TECHNICAL SOLUTIONS
industrial technology

POLYTECHNIC TRAINING EQUIPMENT & LABORATORY SOLUTIONS

Engineering-led training laboratories for
Libya's technical education future

POWER SYSTEMS

ENGINES & TURBINES

PROCESS CONTROL

FLUID MECHANICS

SOLAR PV

We assess. | We engineer. | We procure. | We install. | We commission. | We train. | We support.

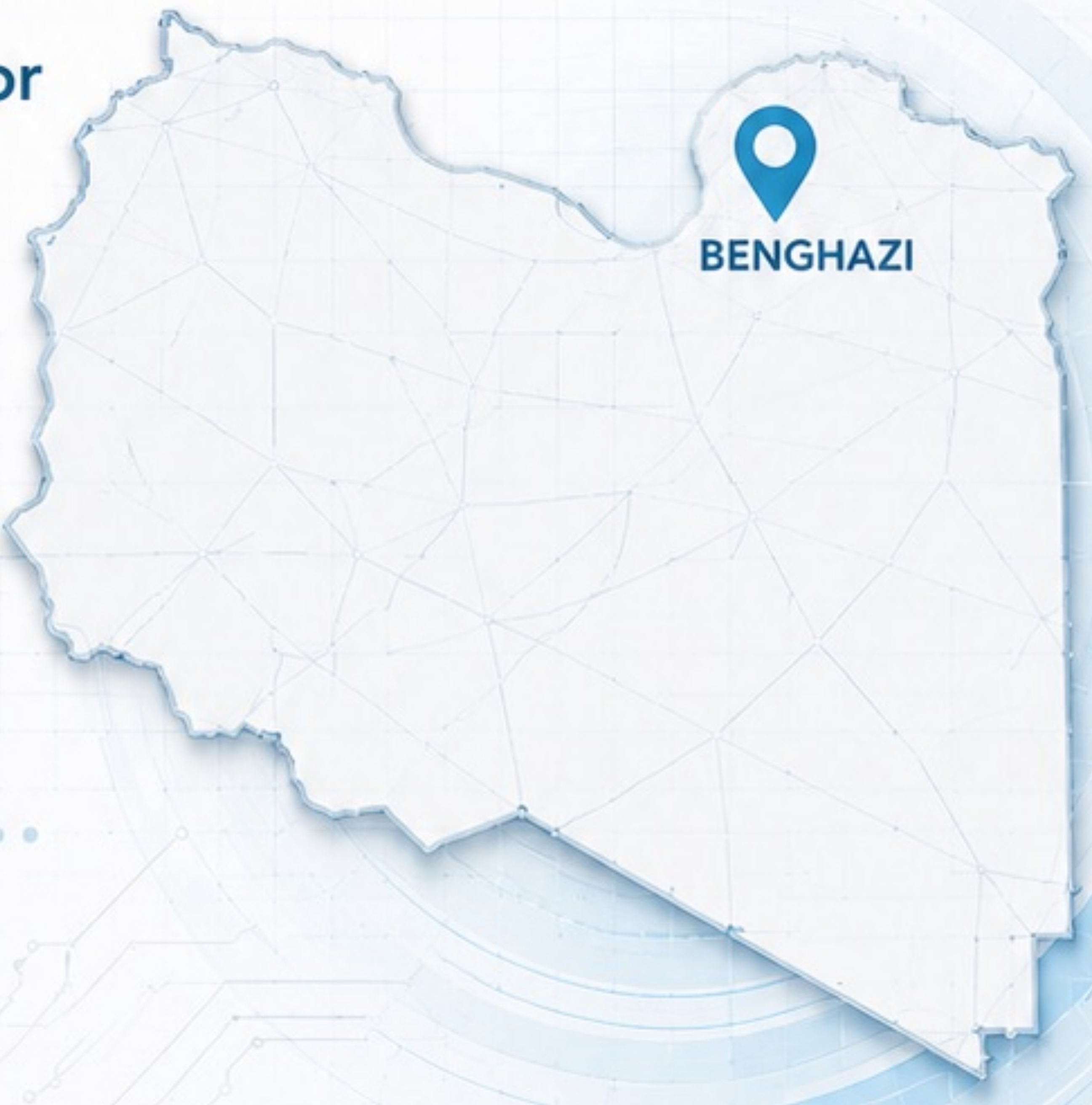
Power Systems • Engines & Turbines • Process Control • Fluid Mechanics • Solar PV

INTRODUCTION TO TECHNICAL SOLUTIONS

A Libyan engineering partner for practical technical education

Technical Solutions supports industrial, educational and infrastructure clients with engineering-led solutions built for real operating conditions.

For polytechnic education, we deliver complete learning environments — not isolated equipment.



- PLANNING
- EQUIPMENT SELECTION
- PROCUREMENT
- INSTALLATION
- COMMISSIONING
- TRAINING
- MAINTENANCE

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SAFETY BY DESIGN | ENGINEERED SOLUTIONS | INTEGRATED SYSTEMS | LIFECYCLE SUPPORT

COMPLETE LABORATORY DELIVERY

From equipment supply to sustainable training facilities

Technical Solutions develops laboratories as complete teaching environments.
We consider curriculum, student flow, safety, utilities, maintenance access, instructor readiness and long-term support.

