

# Virtual Chip Design for Automotive Applications



- 1) General
- 2) Cruise Control Example
- 3) Summary
- 4) Conclusion

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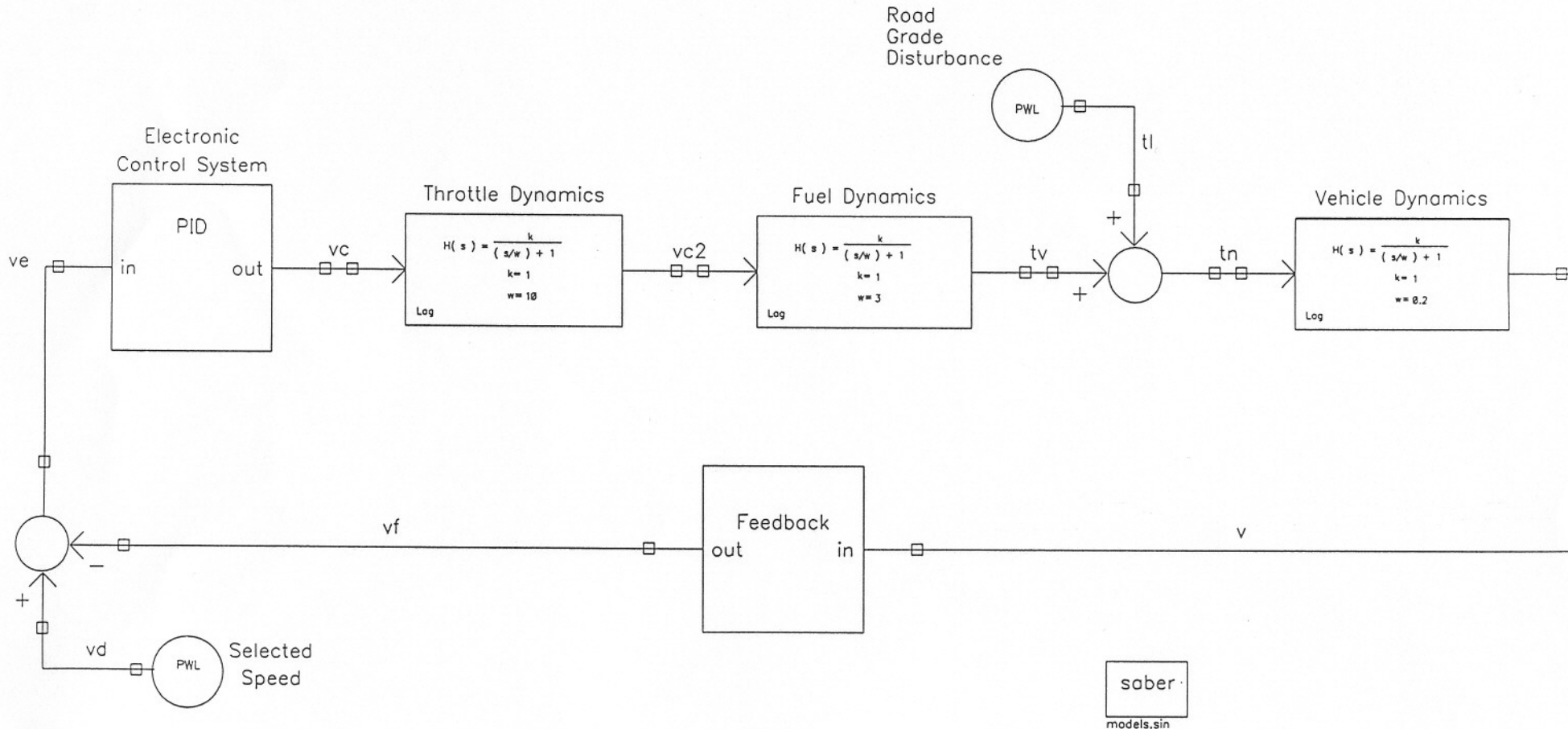
# Virtual Chip Design

- Start From a Given Design Specification
- Develop a Model for the New Design
- Simulate the Device Separately and in the Overall System
- Fine Tune the Design for the Best Systems Response
- Accomplished Before First Prototype Assembly

