ADAPTIVE CRUISE CONTROL

SYSTEM DYNAMICS AND CONTROL – SEMESTER DESIGN PROJECT

TEAM 4:

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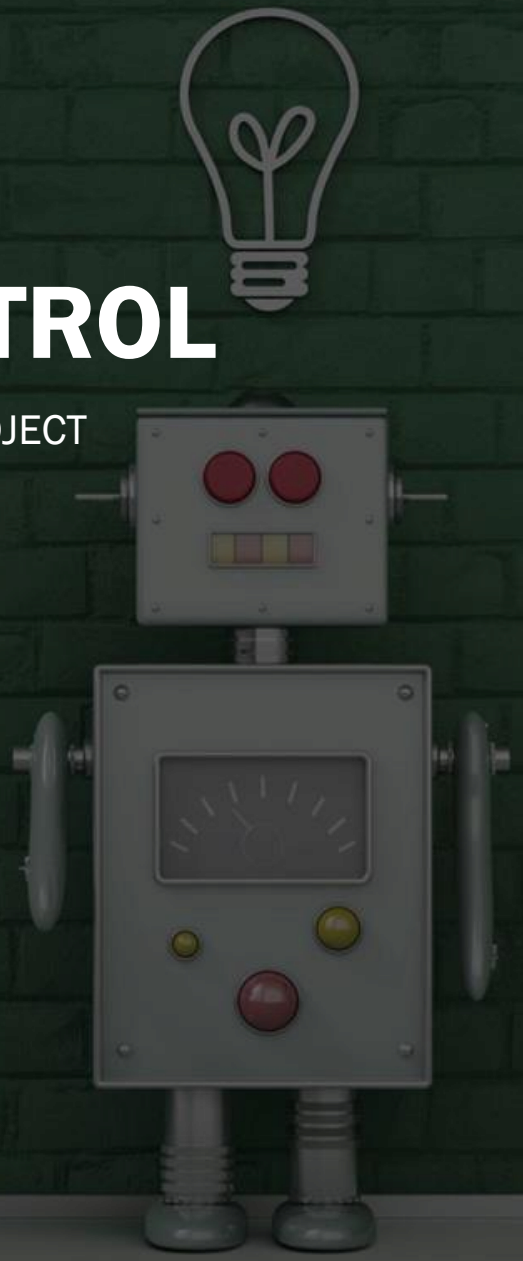

CRUISE CONTROL

BACKGROUND

CRUISE CONTROL

- Invented by Ralph Teetor in 1948
- First implemented in 1958 Chrysler Imperial
- Made driving:
  - Safer
  - More fuel efficient

<u>Limitations:</u>

- Only useful for open road
- Can be dangerous in rapidly oscillating traffic

ADAPTIVE CRUISE CONTROL

- Invented by William Chundrlik and Pamela Labuhn in 1990
  - Patented by GM in 1991
- Actively monitors vehicles in front and responds to changing speeds
- Utilizes many inputs:
  - Radar and/or lasers to measure distance
  - Vehicle acceleration/velocity
  - Lead vehicle velocity
  - And more

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SETUP

ADAPTIVE CRUISE CONTROL

ADAPTIVE CRUISE CONTROL

METHODOLOGY

ADAPTIVE CRUISE CONTROL

- Key assumptions:
  - Initial Velocity (V_i) = 88 $\left(\frac{ft}{s}\right)$
  - Distance to Lead Car (X_o) = 50 (ft)
  - "Two-second Rule"
  - Safe Deceleration Time Constant (T_c) = 15 (sec)
  - Mass of Vehicle (m) $= \frac{3000lb}{32.2 {}^{ft}/_{s^2}} = 93.17\ slugs$
  - Braking Force

$$(F_b) = \left[\frac{V_i - \frac{X_o}{2}}{T_c}\right] \times m = \left[\frac{88 {}^{ft}/_{s} - \frac{50 {}^{ft}/_{s}}{2}}{15s}\right] \times 93.17 slugs = 391.31 lbf$$

ADAPTIVE CRUISE CONTROL

- Key assumptions (Continued):
  - Acceleration Force (u) = 500 (lbf)
  - Drag = Damping Constant (b) = 3.346 $\left(\frac{lbf \cdot s}{ft}\right)$

