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PDEU PANDIT DEENDAYAL ENERGY UNIVERSITY

Formerly Pandit Deendayal Petroleum University (PDPU)

CENTRE OF EXCELLENCE STATUS BY GOVT. OF GUJARAT

SCHOOL OF ENERGY TECHNOLOGY

Department of Chemical Engineering

Name of Laboratory : Instrumentation process Control

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NAME OF EQUIPMENT :
Interacting And Non Interacting System

TECHNICAL SPECIFICATIONS :

- **Process Tanks**: 2-3 Nos., Material Stainless Steel or Acrylic, capacity 2.5–3.5 liters each, with graduated level scales.
- **Supply Tank:** Stainless Steel, 20-liter capacity.
- Overhead Tank: Stainless Steel, 5-liter capacity.
- **Water Circulation:** FHP (Fractional Horse Power) pump or centrifugal pump.
- **Flow Measurement:** Rotameter (e.g., 10-100 LPH) to measure inlet flow rate. Piping: SS or PVC pipes, typically
- **Control/Instrumentation:** Optional RF capacitance-type level transmitter (0-300mm), thyristor-based power driver for pump speed control, and electronic controller.
- **Dimensions:** Compact, tablet top
- **Process Parameters:** Primarily designed for Level-Flow, Flow-Level, or Temperature-Flow cascade control.

NAME OF EQUIPMENT :
Cascade Control Trainer

TECHNICAL SPECIFICATIONS :

- **Main Tank:** Transparent Acrylic or SS, typically 0-250 mm or 0-500 mm height, with graduated scale.
- **Supply Tank:** Stainless Steel (SS304), ~30 liters capacity.
- **Instrumentation & Sensors:**
- **Level Transmitter:** Capacitance or electronic type, 2-wire, 4-20 mA output.
- **Flow Measurement:** Orifice meter with differential pressure (DP) transmitter (4-20 mA) or a 0-1000 LPH Rotameter.
- **I/P Converter:** Input 4-20 mA, Output 3-15 psig.
- **Final Control Element:** Pneumatic Control Valve, Size 1/4" or 1/2", 3-15 psig, Air-to-Close, Linear or Equal Percentage characteristics.
- **Pump:** 1/4 HP, Single Phase, Centrifugal or Submersible.
- **Controller & Data Acquisition:**
- Controller: Digital PID controller with dual display (PV & SP).
- Communication: USB port via RS485-USB converter or RS232.
- Software: Optional SCADA or LabVIEW/MATLAB interface for data logging and analysis..

NAME OF EQUIPMENT :
Temperature Measurement

TECHNICAL SPECIFICATIONS :

- **Temperature Range:** Minimum to maximum temperatures the sensor can reliably measure (e.g., -200°C to 850°C for RTDs; up to 1700°C for thermocouples).
- **Accuracy & Tolerance:** Max permissible error per IEC 60751 (e.g., Class A or B for Pt100). Resolution: smallest detectable change, typically 0.1°C or better.
- **Response Time:** Time for sensor to reach a specified percentage of final temperature, critical for dynamic processes.

Sensor Type & Configuration:

  - **RTD:** 2, 3, or 4-wire connections (4-wire most stable).
  - **Thermocouple:** Chosen based on temperature range and environmental conditions.

- **Output Signal:** Analog (4–20 mA, 0–10 V) or Digital (HART, Modbus) for transmitting data to control systems.
- **Immersion Length & Diameter:** Physical probe dimensions such as diameter and insertion length.
- **Material & Protection:** Thermowell material (e.g., SS316) and IP rating for environmental sealing.

NAME OF EQUIPMENT :
Flapper-Nozzle System

TECHNICAL SPECIFICATIONS :

- **Operating Principle:** Pneumatic amplification — converts mechanical position to output pressure.
- **Input Motion:** Micrometer/mechanical linkage (low displacement).
- **Output Pressure Range:** Typically 3–15 psig (pneumatic standard).
- **Supply Pressure:** Typically 20 psig (regulated).
- **Sensitivity:** High — significant output changes for minute flapper gap variations.
- **Response Time:** Very fast; near-instantaneous pneumatic response.
- **Accuracy:** Designed for 100% pneumatic accuracy in lab settings.
- **Components:** Nozzle, flapper, nozzle-flapper gap, restrictor/orifice, air filter regulator, and pressure gauges.
- **Dimensions:** Compact, tabletop unit.

