CONTENTS

Abstract—This manual is an introduction to control systems based on GATE problems.Links to sample Python codes are available in the text.

Download python codes using

svn co https://github.com/gadepall/school/trunk/
    control/codes

1 ROUTH HURWITZ CRITERION

1.1. Consider the following second order system with the transfer function:

$$G(s) \quad = \quad \frac{1}{1 + 2s + s^2} \quad (1.1.1)$$

with input unit step

$$R(s) \quad = \quad \frac{1}{s} \quad (1.1.2)$$

Let C(s) be the corresponding output. The time taken by the system output c(t) to reach 94% of its steady state value, rounded off to two decimal places is
Solution:

$$C(s) = R(s).G(s) = (\frac{1}{s})(\frac{1}{1 + 2s + s^2}) \quad (1.1.3)$$

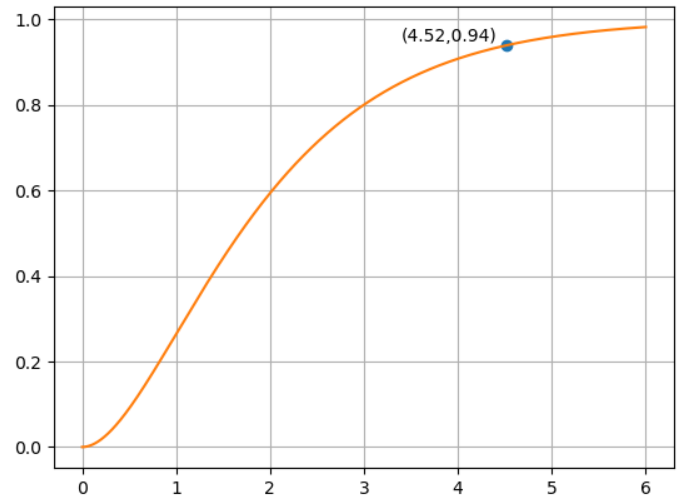$$C(s) \quad = \quad \frac{1}{s(1 + s)^2} \quad (1.1.4)$$

We found C(s) as:

$$C(s) \quad = \quad \frac{1}{s(1 + s)^2} \quad (1.1.5)$$

Therefore,

$$C(s) \quad = \quad \frac{1}{s} - \frac{1}{(1 + s)} - \frac{1}{(1 + s)^2} \quad (1.1.6)$$

Therefore;

$$c(t) = L^{-1}(\frac{1}{s}) - L^{-1}(\frac{1}{(1 + s)}) - L^{-1}(\frac{1}{(1 + s)^2}) \quad (1.1.7)$$

Using the Known inverse transforms:

$$c(t) \quad = \quad (1 - e^{-t} - te^{-t}).u(t) \quad (1.1.8)$$

To know the steady state value of c(t), we calculate

$$\lim_{t \to \infty} c(t) \quad = \quad (1 + 0 + 0).(1) \quad = \quad 1 \quad (1.1.9)$$

Now, 94% of 1 is 0.94, so we should now solve for a positive t such that

$$(1 - e^{-t} - te^{-t}) \quad = \quad 0.94 \quad (1.1.10)$$

$$t \quad = \quad 4.5228 \quad (1.1.11)$$

2 BODE PLOT

3 COMPENSATORS

4 NYQUIST PLOT