Designed for universities, polytechnics, vocational institutes and industrial training centers.

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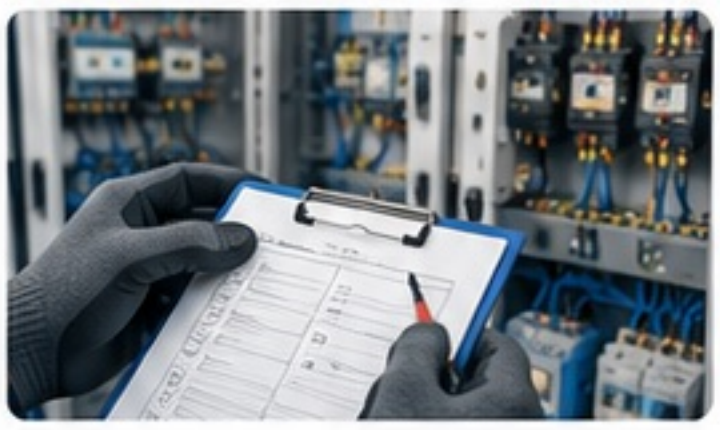
TRAINING & CONTINUOUS MAINTENANCE SERVICES

Keeping laboratories operational, safe and ready for teaching

Technical Solutions supports institutions beyond delivery through preventive maintenance, troubleshooting, inspection, spare parts planning and academic-term readiness support.

Reduce downtime. Protect equipment value. Support continuous practical teaching.

PREVENTIVE MAINTENANCE



- Regular inspection and testing
- Performance verification
- Early issue detection
- Extended equipment life

SPARE PARTS PLANNING

- Critical spare parts identification
- Stock level recommendations
- Availability planning
- Reduced downtime risk

LABORATORY READINESS

- Academic-term readiness checks
- Equipment functionality review
- Safety verification
- Operational readiness reports

Inspection | Calibration Support | Troubleshooting | Consumables | Spare Parts | Refresher Training

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TRAINING OF TRAINERS

Building instructor capability for long-term laboratory success

Technical Solutions prepares instructors to operate equipment confidently, deliver practical sessions safely and guide students through meaningful engineering experiments.

Operate

Equip instructors with hands-on equipment skills and safe operating practices.

Teach

Develop effective teaching methods and experiment delivery strategies.

Troubleshoot

Build diagnostic skills to identify issues and restore system performance.

Assess

Apply assessment techniques to evaluate student learning outcomes.

Maintain

Ensure instructors can maintain equipment and extend lab life.

CURRICULUM ALIGNMENT

Training can be aligned by curriculum, module, semester or competency level.

- CURRICULUM
- MODULE
- SEMESTER
- COMPETENCY LEVEL

- PRACTICAL EXPERIENCE
- SAFETY FOCUSED
- LEARNING OUTCOMES
- INSTRUCTOR CONFIDENCE
- SUSTAINABLE LAB OPERATION

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POWER SYSTEMS & ELECTRICAL GRIDS

Understanding the complete electrical network

Generation · Synchronization · Transformers · Transmission

Distribution · Protection · Switching · Power Electronics

Delivered by Technical Solutions as a complete turnkey training laboratory.