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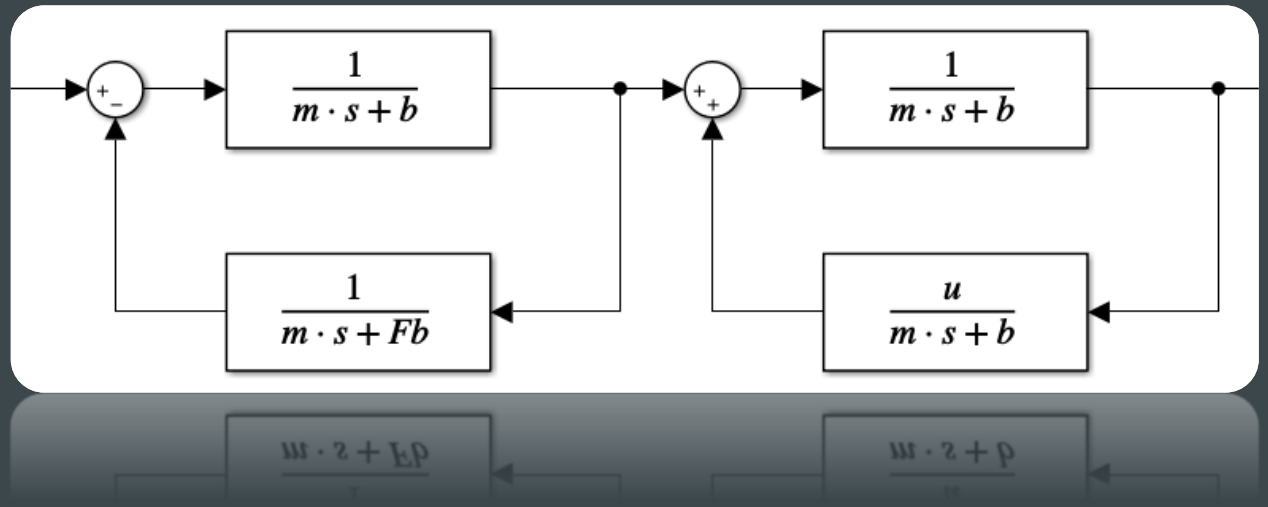
TRANSFER FUNCTIONS

ADAPTIVE CRUISE CONTROL



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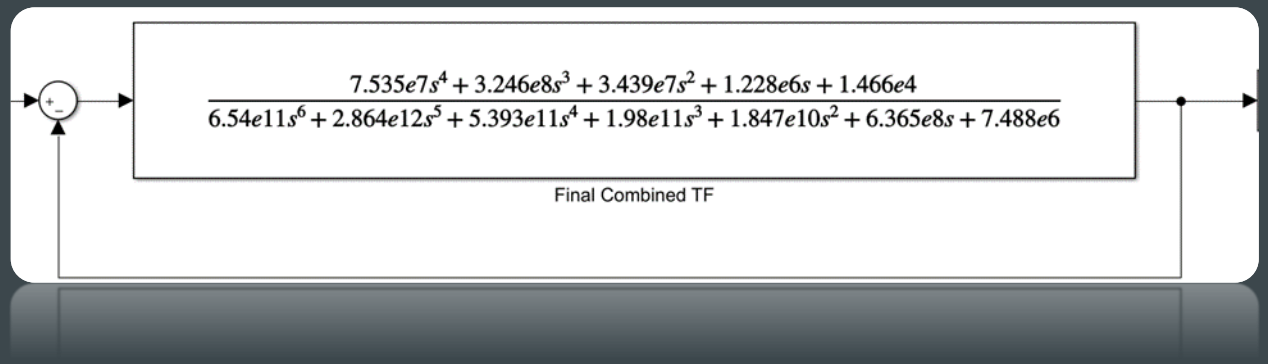

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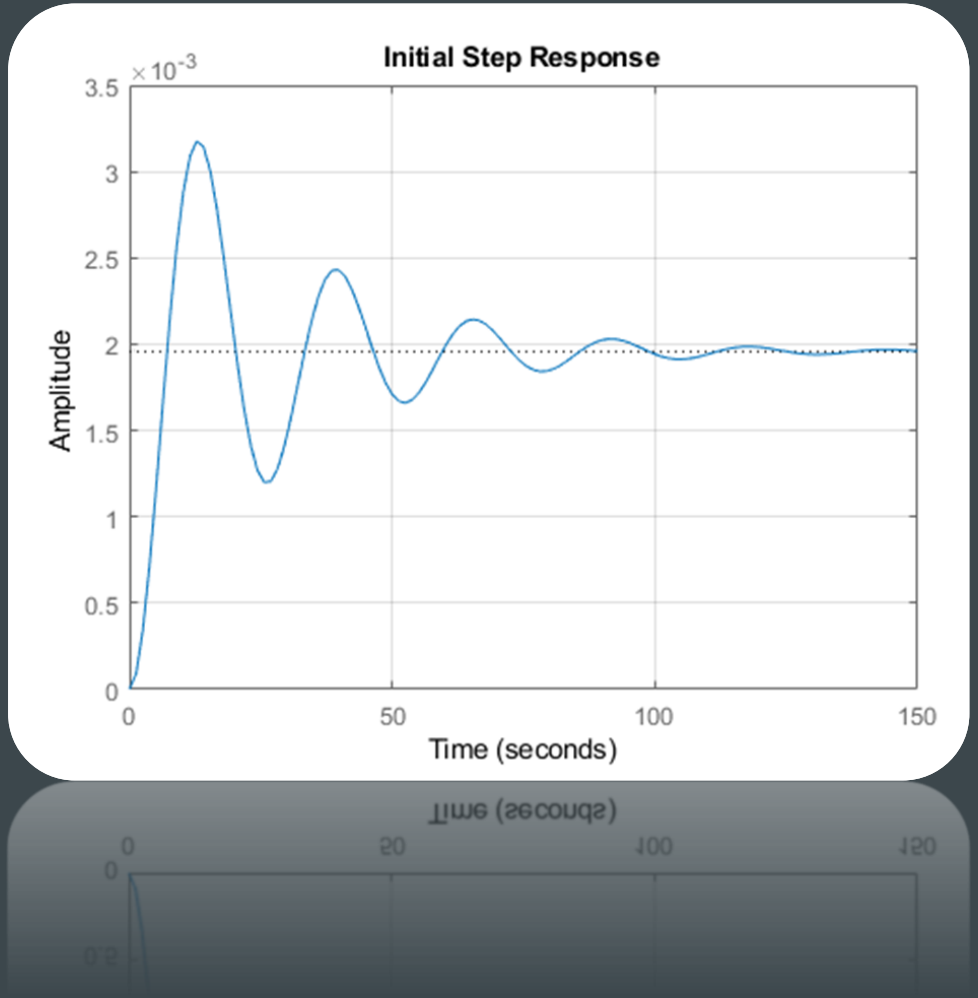
RESPONSE

