

Figure 13: complementary sensitivity function bode magnitude



- Nichols chart for sensitivity function and complementary sensitivity function

Figure 14: nyquist chart



Contents

List of Figures

List of Tables