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# CCTA Test 10: Control System Verification

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## Objective

## Verify that the PID control system implemented within the MATLAB GUI can accurately respond to both flow and pressure setpoints, and that the system behavior (overshoot, settling time) remains within acceptable parameters under different starting conditions.

## Equipment Needed

Table 1: Test Apparatus

|  |  |
| --- | --- |
| Item | Purpose |
| Diaphragm pump (BYT-7A111) | Device under test |
| Flow meter | To measure flow (L/min) |
| Pressure transducer (max 300 mmHg) | To measure pressure (mmHg) |
| Power supply (0–12V DC) | To vary pump speed |
| Needle valve | To vary system resistance |
| Tubing (3/8 inch) + water | Pump setup |

## Test Procedure

1. **Set Up the System**
   * Connect the pump inlet and outlet with tubing.
   * Position the flow meter(s) and pressure transducer(s) at the desired test points within the system.
   * Ensure the system is filled with water and is leak-free.
2. **Activate PID Control**
   * Switch the GUI to PID control mode.
   * Enter a setpoint value for either flow or pressure.
   * Confirm setpoint acceptance via dotted line on GUI graph.
   * Observe and record the system’s response to each setpoint change.
3. **Data Collection**
   * For both flow and pressure, perform three distinct tests:
     + A large change from a high starting value to a low setpoint.
     + A large change from a low starting value to a high setpoint.
     + A small change between similar values.
   * Record overshoot and settling time for each test.

## Control Parameters

* **Flow Control PID Gains**
  + Kp = 5
  + Ki = 0.5
  + Kd = 0
* **Pressure Control PID Gains**
  + Kp = 0.18
  + Ki = 0.1
  + Kd = 0

## Test Results

**Flow**

Table 2: Flow Control Results

|  |  |  |  |
| --- | --- | --- | --- |
| Starting Value (L/min) | Setpoint (L/min) | Overshoot (L/min) | Settling Time (s) |
| 4.5 | 1.0 | 0.7 | 25 |
| 1.0 | 4.2 | 0.2 | 25 |
| 2.5 | 3.0 | 0.1 | 10 |

**Pressure**

Table 3: Pressure Control Results

|  |  |  |  |
| --- | --- | --- | --- |
| Starting Value (mmHg) | Setpoint (mmHg) | Overshoot (mmHg) | Settling Time (s) |
| 20 | 100 | 65 | 40 |
| 100 | 15 | 15 | 30 |
| 100 | 50 | 10 | 35 |

## Discussion

The flow control system performed well, showing minimal overshoot and consistent settling times across all tests. The largest overshoot observed was 0.7 L/min during a sharp decrease, but small step changes had little overshoot.

Pressure control was more aggressive, especially in large step changes. The test from 20 mmHg to 100 mmHg showed a 65 mmHg overshoot, indicating a need for further tuning. Smaller transitions resulted in more controlled responses with overshoots of 10–15 mmHg.