Dept. of Mechanical and Aeronautical Engineering

MAE - 275

Modeling Flight Control Actuators

Stick Grip

Forward Bobweight

Damper (C_s)

Damper Spring (K_s)

acts as an extensible link

Series Servo Actuator

δ_c

$$\frac{\delta_e(s)}{\delta_c} \approx \frac{K\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

drain

fluid under pressure

pilot valve

power cylinder

δ_e

HYDRAULIC SERVO-ACTUATOR

MATHEMATICAL MODELS OF PHYSICAL SYSTEMS

An hydraulic actuator is essentially a rate-command device
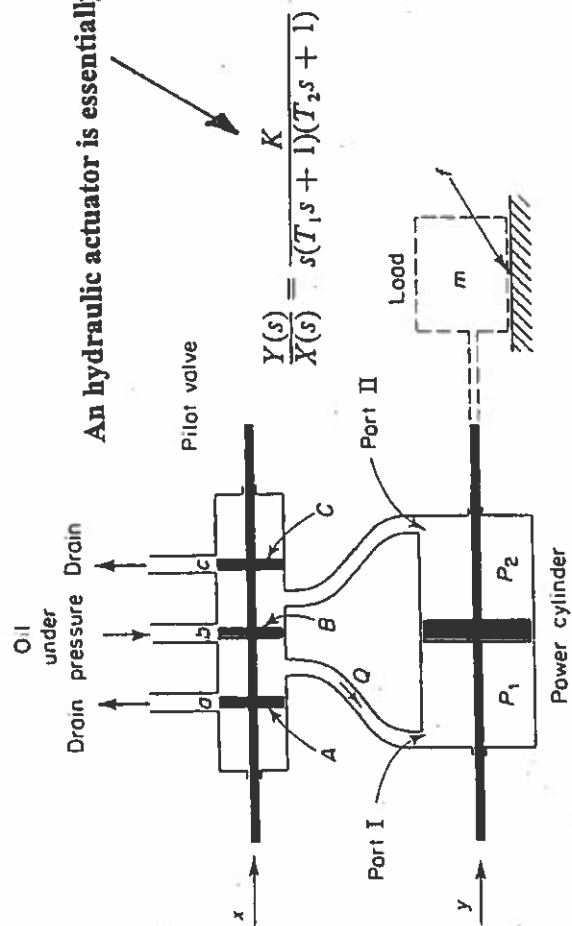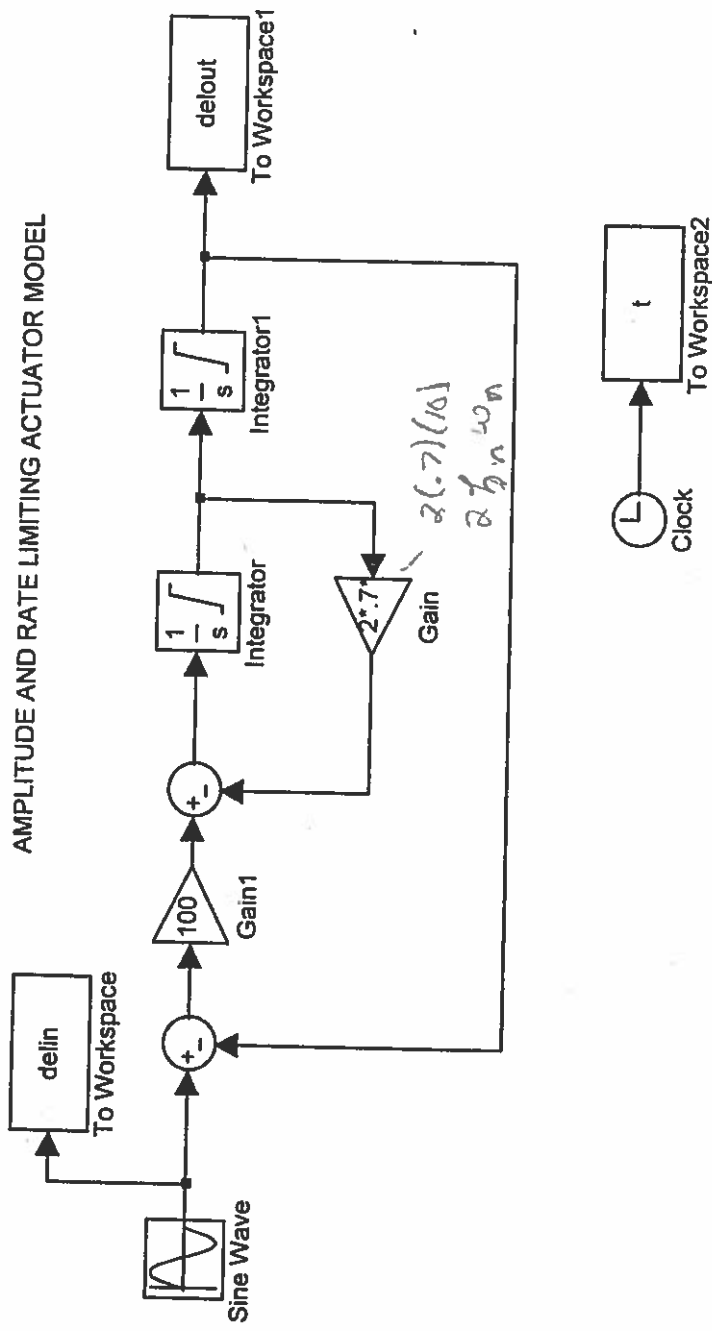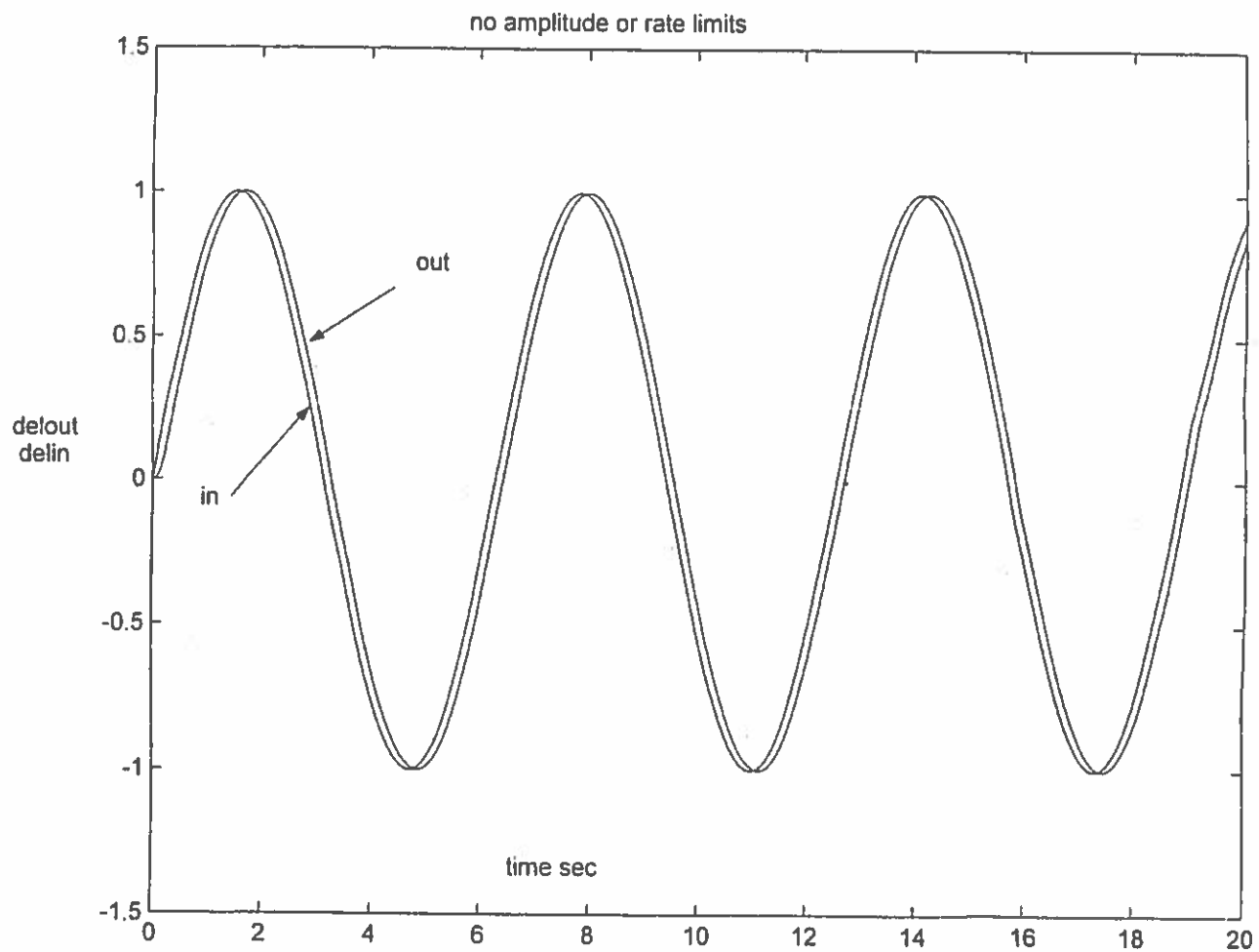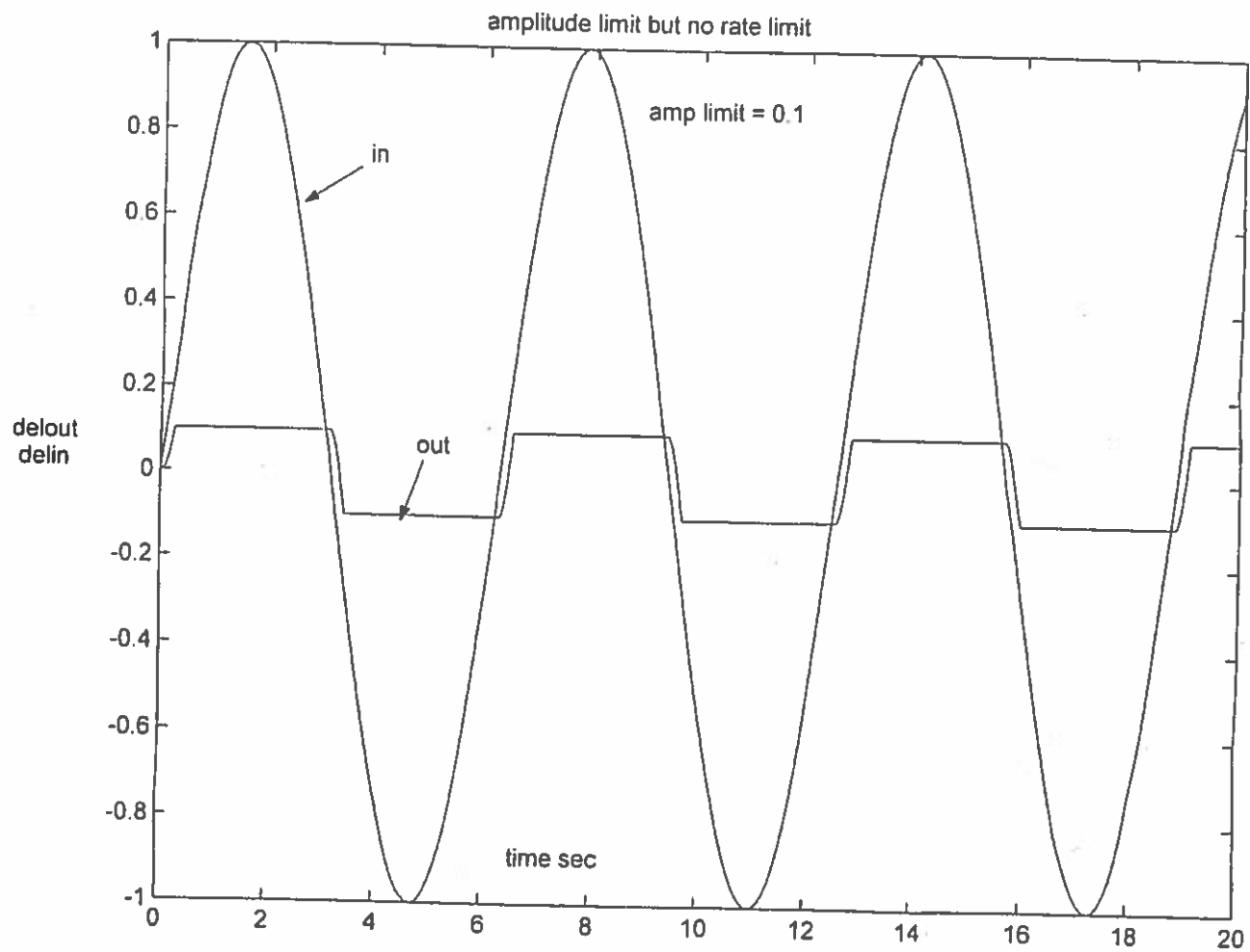
$$\frac{Y(s)}{X(s)} = \frac{K}{s(T_1 s + 1)(T_2 s + 1)}$$