# Cruise Control System Example

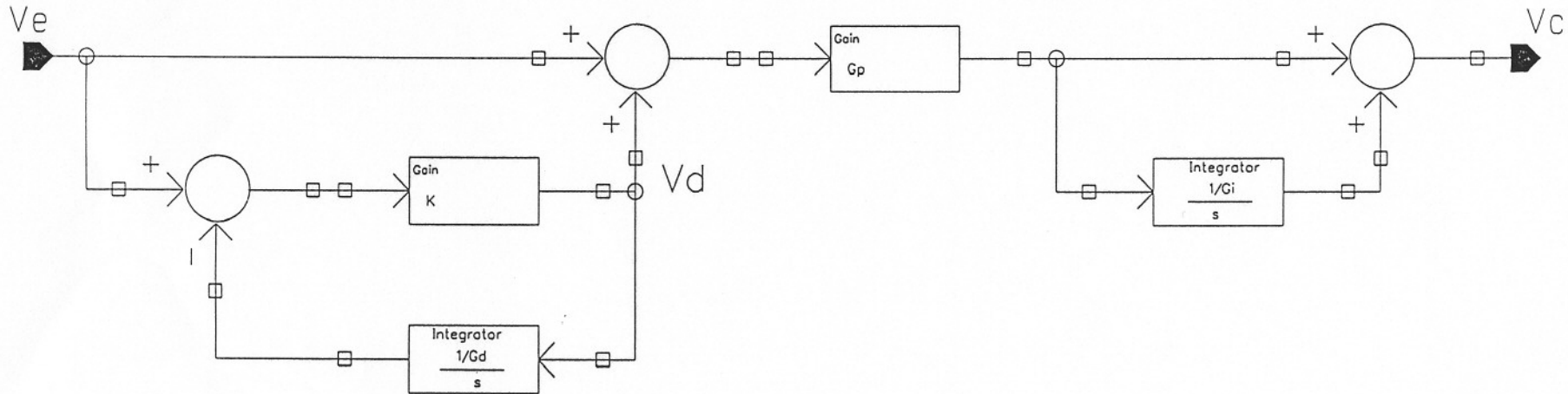
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- **Electrical-Mechanical System**
  - **Electronic Control Block**
    - Simulated at Functional, Behavioral, and Component Level
  - **Introduce a Failure Mode**
    - Observe Overall System Response

# Automotive Cruise Control System





## Generation of PID



$$V_d = G_d S / (1 + G_d S / K) V_e$$

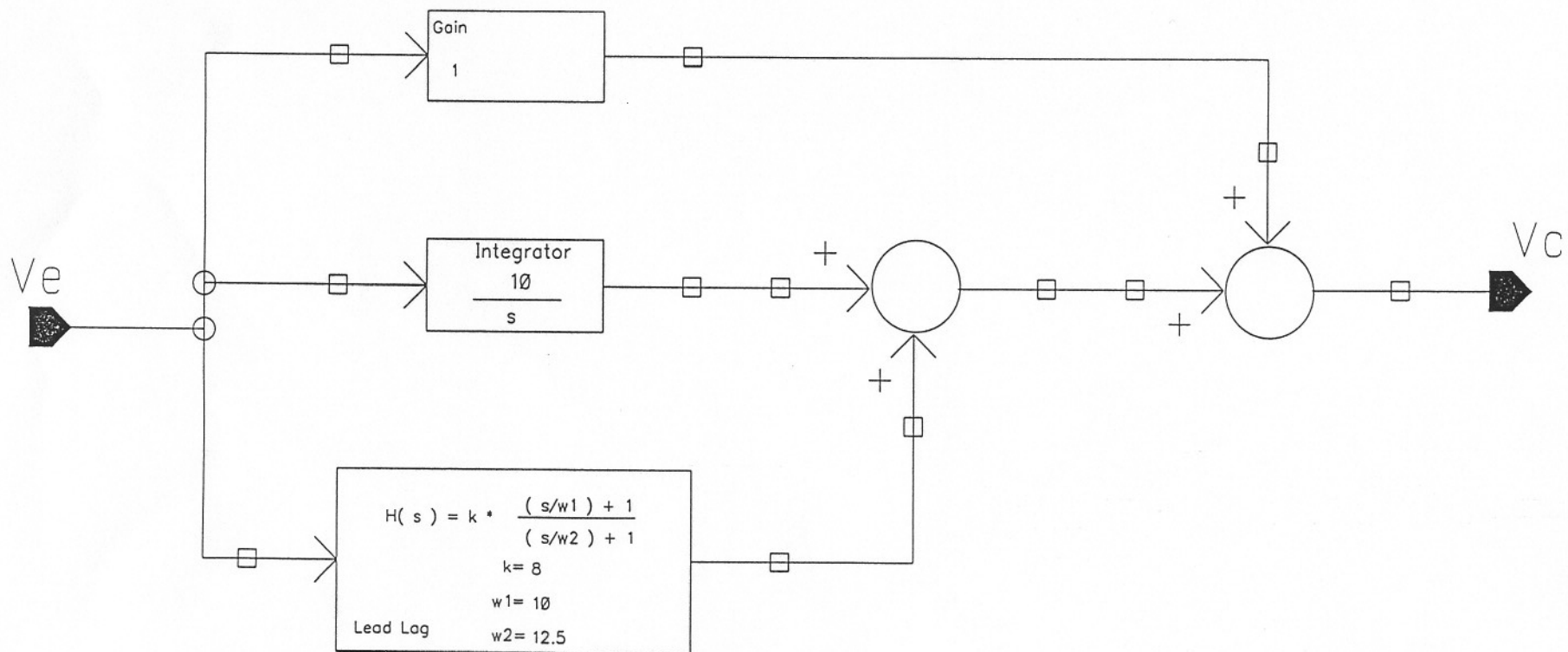
$$V_c = G_p (V_e + V_d) (1 + 1 / (G_i S))$$