SALIENT POLE GENERATOR

TRANSFORMER TRAINER

TRANSMISSION LINE SIMULATOR

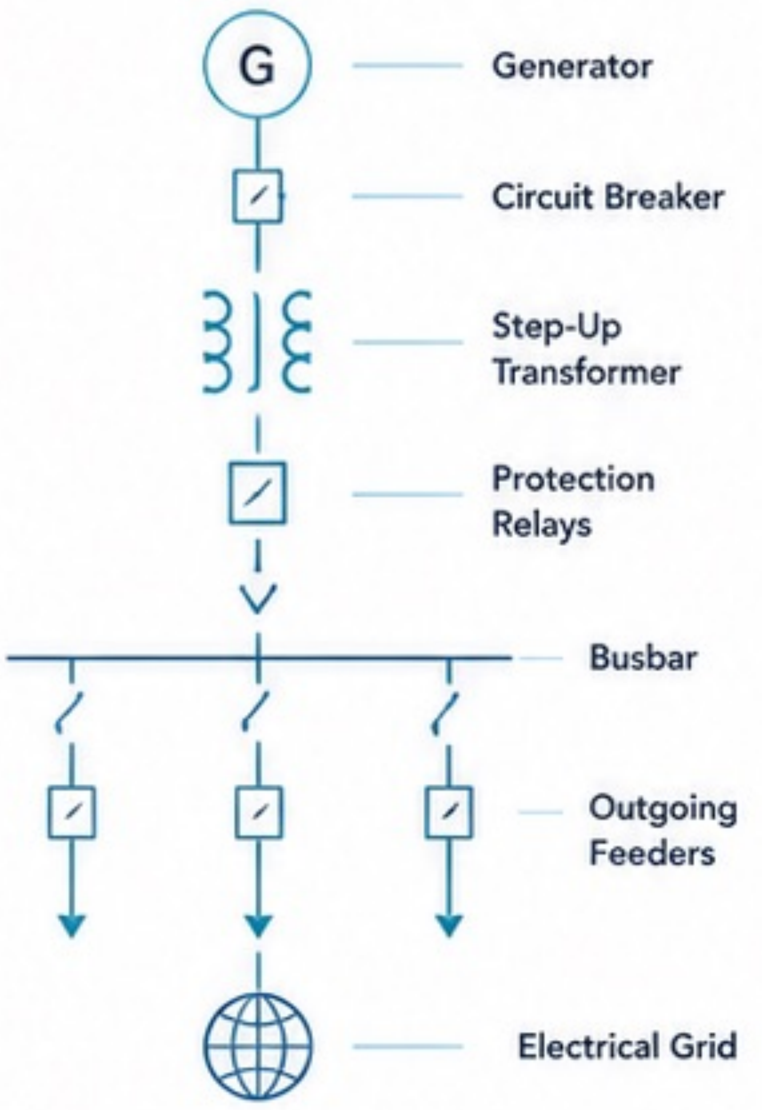
DISTRIBUTION TRAINER

ELECTRICAL GENERATION, SYNCHRONIZATION & LOAD SHARING

From rotating machines to grid connection

Students investigate generator behavior, excitation, terminal voltage, frequency, real power, reactive power and load response.

GENERATOR TO GRID – SINGLE LINE DIAGRAM



SALIENT POLE SYNCHRONOUS GENERATOR TRAINER

- EXCITATION CONTROL
- VOLTAGE & FREQUENCY MEASUREMENT
- REAL & REACTIVE POWER
- SYNCHRONIZATION TRAINING
- PARALLEL OPERATION & LOAD SHARING

Practical skills developed

- Generator operation
- Voltage and frequency control
- Synchronization
- Parallel operation
- Load sharing
- Safe operating discipline

Technical Solutions integrates generation training into the wider power systems laboratory.

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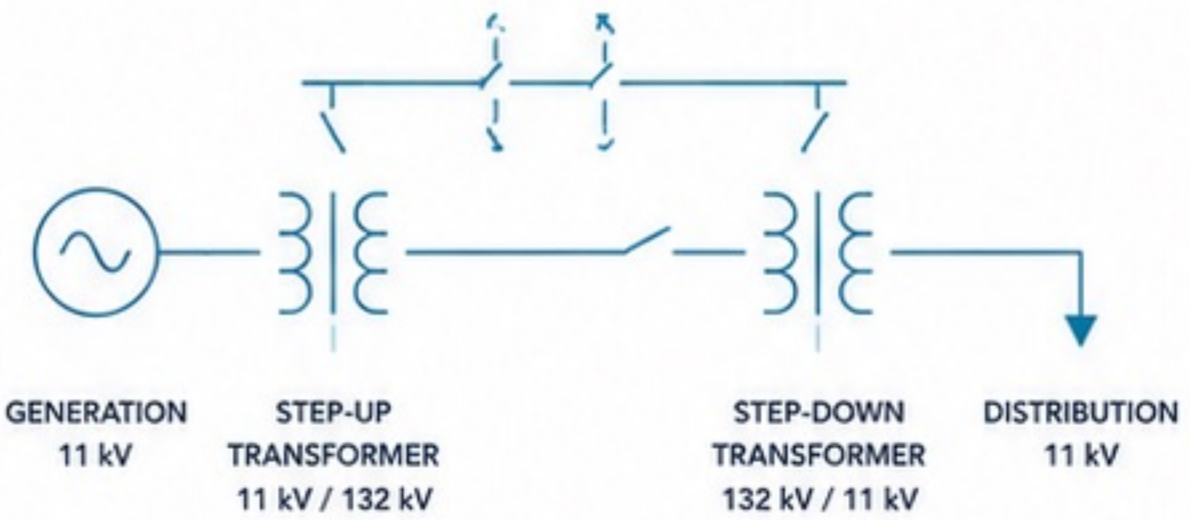
TRANSFORMERS & SUBSTATION FUNDAMENTALS

Understanding the equipment behind transmission and distribution

Students study voltage transformation, current relationship, polarity, loading, efficiency, losses and voltage regulation.

THREE-PHASE TRANSFORMER TRAINER

SUBSTATION VOLTAGE TRANSFORMATION



11 kV
LOW VOLTAGE

STEP-UP
→
STEP-DOWN

132 kV
HIGH VOLTAGE

THREE-PHASE MOBILE TRANSFORMER

Practical skills developed

- Transformer connections
- Voltage ratio
- Three-phase operation
- Efficiency calculation
- Load testing
- Substation awareness

Technical Solutions connects transformer training to real power system applications.