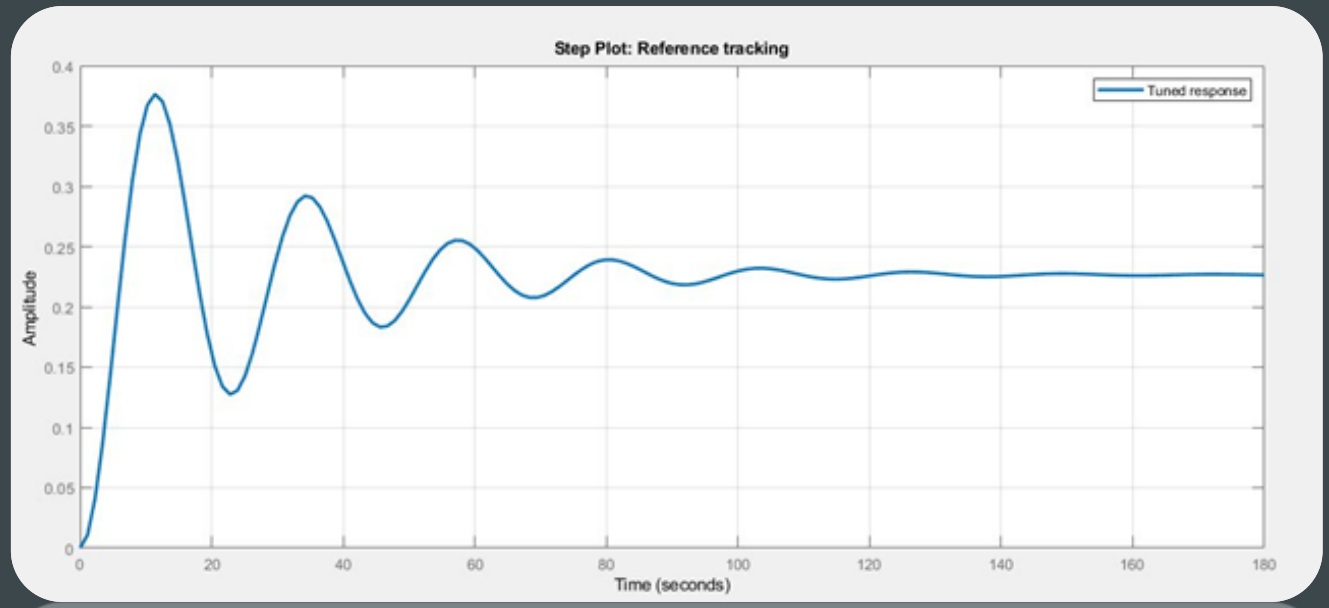
Open-Loop Response

- RISE TIME:
  - 4.84s
- OVERSHOOT:
  - 62.26%
- SETTLING TIME:
  - 106.92s



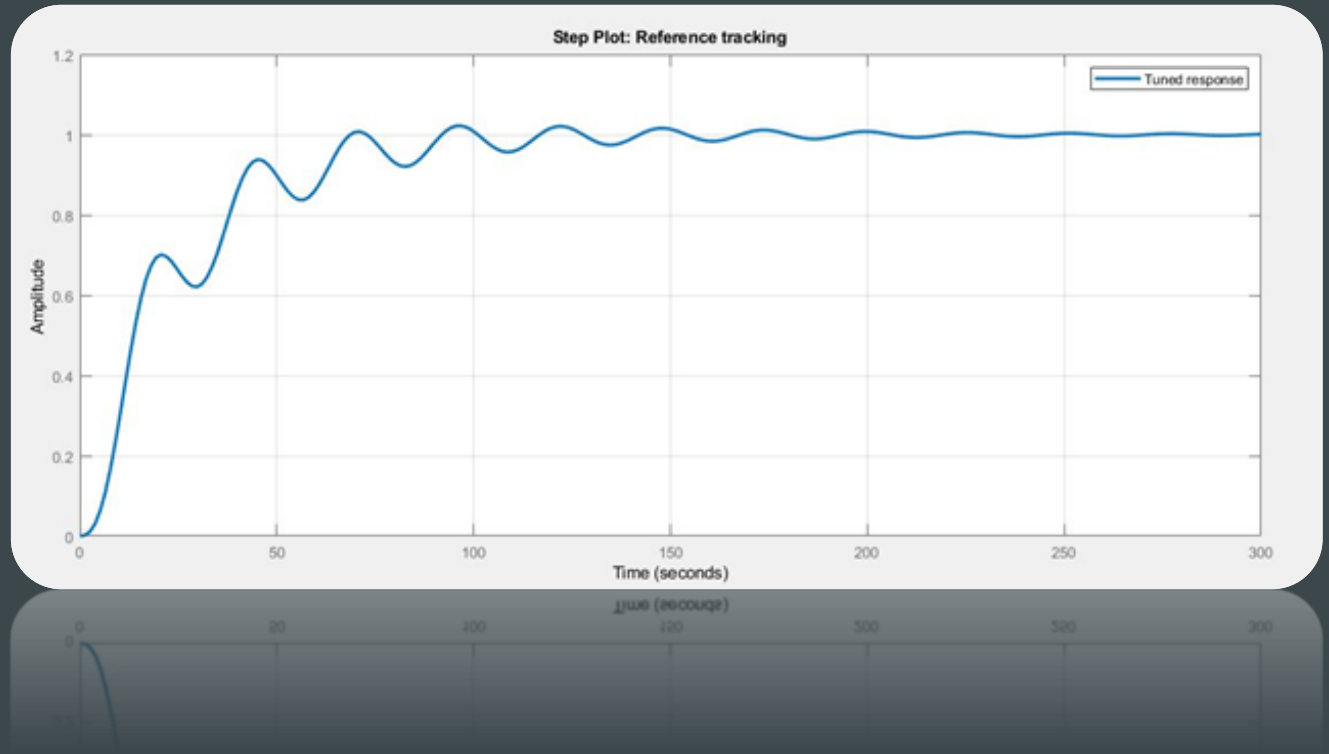
P-Controller Response

- RISE TIME:
  - 4.19s
- OVERSHOOT:
  - 66.10%
- SETTLING TIME:
  - 106.00s
- $K_P = 149.64$