$$V_c / V_e = G_p + G_p / (G_i S) + G_p G_d / G_i (1 + G_i S) / (1 + G_d S / K)$$

proportional + integral + differential

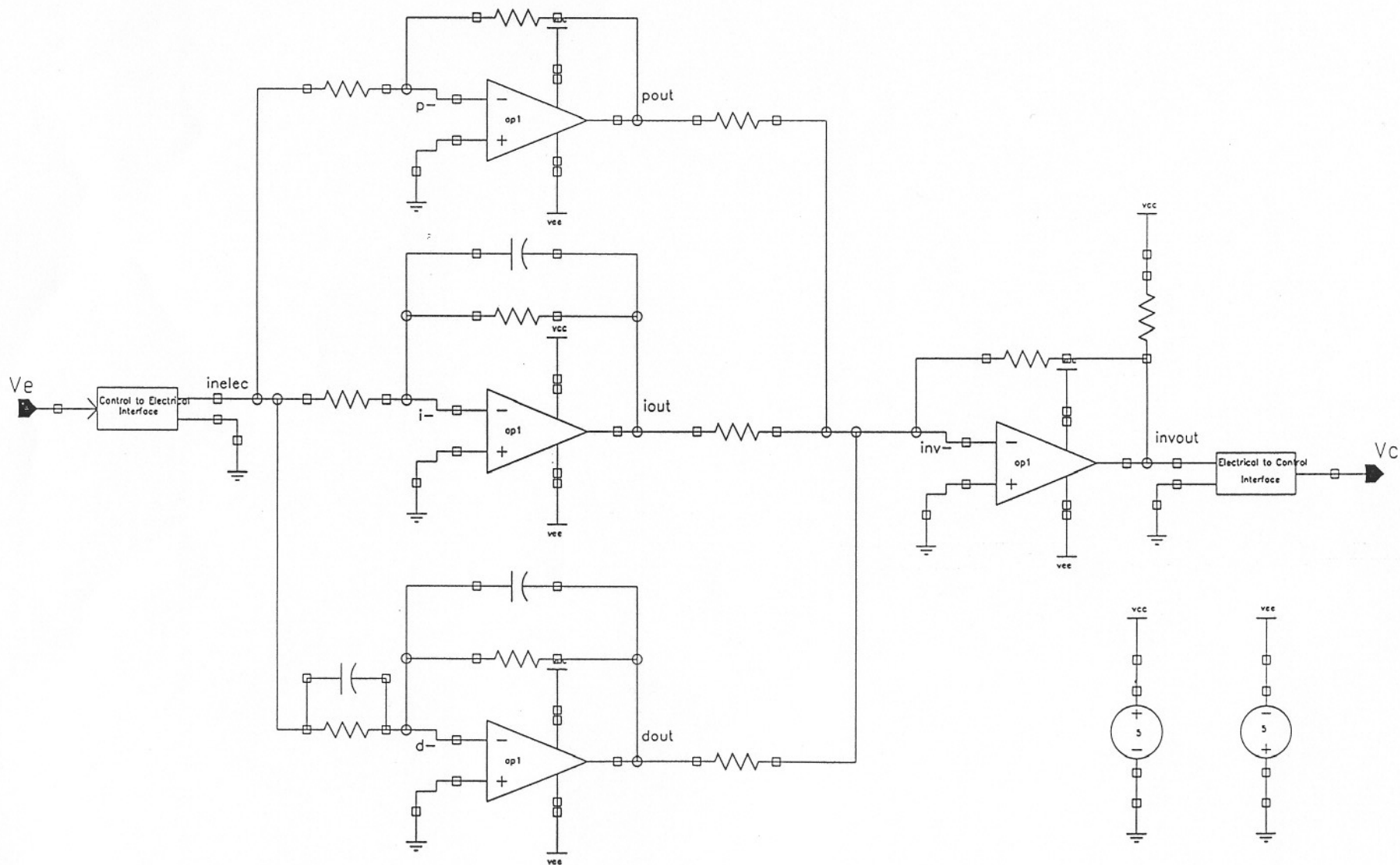


# Functional PID



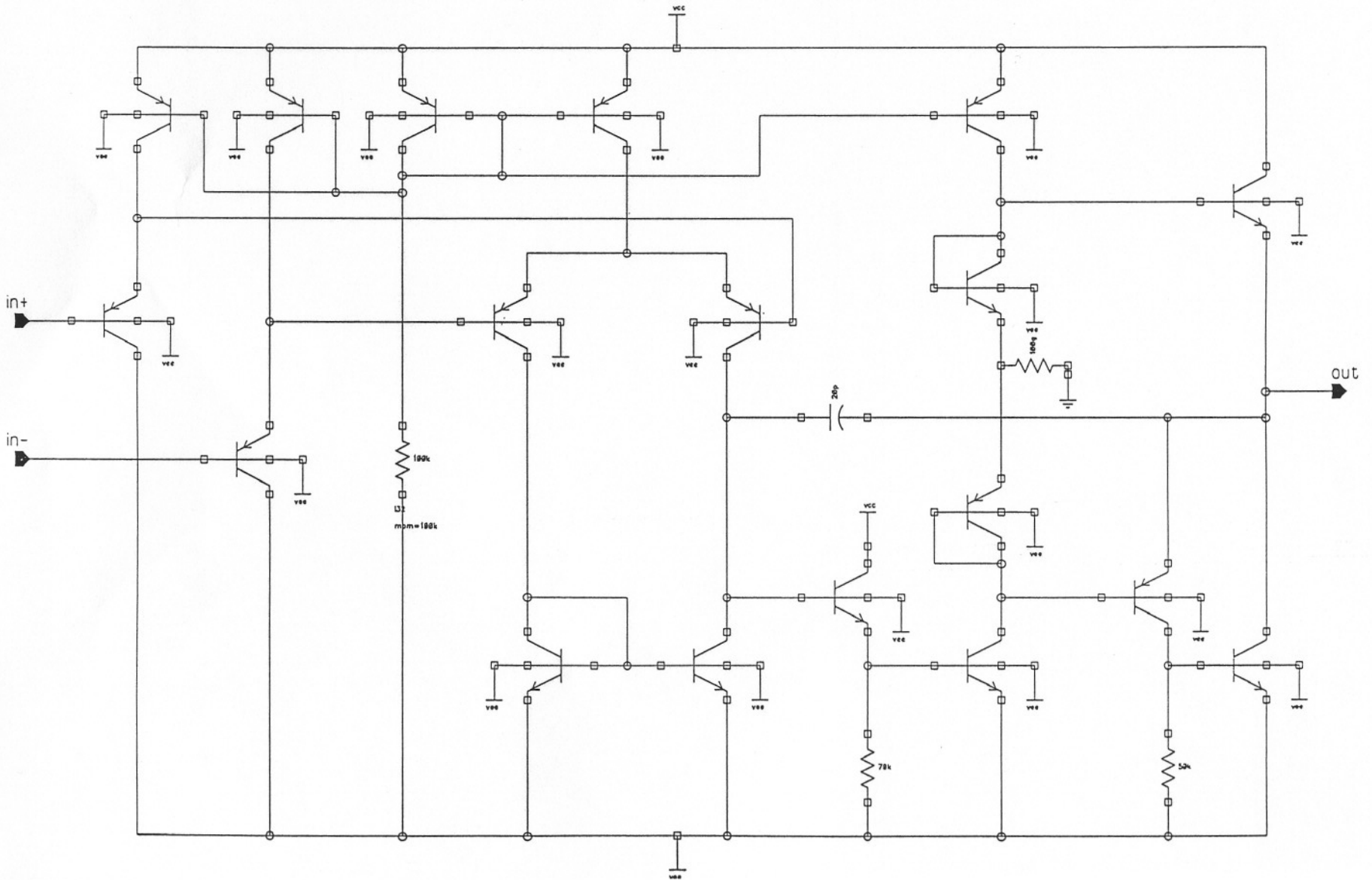


