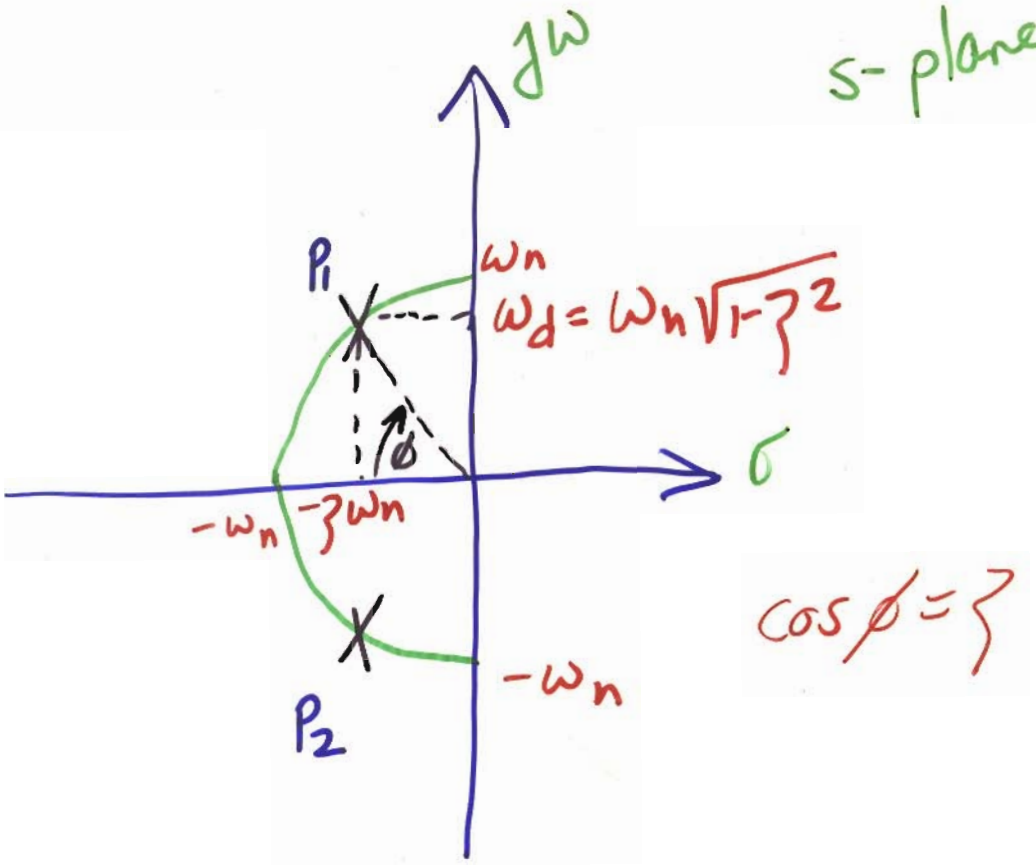
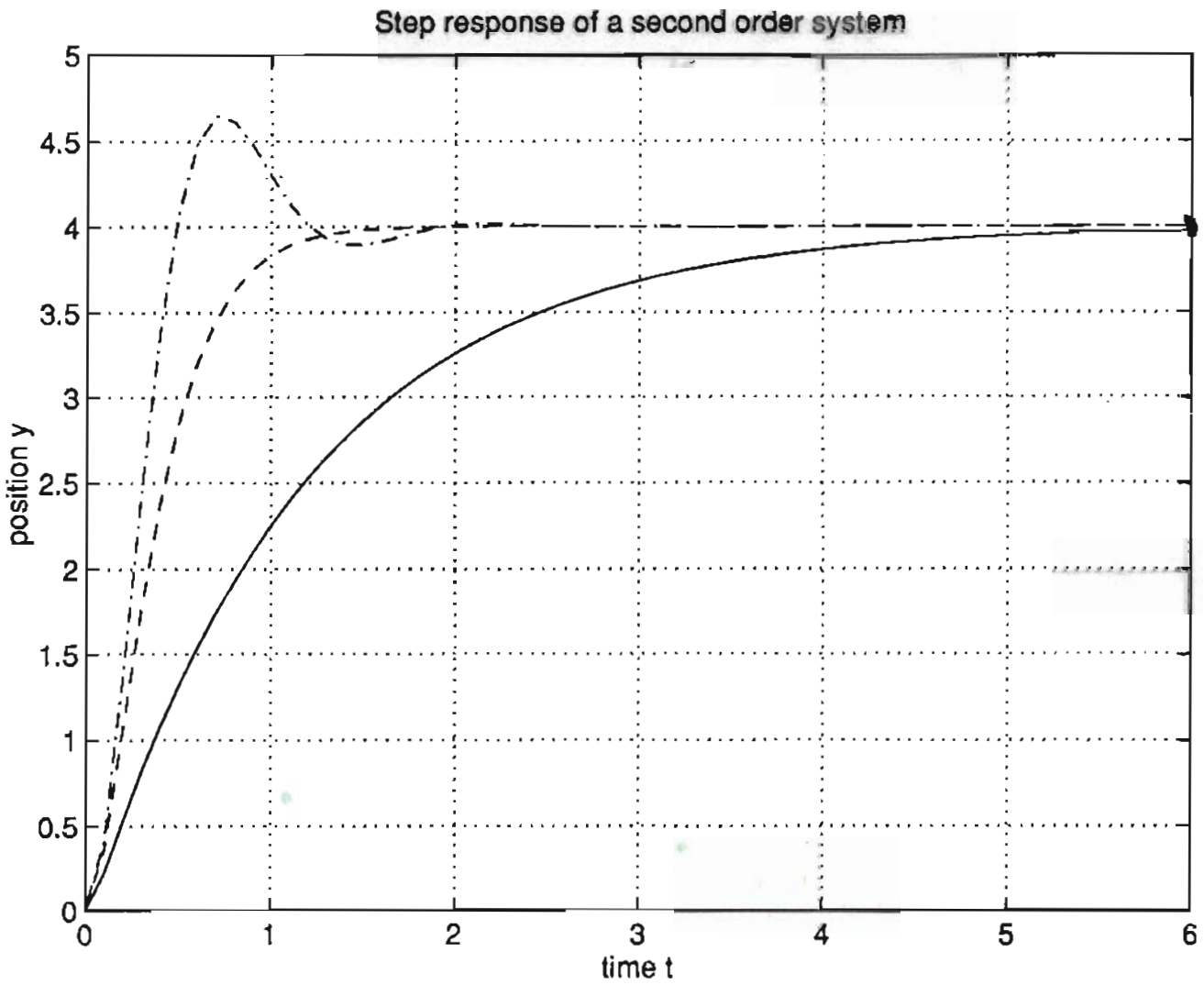
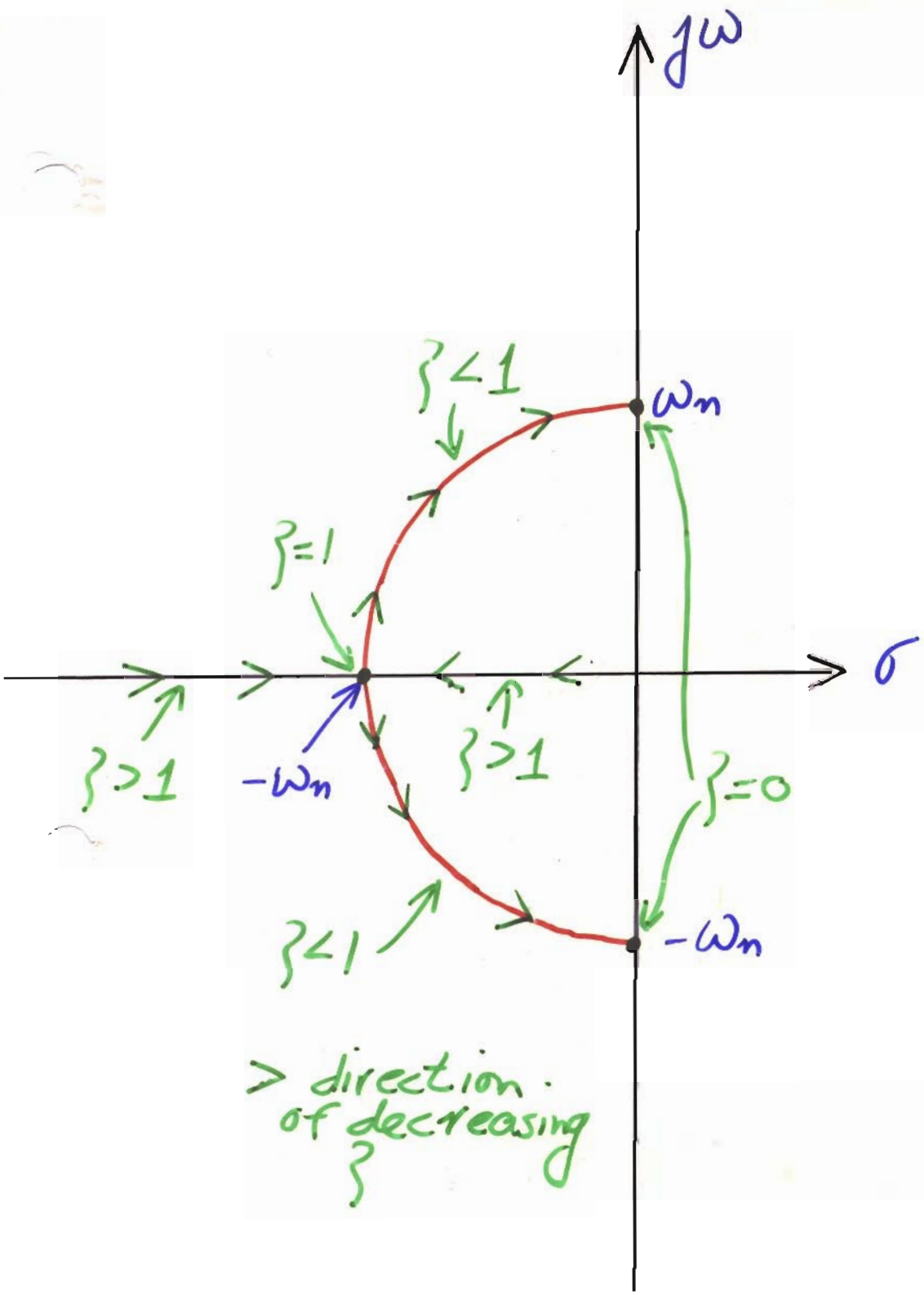
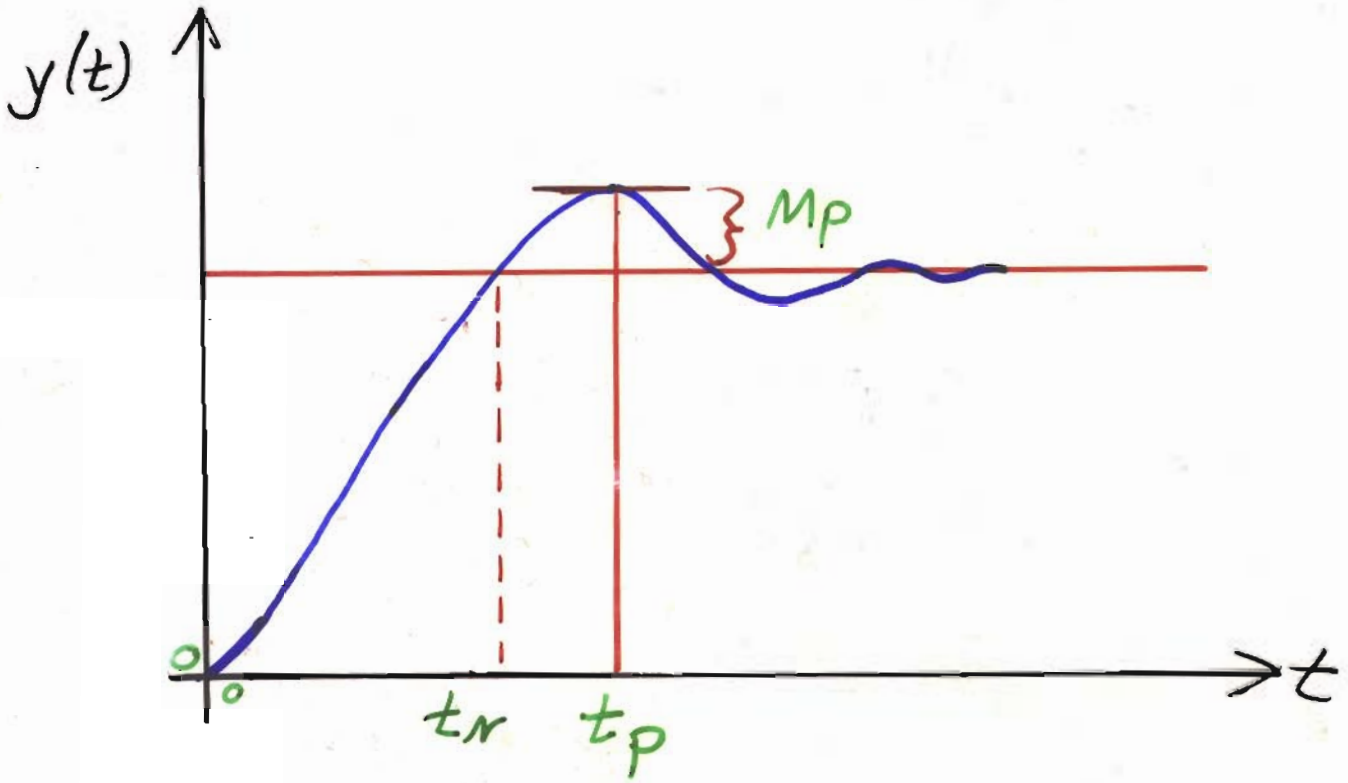

jω
s- plane
P1
ωn
ωd = ωn√(1-ζ²)
θ
σ
-ωn
-ζωn
-ωn
P2
cos θ = ζ


Step response of a second order system
position y
time t
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
1
2
3
4
5
6


jω
σ
s-plane
ζ<1
ωn
ζ=1
ζ>1
-ωn
ζ>1
ζ=0
ζ<1
-ωn
> direction of decreasing ζ

Dynamics of 2nd order Systems



$t_p = \frac{\pi}{\omega_d}$ = time to peak

t_s = settling time

$= \frac{3}{\zeta\omega_n}$ 5%

$\frac{4}{\zeta\omega_n}$ 2%

time constant $= \frac{1}{\zeta\omega_n}$

M_p = overshoot $= e^{-\frac{\zeta}{\sqrt{1-\zeta^2}}\pi} \times 100\%$

t_r = rise time $= \frac{\pi - \phi}{\omega_d} = \frac{\pi - \cos^{-1}\zeta}{\omega_d}$