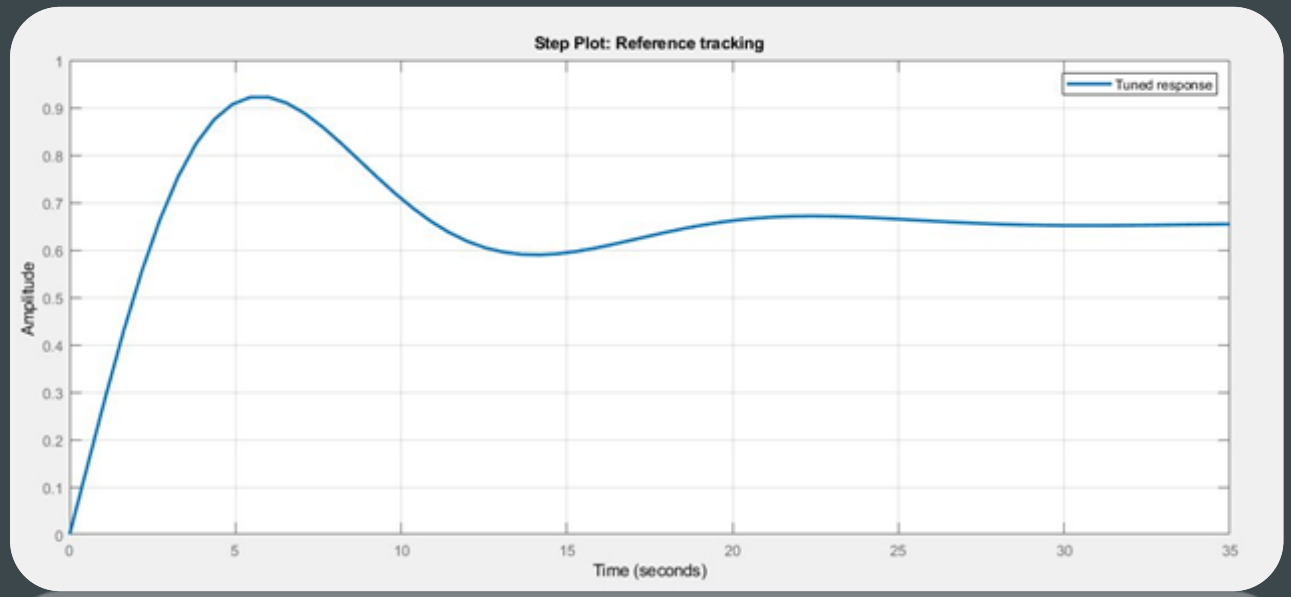
PI-Controller Response

- RISE TIME:
  - 35.5s
- OVERSHOOT:
  - 2.21%
- SETTLING TIME:
  - 138.00s
- $K_P = 13.25$
- $K_I = 21.37$



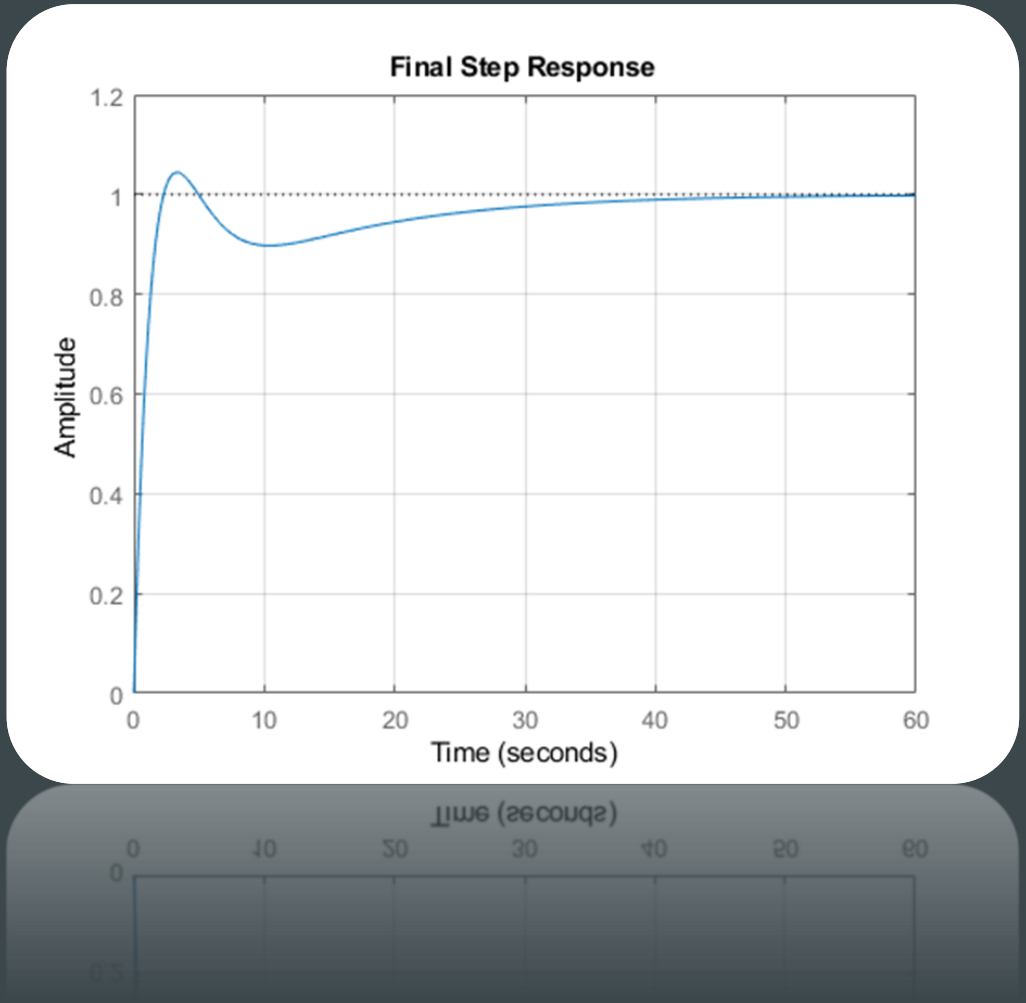
PD-Controller Response

- RISE TIME:
  - 2.11s
- OVERSHOOT:
  - 40.7%
- SETTLING TIME:
  - 24.0s
- K_P = 970.90
- K_D = 2308.42



PID-Controller Response

- RISE TIME:
  - 1.54s
- OVERSHOOT:
  - 4.45%
- SETTLING TIME:
  - 32.3s
- K_P = 2673.68
- K_I = 203.47
- K_D = 8783.15



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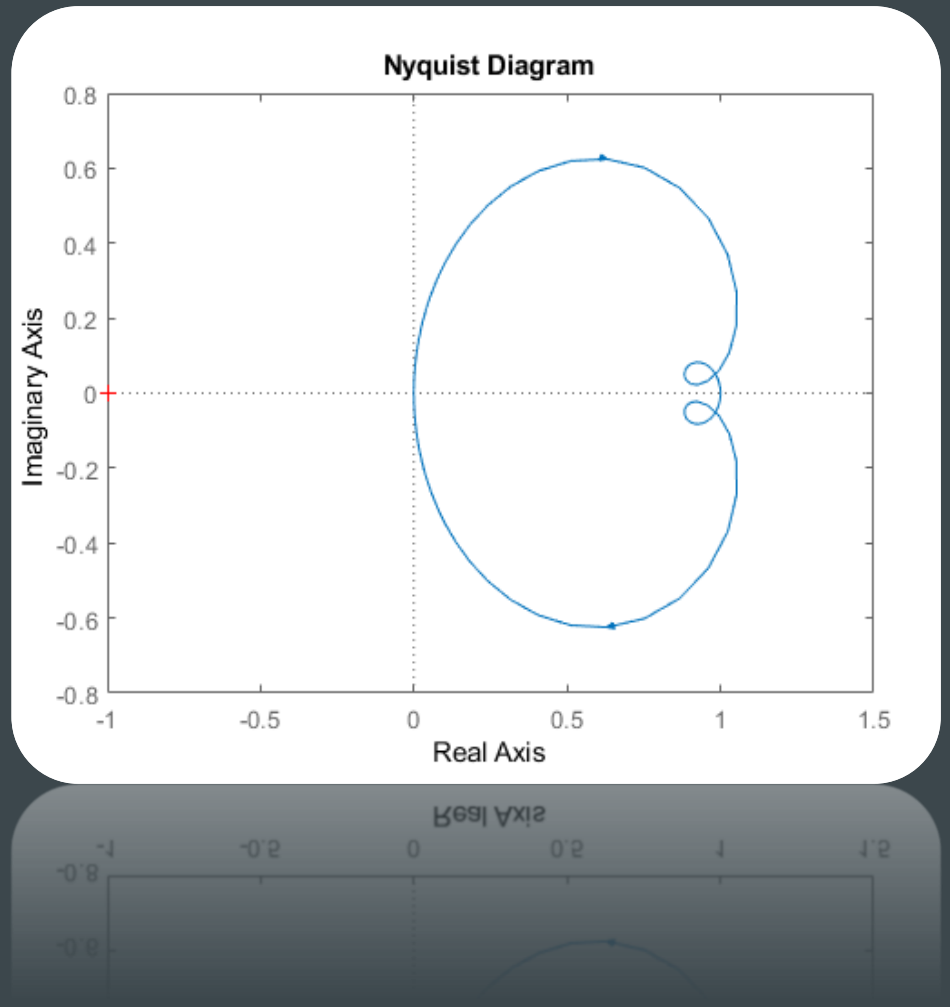
DIAGRAMS