NAME OF EQUIPMENT :
First And Second Order System

TECHNICAL SPECIFICATIONS :

- **First-Order System:** Step response of a mercury-in-glass thermometer (–10°C to 100°C) or thermowell response.
- **Second-Order System:** Step response of a U-tube manometer; two manometers with different IDs (e.g., 5 mm Hg, 22 mm water) to study damping effects.
- **Heating Elements:** SS304 heating bath with 3 kW electrical heater and cyclic timer for heater operation.
- **Pneumatic Components:** Diaphragm-type mini compressor for pressure-based input signals.
- **Control Unit:** Digital temperature indicator, beeper with 2–10 s time range, manual/auto switches.

Experiments Supported:

- **Thermometer Dynamics:** Bare vs. thermowell time-constant measurement.
- **Manometer Response:** Underdamped/overdamped/critically damped oscillations.
- **Frequency Response:** Sinusoidal input analysis.

NAME OF EQUIPMENT :
Pressure Control Trainer

TECHNICAL SPECIFICATIONS :

- **Process Vessel:** SS or MS tank, typically 150 mm dia × 300 mm length.
- **Pressure Sensor/Transmitter:** 2-wire, 4–20 mA, range 0–2.5 bar or 0–100 psi.
- **Control Unit:** Digital PID controller with optional USB/Ethernet SCADA software.
- **Actuator/Valve:** Pneumatic globe valve (1/4" or 1/2") with diaphragm actuator, 3–15 psig, air-to-close.
- **Pressure Source:** Internal/external oil-free compressor (~6 bar) or hand pump.
- **Air Regulator/Gauge:** 0–2.5 kg/cm² regulator; 0–7 kg/cm² pressure gauges.
- **Control Options:** On/Off, P, PI, PID; manual/auto tuning.
- **Safety:** Safety relief valve and non-return valve.
- **Software:** Windows-based SCADA with live data, trend graphs, and data export.
- **Dimensions:** Approx. 550W × 480D × 525H mm. Compressor: 1 HP miniature.

NAME OF EQUIPMENT :
Control Valve Characteristics

TECHNICAL SPECIFICATIONS :

Inherent Flow Characteristics:

- **Linear:** Flow directly proportional to travel; best for constant pressure-drop systems.
- **Equal Percentage:** Equal travel increments give equal % changes in flow; used for non-linear systems.
- **Quick Opening:** Large flow change at low travel; used for on/off control.

- **Installed Flow Characteristic:** Relationship between flow and travel in actual system with varying pressure drops.
- **Flow Coefficient (Cv):** Per ISA 75.01 — flow capacity (GPM) of water at 60°F with 1 psi drop.
- **Rangeability:** Ratio of max to min controllable flow; minimum 30:1 typically required.
- **Noise Levels:** Managed per ISA 75.17; anti-noise trim required for high ΔP applications.
- **Materials & Connections:** Body/trim matched to fluid; ASME B16.5 RF flanged connections.
- **Optimal Opening:** Target 30%–70% open for effective control range.

NAME OF EQUIPMENT :
Multi-Process Trainer

TECHNICAL SPECIFICATIONS :

- **System Type:** Compact tabletop or sturdy MS powder-coated skid-mounted unit.
- **Process Tanks:** Transparent acrylic level tanks (e.g., 150 mm × 500 mm H); SS304 sump/supply tanks (~15–30 L).
- **Sensors & Transmitters:** 2-wire electronic transmitters for Level (capacitance, 0–500 mm), Pressure (piezo-resistive), Flow (turbine/orifice), Temperature (RTD Pt100).
- **Actuators & Valves:** Pneumatic control valve (1/4" or 1/2", 3–15 psig, air-to-close) with I/P converter.
- **Pump:** Submersible or centrifugal FHP pump (1/4 HP, 230 V AC).
- **Control Loop:** Digital or PC-based PID controller, PLC (Siemens/Omron/Schneider), or SCADA with HMI and tuning.
- **Utilities:** 230 V AC, 1-phase; oil-free compressed air at 2.1 kg/cm²
- **Optional Accessories:** Miniature air compressor (2 CFM, 5–6 kg/cm²); SCADA with online data acquisition and GUI; PLC/HMI system.