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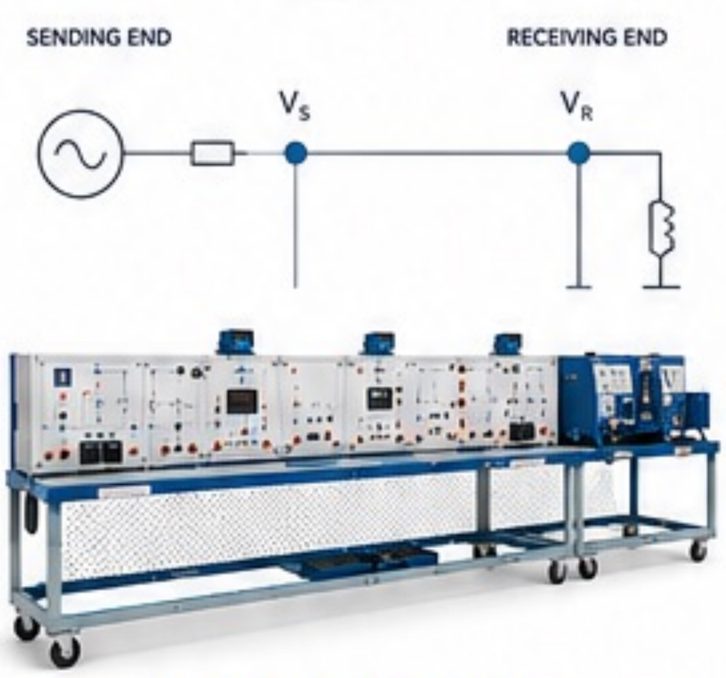
TRANSMISSION LINE SIMULATION

Teaching power flow, voltage drop and network losses

Students observe how load current, power factor and line impedance affect voltage regulation, losses and efficiency.

TRANSMISSION LINE MODELS

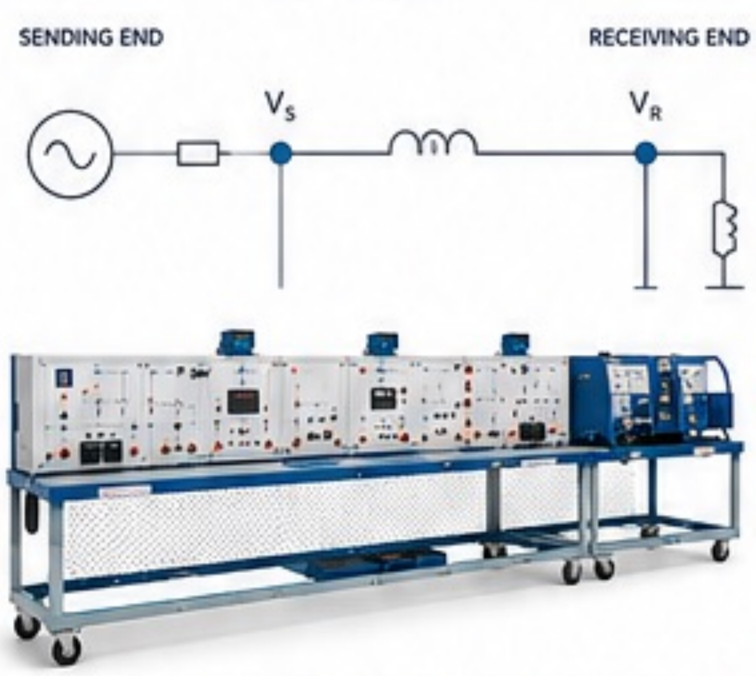
SHORT LINE MODEL
(< 80 km)



MEASUREMENT POINTS

- Sending end voltage (V_S)
- Receiving end voltage (V_R)
- Line current (I)
- Real & reactive power (P, Q)

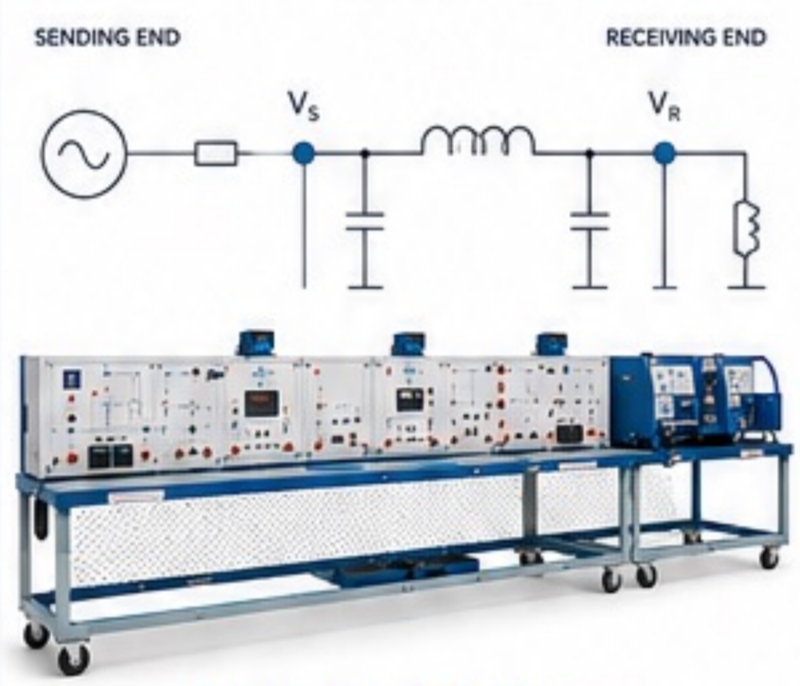
MEDIUM LINE MODEL
(80 – 250 km)



MEASUREMENT POINTS

- Sending end voltage (V_S)
- Receiving end voltage (V_R)
- Line current (I)
- Real & reactive power (P, Q)

LONG LINE MODEL
(> 250 km)



MEASUREMENT POINTS

- Sending end voltage (V_S)
- Receiving end voltage (V_R)
- Line current (I)
- Real & reactive power (P, Q)

PRACTICAL SKILLS DEVELOPED

- Transmission line modeling
- Voltage drop measurement
- Line regulation
- Power loss calculation
- Power factor effects
- Three-phase analysis

Technical Solutions helps students connect theory with measurable grid behavior.