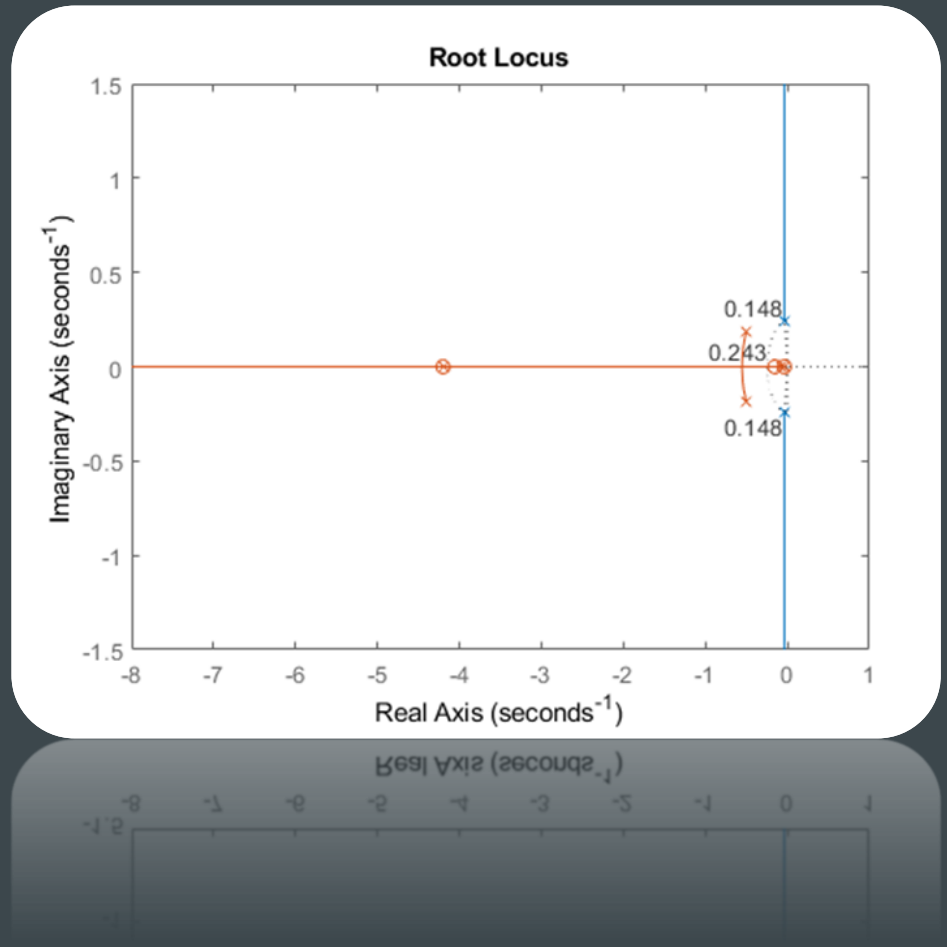
ADAPTIVE CRUISE CONTROL



ADAPTIVE CRUISE CONTROL

Original

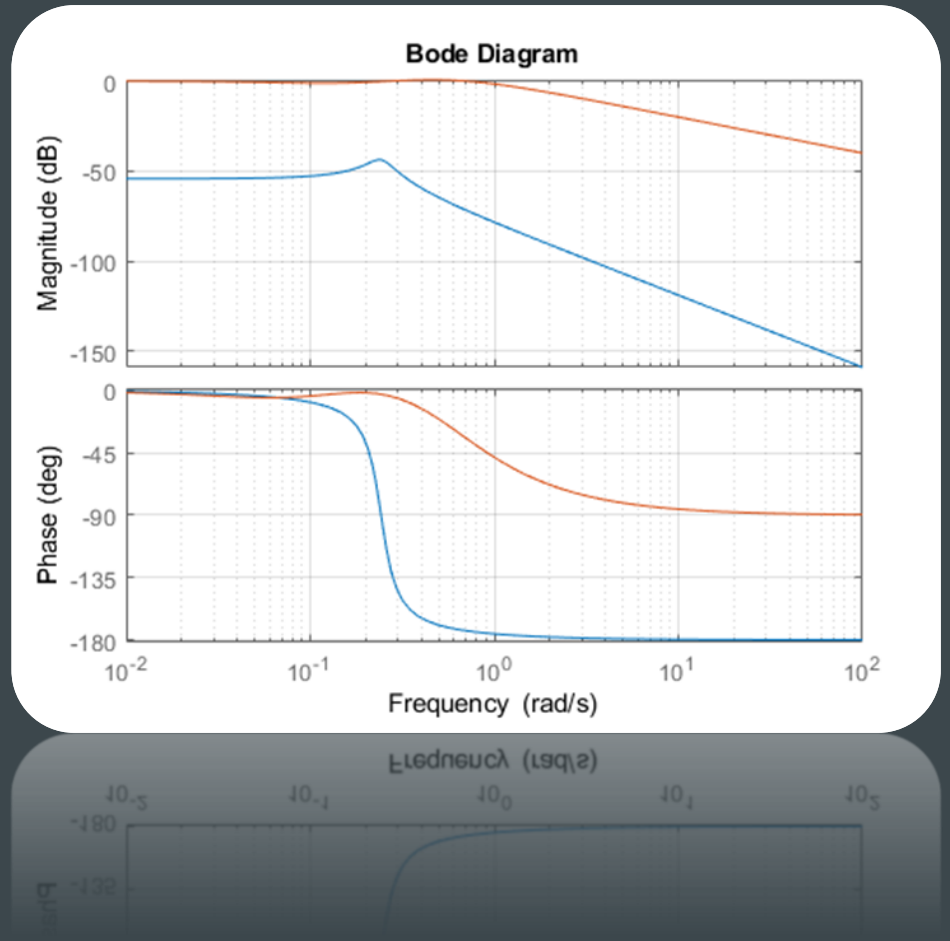
PID Controlled