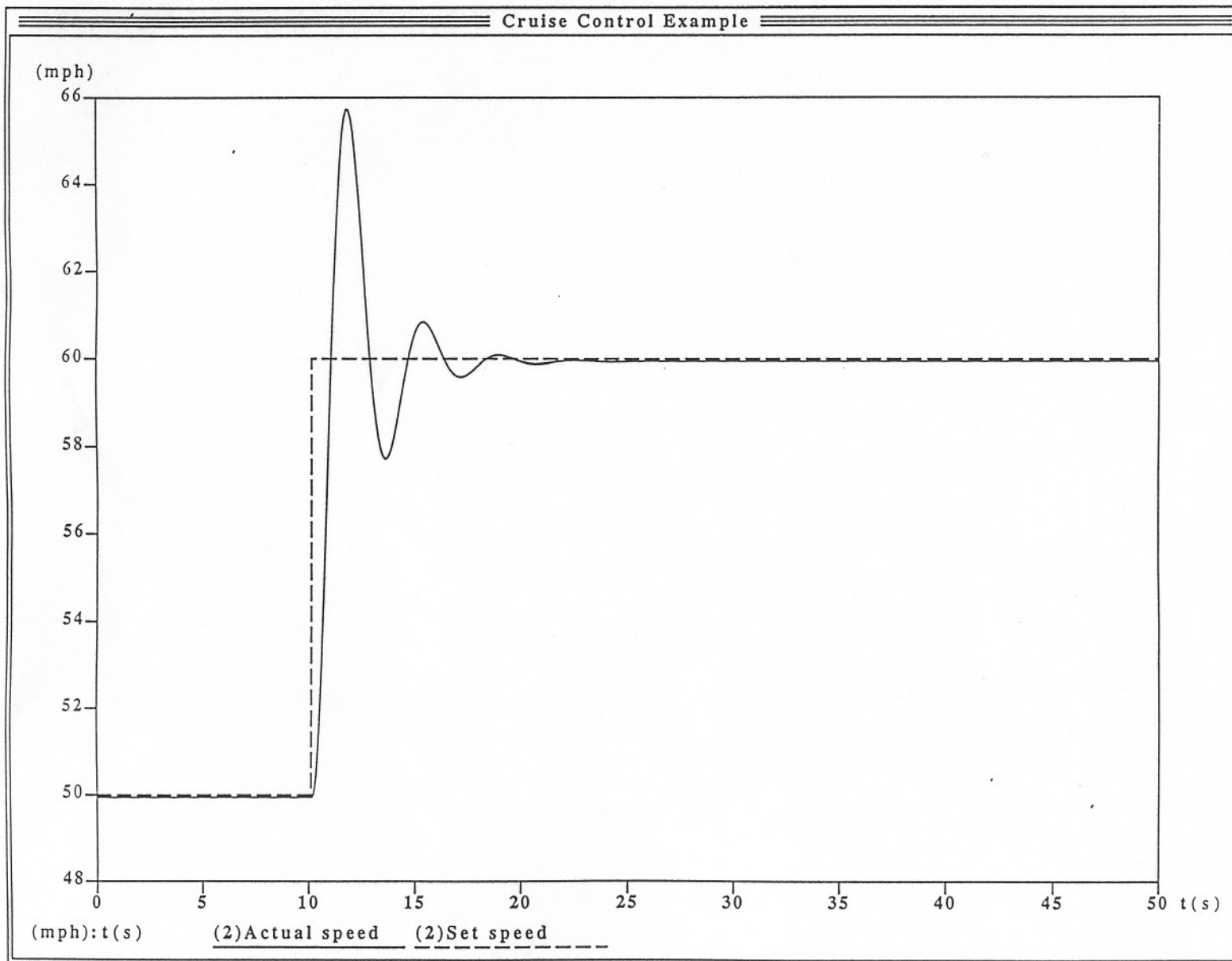
### Behavioral or Component PID

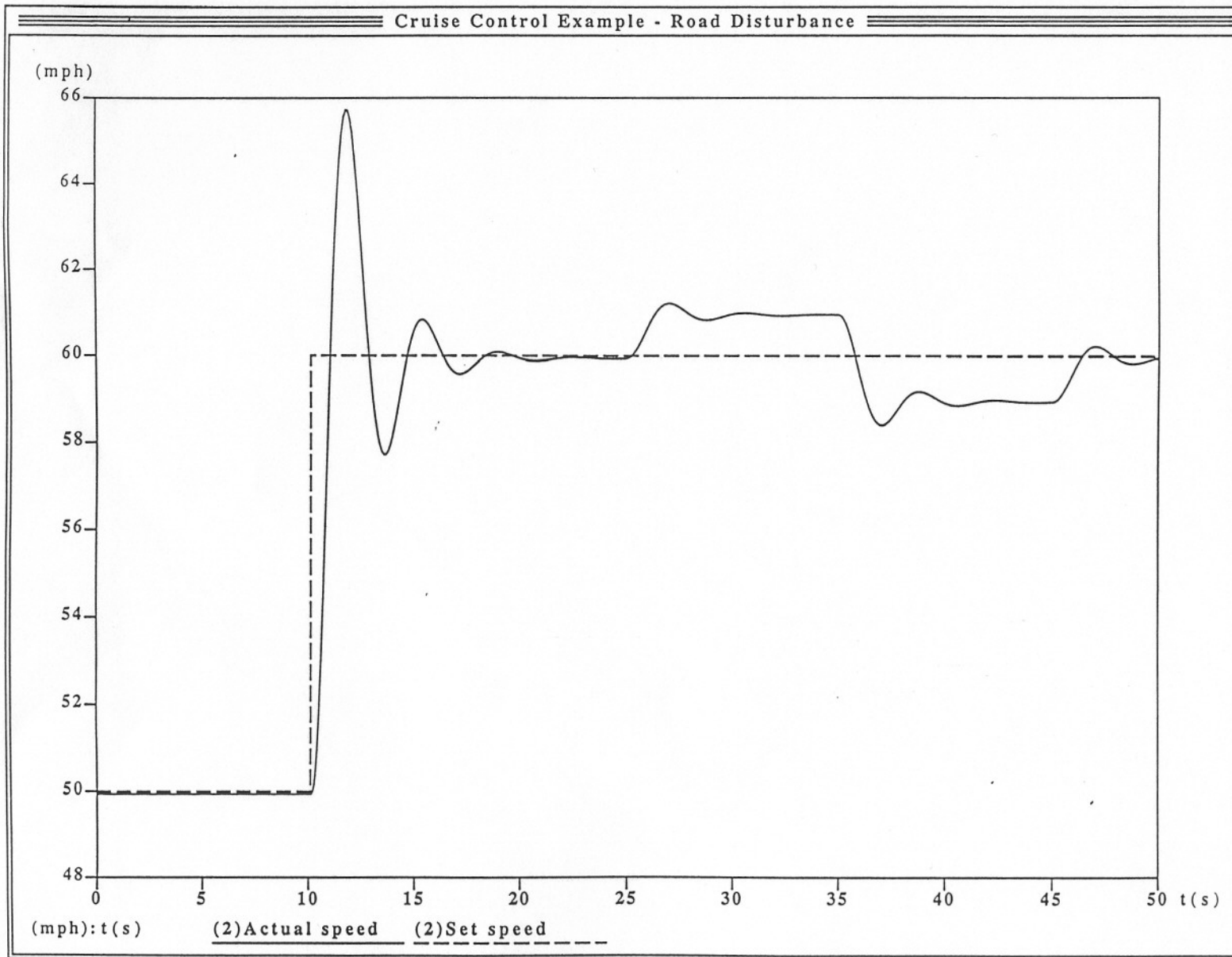


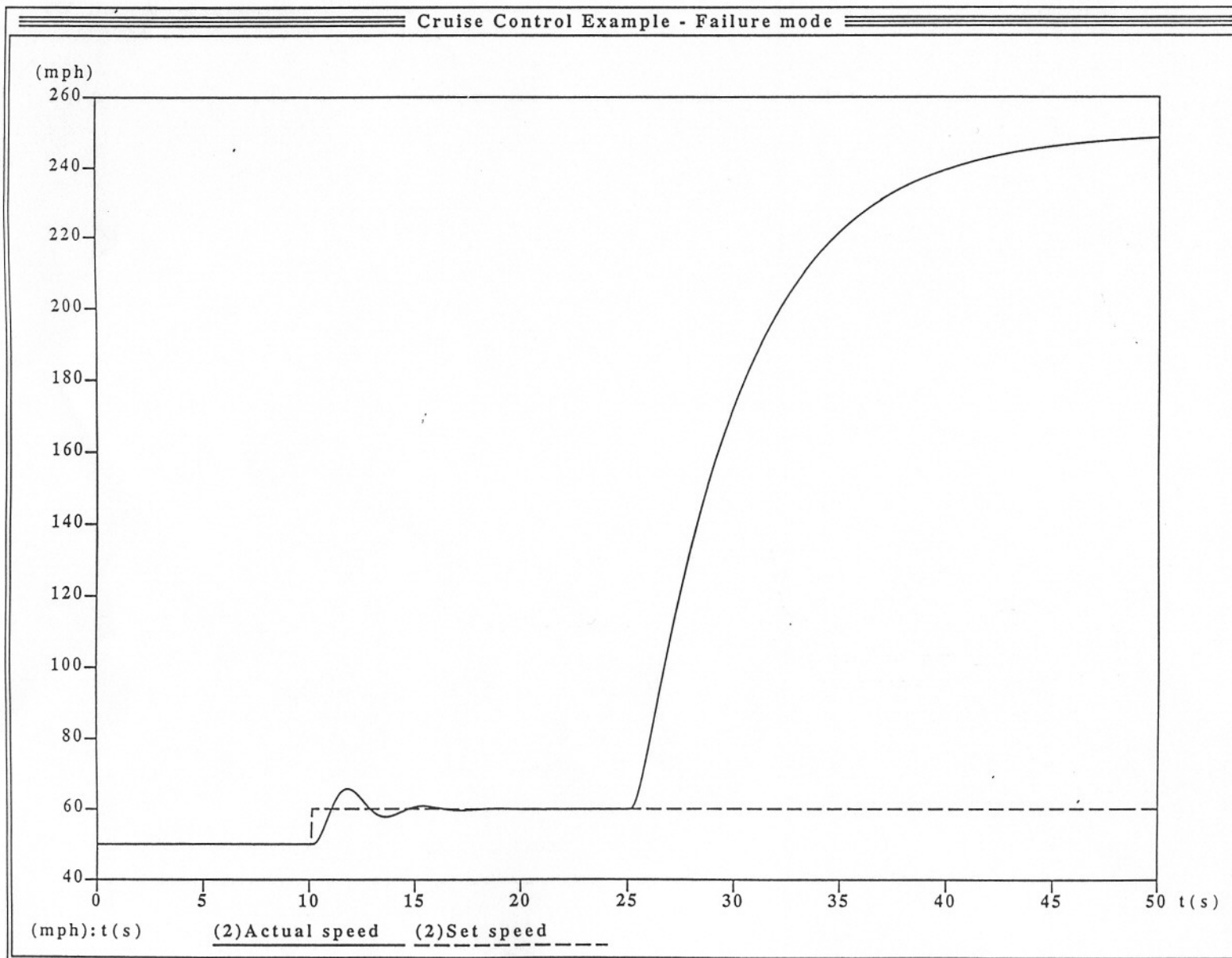


### Operational Amplifier



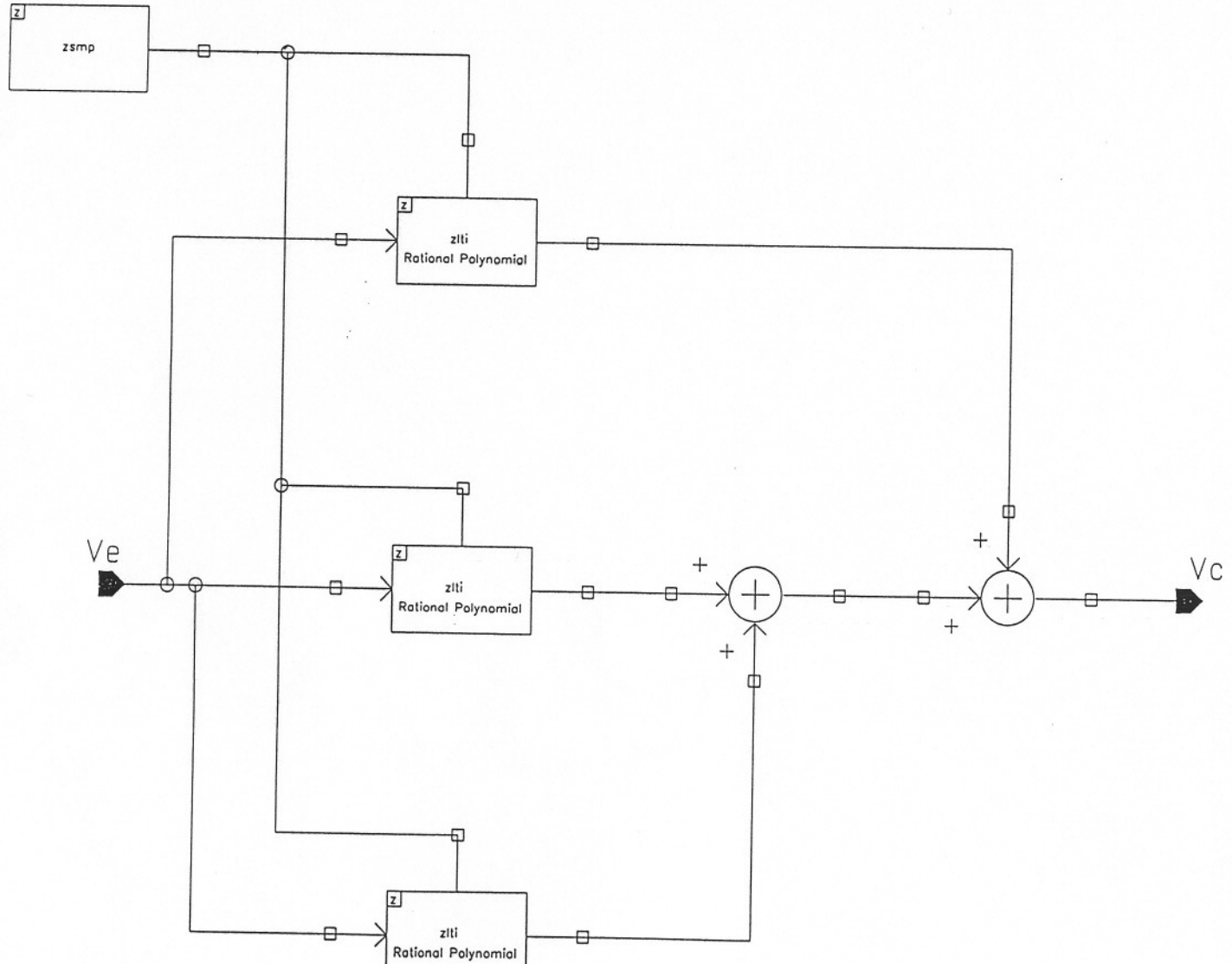