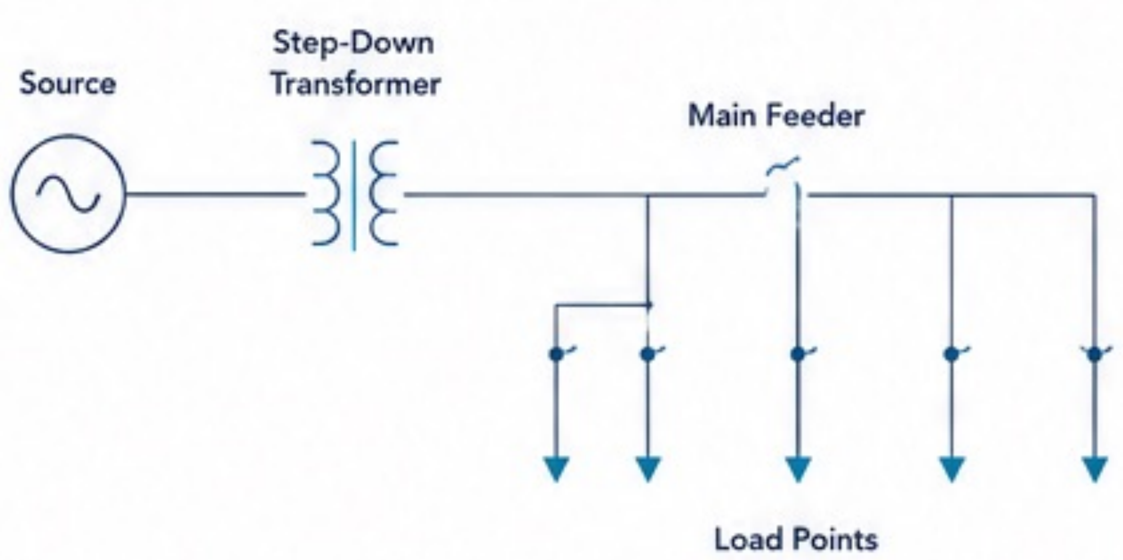
DISTRIBUTION NETWORKS & LOAD MANAGEMENT

Delivering power safely and reliably to end users

Students study transformer-fed distribution, radial feeders, ring-main networks, load points, voltage regulation and efficiency.

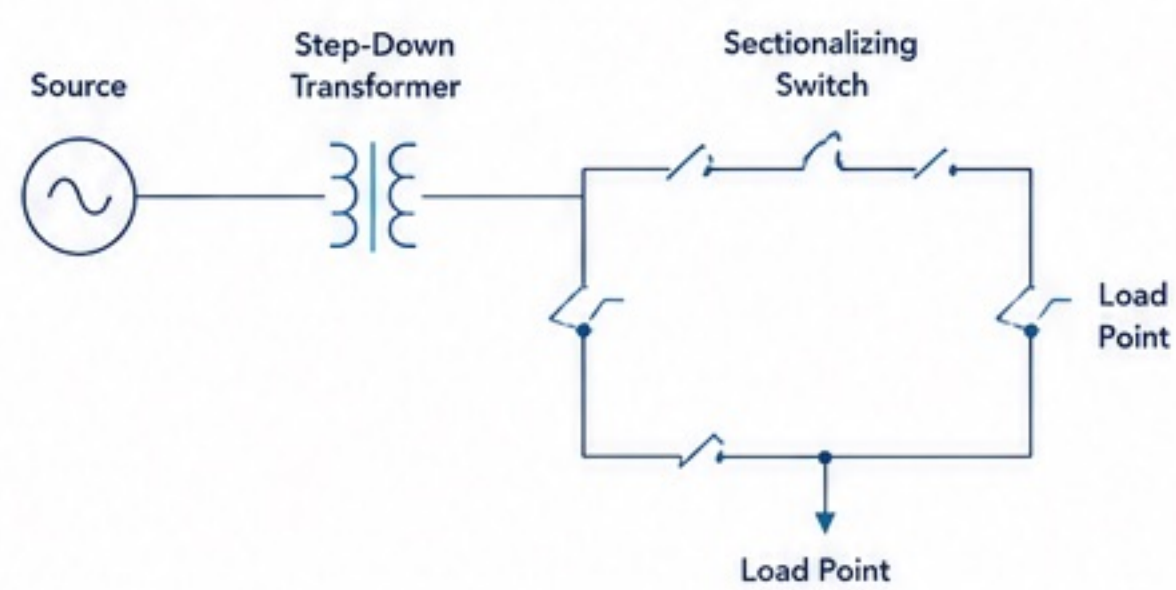
DISTRIBUTION TRAINER

RADIAL FEEDER NETWORK



- Single path power flow
- Simple, low cost
- Easy fault identification
- Suitable for rural & urban networks

RING-MAIN NETWORK



- Multiple paths for power
- Higher reliability and resilience
- Fault isolation capability
- Improved service continuity

PRACTICAL SKILLS DEVELOPED

- Distribution configuration
- Load management
- Voltage regulation
- Fault isolation awareness
- Distribution efficiency
- Service continuity

Technical Solutions designs distribution training around real utility and industrial needs.