ADAPTIVE CRUISE CONTROL

Original

PID Controlled



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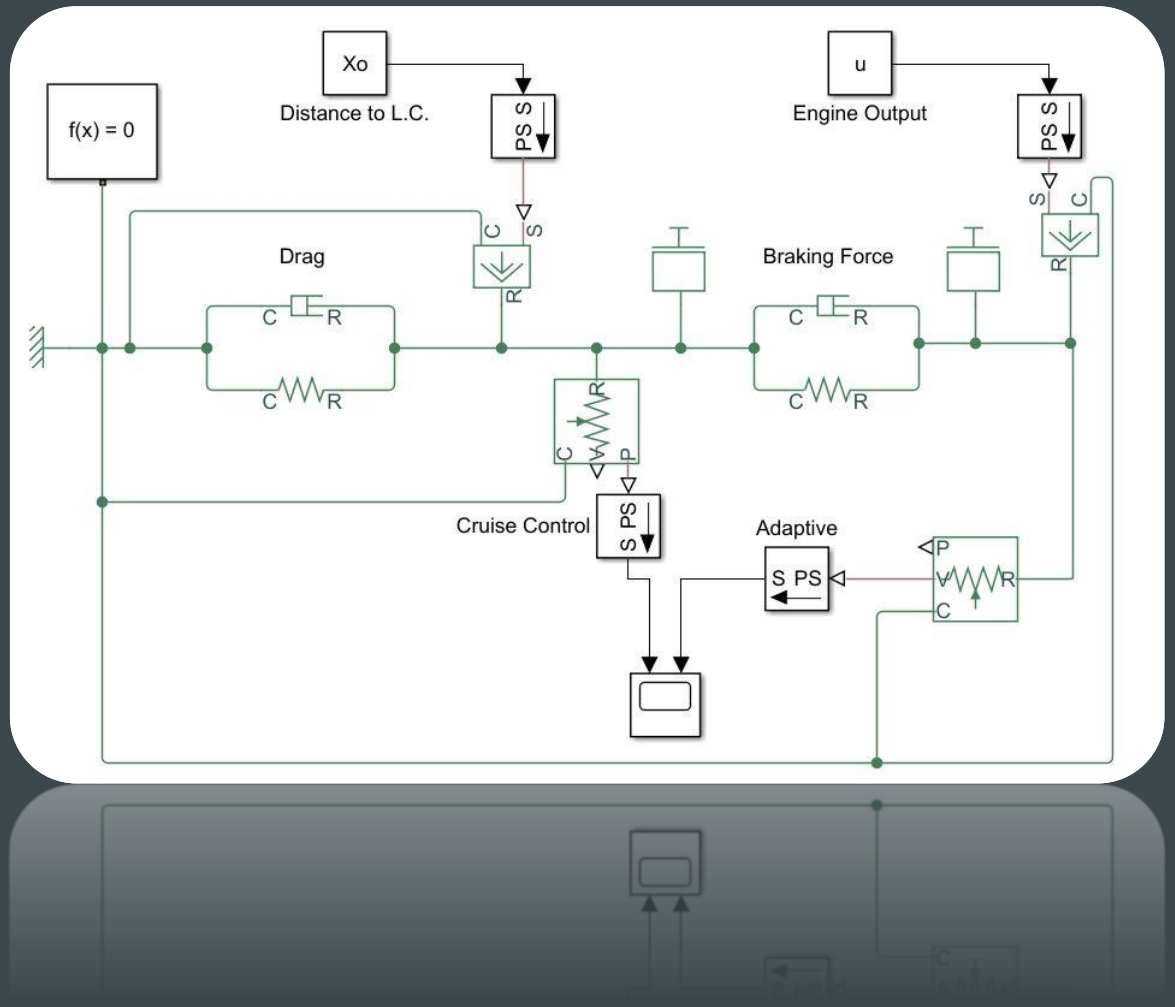
MODEL

ADAPTIVE CRUISE CONTROL