Fig. 4-12. Schematic diagram of a hydraulic servomotor.

AMPLITUDE AND RATE LIMITING ACTUATOR MODEL

Sine Wave

To Workspace
delin

Gain1
100

Integrator
$\frac{1}{s}$

Integrator1
$\frac{1}{s}$

To Workspace1
delout

Gain
2*.7*

$2(.7)(10)$
$2 \zeta_n \omega_n$

Clock

To Workspace2
t

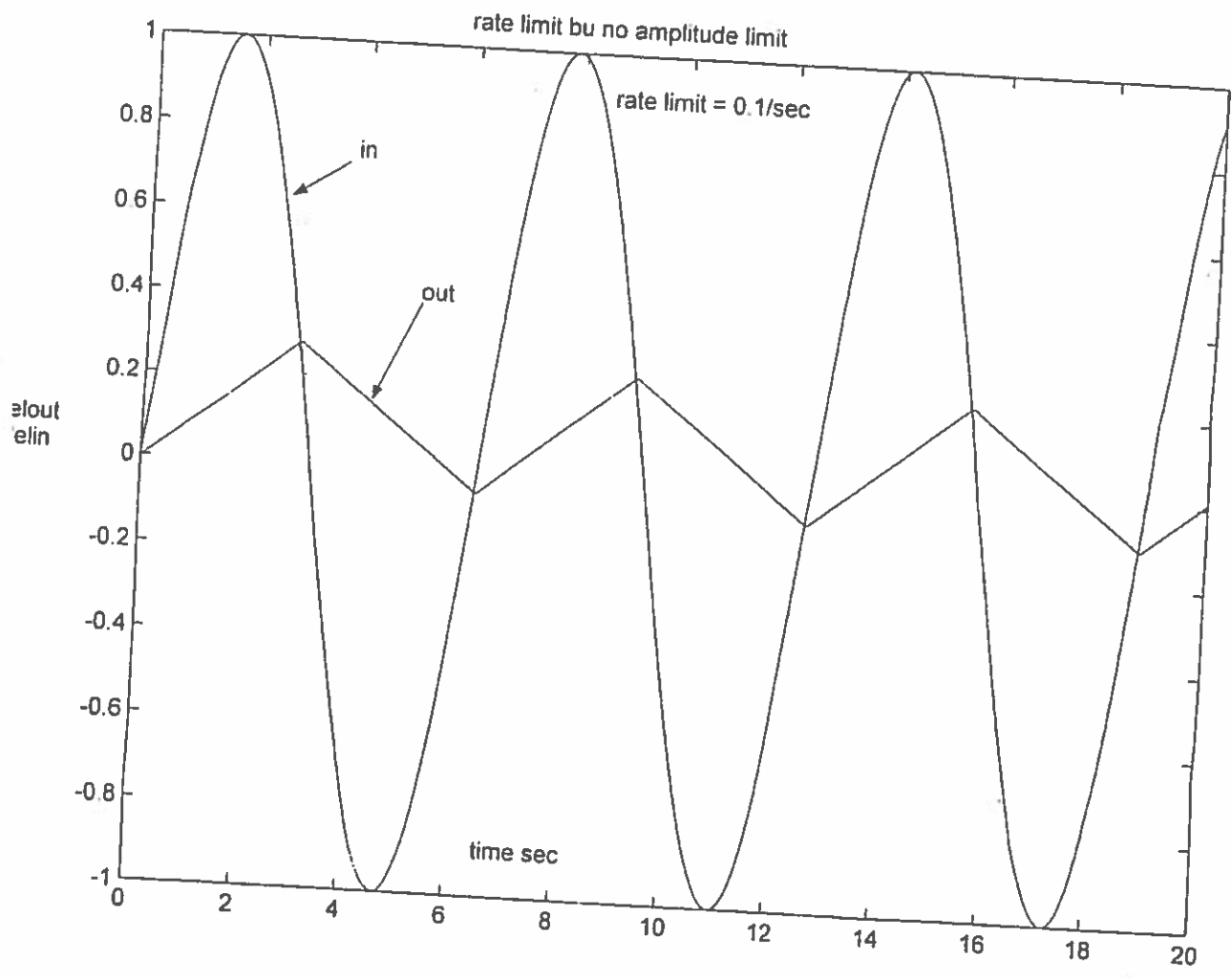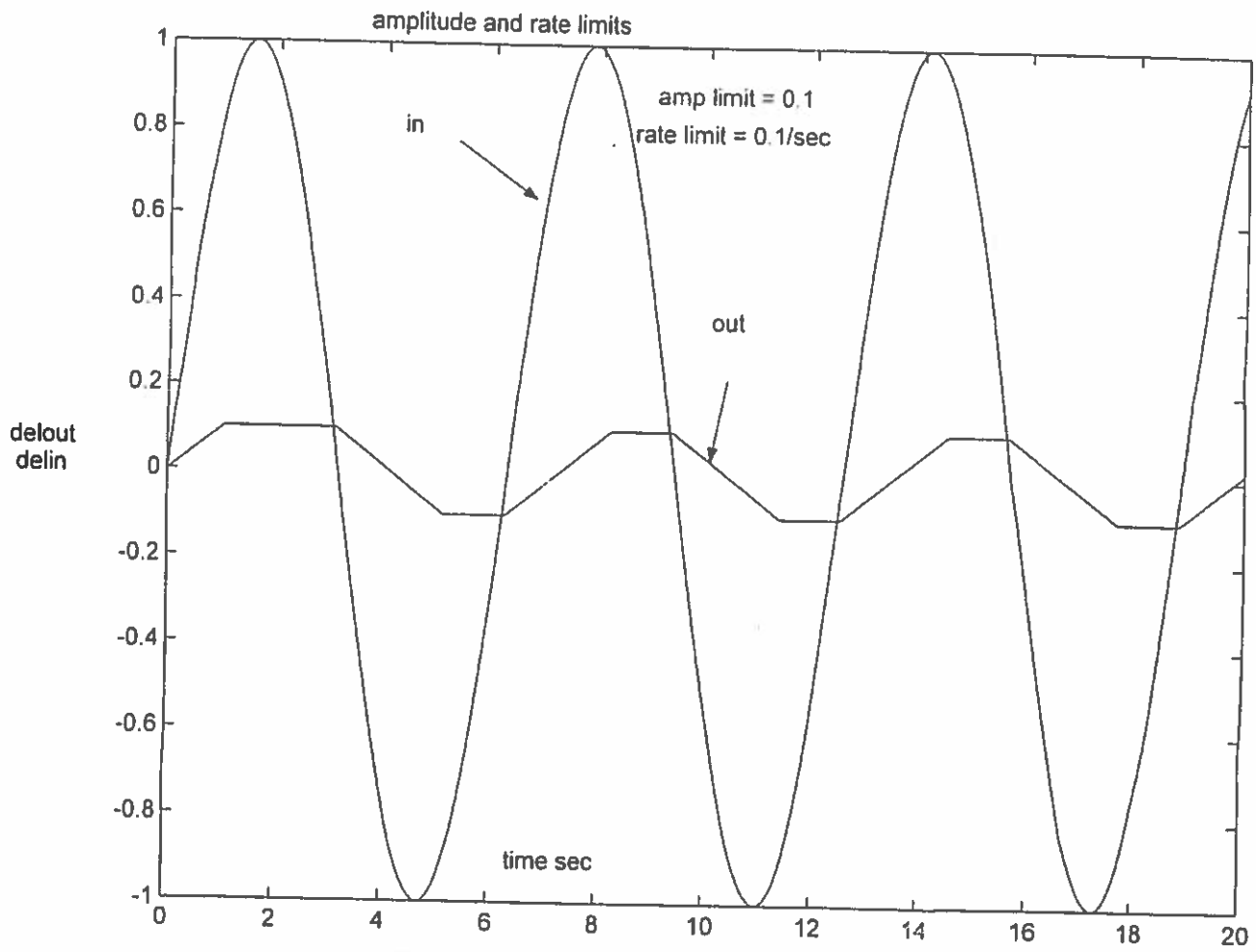LINEAR ACTUATOR CHARACTERISTICS
omega n = 10 rad/sec
zeta n = 0.7

no amplitude or rate limits

amplitude limit but no rate limit

amp limit = 0.1

in

out

delout delin

time sec

rate limit bu no amplitude limit

rate limit = 0.1/sec

in

out

time sec

amplitude and rate limits

$$\frac{K(s+4)}{s(s+1)}$$

Root Locus

Imaginary Axis (seconds⁻¹)

Real Axis (seconds⁻¹)
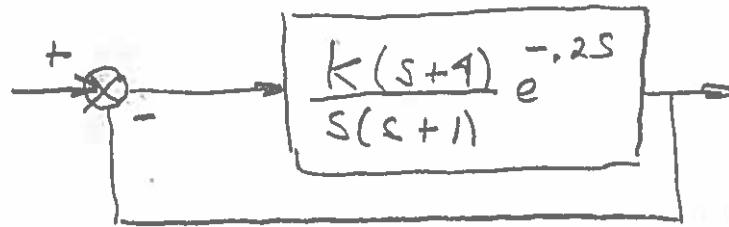
$$e^{-.2S} \cong \frac{-(s-10)}{s+10}$$

$$\frac{K(s+4)}{s(s+1)} e^{-.2S}$$

Root Locus