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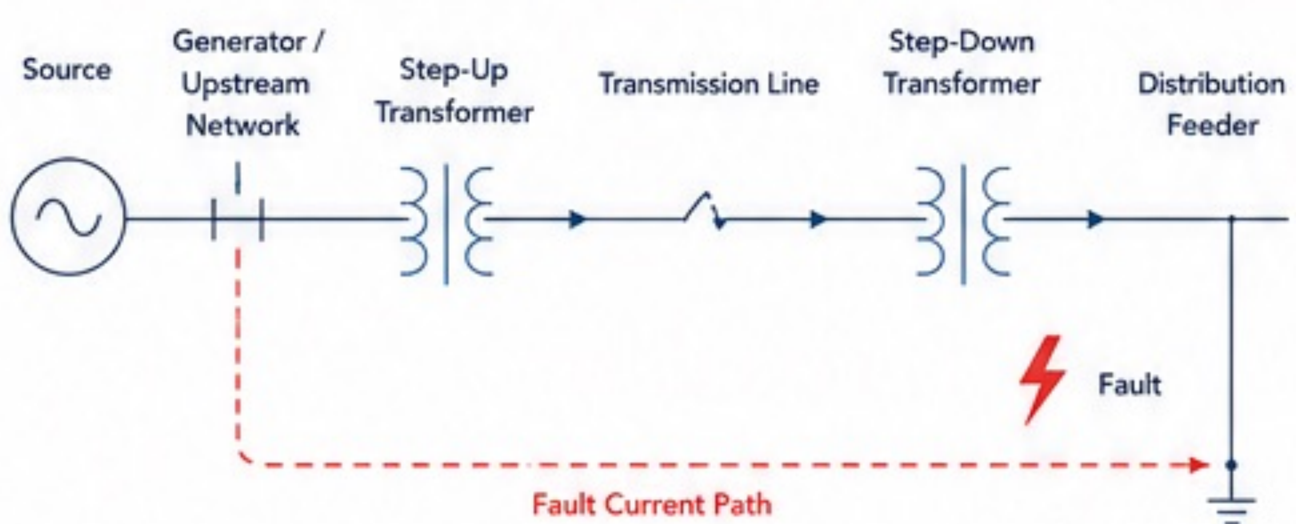
PROTECTION RELAYS & FAULT STUDIES

Developing competence in electrical safety and reliability

Students learn how abnormal conditions are detected and how only the affected part of the network is isolated.