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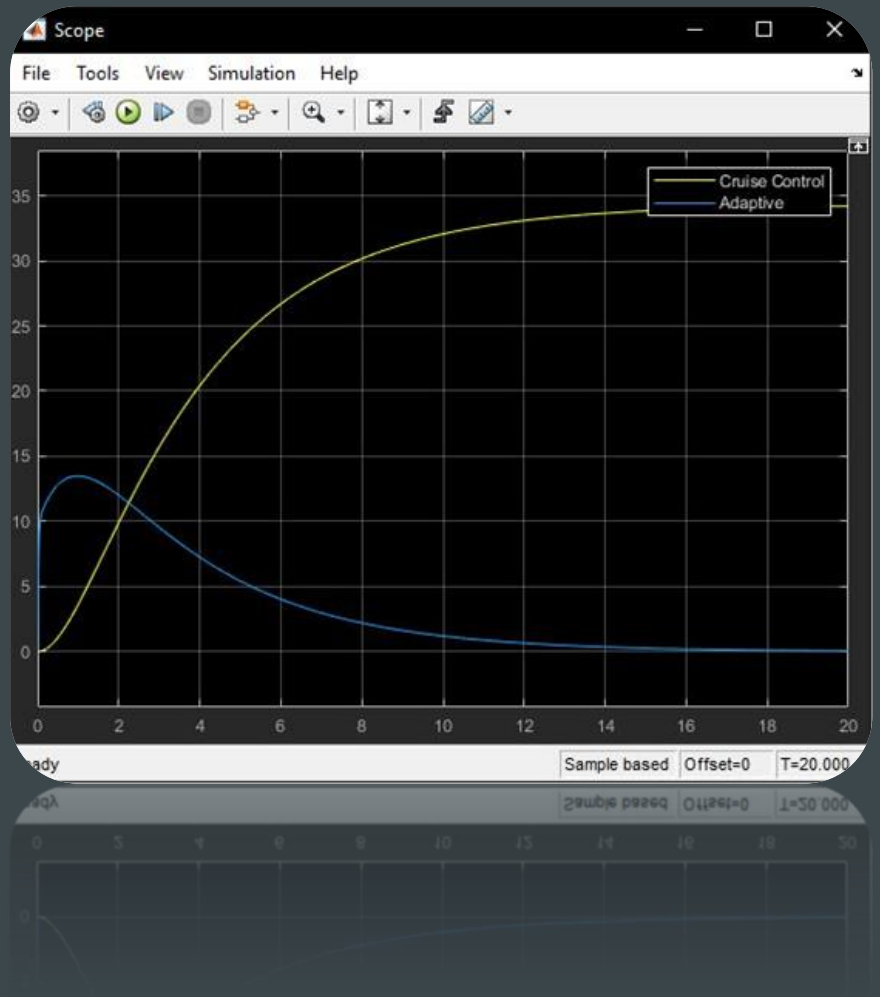

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QUESTIONS?