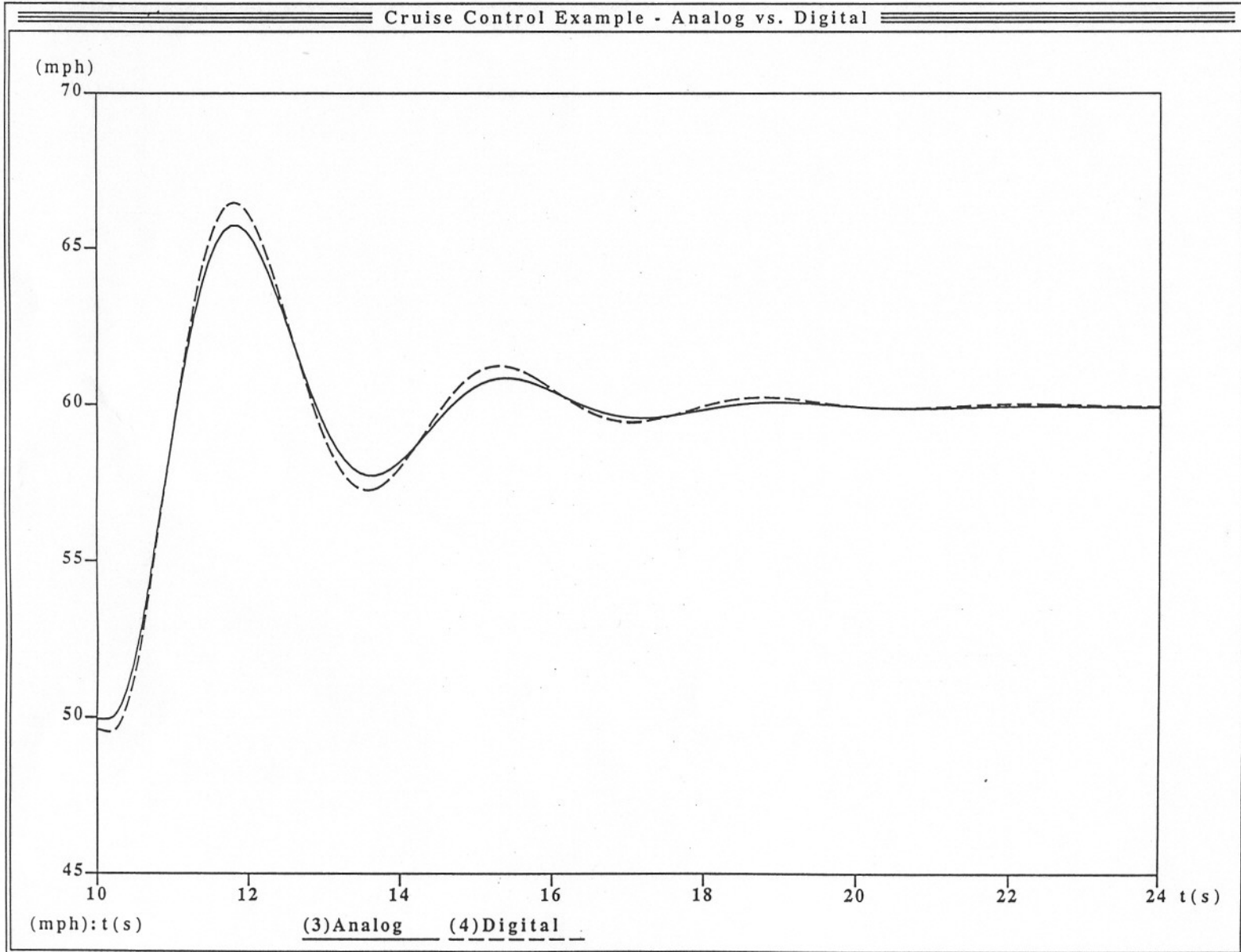


# Digital PID





Cruise Control Example - Analog vs. Digital





# Summary

- Multiple Technology Simulation
  - Electrical
  - Mechanical
  - Etc. ...
- Levels of Simulation Models
  - Functional, Fast Results to New Circuit Ideas
  - Behavioral, More Realistic Simulation Results
  - Component, Final design verification
- Failure Analysis
  - FMEA, Introduce Failures and Study Overall System Response
  - Process Variations, Shifts in Process Parameters



# Conclusion

- **Better Customer Relations**
  - Excellent Medium for Customer-Supplier Communications
- **Better Designs**
  - Optimize Design from Within the Overall System
- **Increased Reliability**
  - Better Understanding of Failure Modes
- **Reduced Cycle Time**
  - Work Up Front, Increases Probability Part Works 1st Time
- **Reduced Developmental Costs**