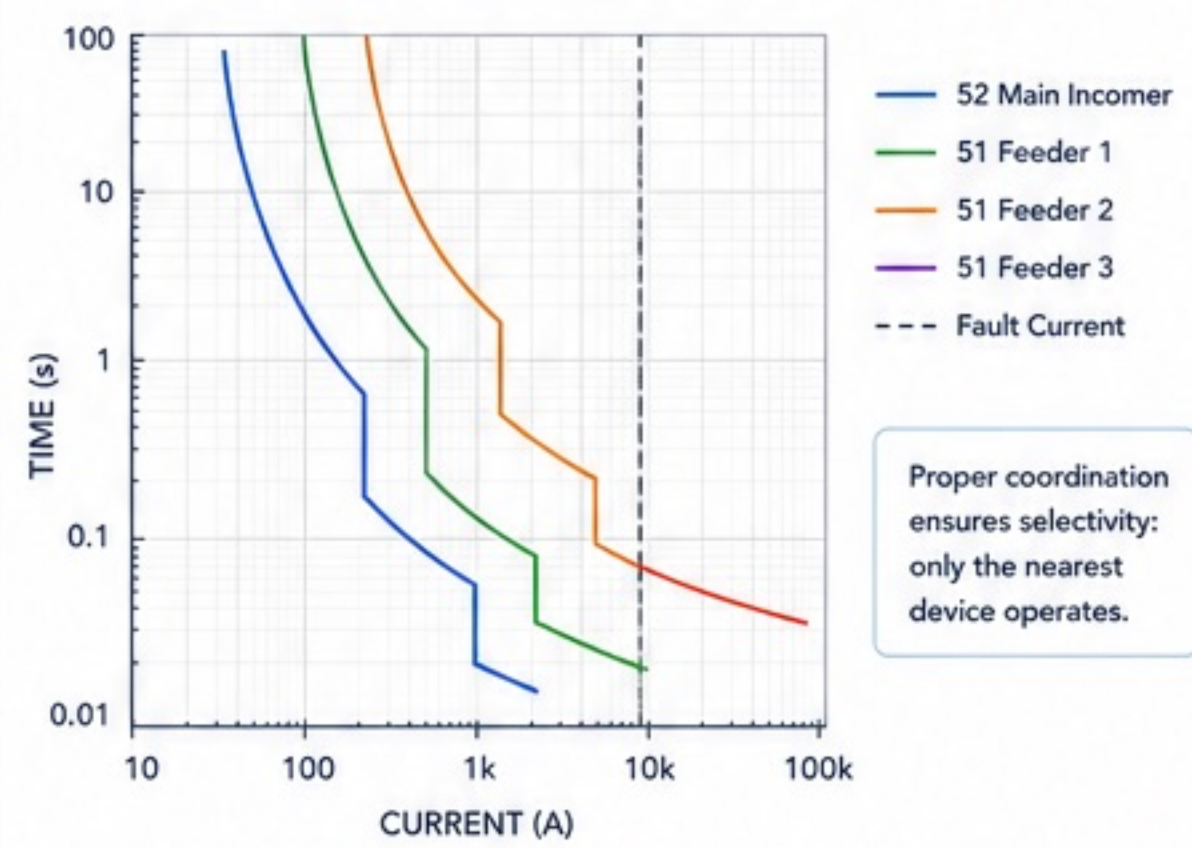
PROTECTION RELAY TEST SET

FAULT CURRENT PATH (EXAMPLE)



- High fault current flows
- Relays detect the fault
- Circuit breaker opens
- Only the affected section is isolated
- System remains in operation

TIME–CURRENT COORDINATION CURVE (TCC)



Proper coordination ensures selectivity: only the nearest device operates.

PRACTICAL SKILLS DEVELOPED

- Fault identification
- Relay operation
- Protection settings
- Overcurrent protection
- Earth fault protection
- Coordination principles

Technical Solutions teaches protection as part of a complete electrical system.

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CIRCUIT BREAKERS, SWITCHING & BUSBAR SYSTEMS

Safe switching and controlled network operation

Students compare protection devices, study breaker response, examine switching sequences and understand busbar arrangements.

CIRCUIT BREAKER TRAINER

- Protection study
- Breaker response
- Operation practice

SWITCHED BUSBAR MODULE

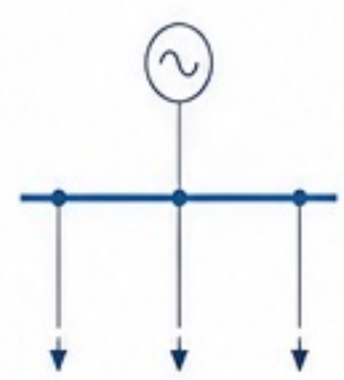
- Busbar arrangements
- Safe isolation
- Controlled operation

TYPICAL SWITCHING SEQUENCE

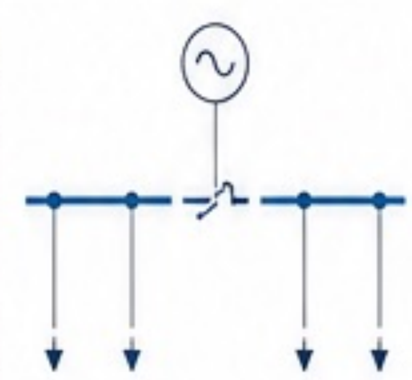
1. OPEN CIRCUIT BREAKER →
2. ISOLATE & EARTH →
3. PERFORM WORK →
4. RE-INSTATE EARTHING →
5. CLOSE CIRCUIT BREAKER

⚠ Always follow correct switching sequence for safety.

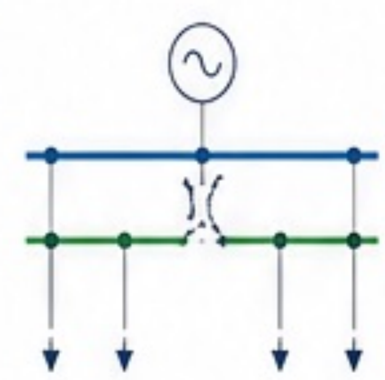
SAMPLE BUSBAR ARRANGEMENTS



SINGLE BUSBAR



SECTIONALIZED BUSBAR



MAIN & TRANSFER BUSBAR

PRACTICAL SKILLS DEVELOPED

- Circuit breaker operation
- Isolation principles
- Switching procedures
- Busbar arrangements
- Fault interruption awareness
- Electrical safety discipline

SAFE ISOLATION PRINCIPLES

Identify all energy sources › Open all isolators › Apply earthing where required › Lock out and tag out › Verify zero energy state › Proceed with work safely

Technical Solutions builds safe operating discipline into the laboratory environment.

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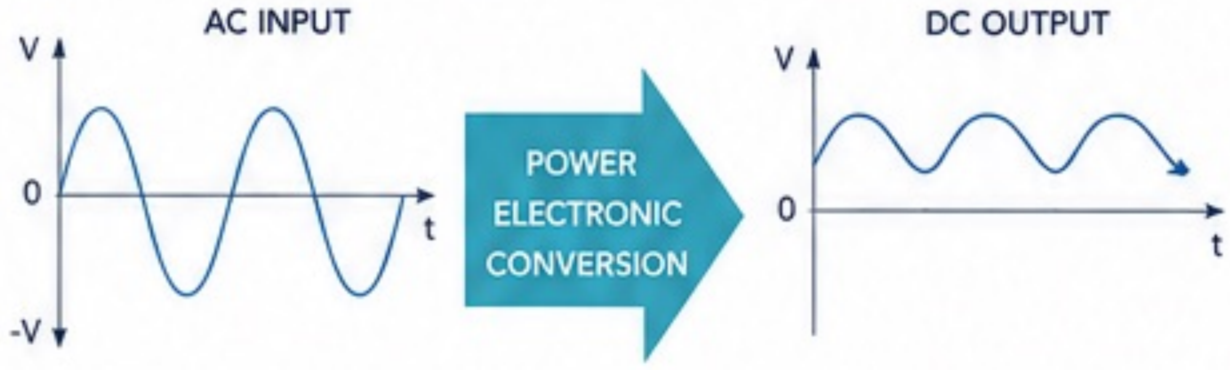
POWER ELECTRONICS FOR GRID & INDUSTRIAL APPLICATIONS

Modern energy conversion and electrical control

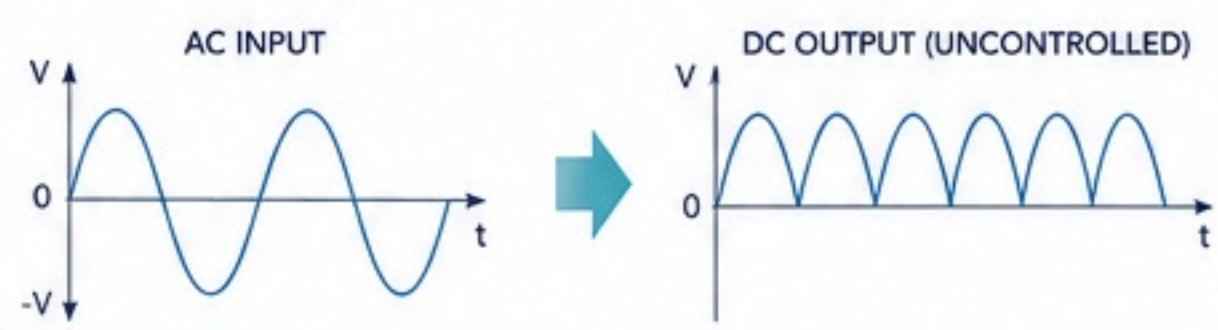
Students investigate diode converters, thyristor converters, controlled rectification, waveform behavior, ripple and conversion efficiency.

THYRISTOR & DIODE CONVERTER TRAINER

AC TO DC CONVERSION



DIODE BRIDGE RECTIFIER WAVEFORM



THYRISTOR CONTROLLED RECTIFIER WAVEFORM

PRACTICAL SKILLS DEVELOPED

- Rectifier operation
- Controlled conversion
- Waveform analysis
- Output control
- Ripple observation
- Industrial application awareness

POWER ELECTRONICS IN MODERN ENERGY SYSTEMS

- SOLAR PV SYSTEMS
- BATTERY STORAGE
- MOTOR DRIVES & VARIABLE SPEED
- INDUSTRIAL AUTOMATION
- GRID SUPPORT & POWER QUALITY
- ENERGY EFFICIENCY

Technical Solutions connects power electronics to solar PV, battery storage, drives and automation.

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INTEGRATED GRID OPERATION & SYSTEM-LEVEL LEARNING

Connecting generation, transmission, distribution and protection

Students learn how decisions in one part of the network affect the complete electrical system.

1 GENERATION
Salient Pole Generator Trainer

2 TRANSFORMATION
Transformer Trainer

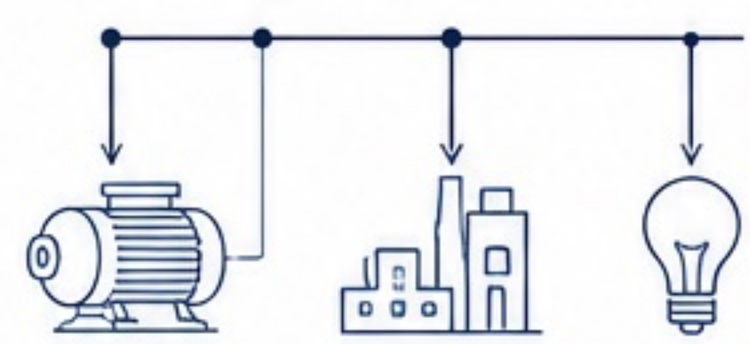
3 TRANSMISSION
Transmission Line Simulator

4 DISTRIBUTION
Distribution Trainer

LEGEND
- Power Flow
- Control / Communication
- Transformer
- Transmission Line
- Bus / Connection
- AC Source
- Power Flow Direction

5 PROTECTION
Protection Relay Test Set

6 LOADS
Industrial & Commercial Loads



INTEGRATED EXERCISES

- Generator-to-load operation
- Voltage regulation
- Distribution switching
- Fault response
- Load sharing
- Relay coordination
- Technical reporting

Technical Solutions develops power laboratories as complete training systems.

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POWER SYSTEMS LABORATORY DELIVERED BY TECHNICAL SOLUTIONS

A complete training environment for electrical power education

Technical Solutions supports curriculum review, equipment selection, laboratory layout, electrical requirements, safety planning, procurement, installation, commissioning and instructor training.

Designed for technical colleges, utilities, industrial maintenance teams and workforce development programs.

Expandable. Practical. Safe. Sustainable.

IMPLEMENTATION PACKAGE

1. CURRICULUM REVIEW
Aligning laboratory capabilities with learning outcomes.

2. LABORATORY LAYOUT
Optimized space planning for safety, access and workflow.

3. EQUIPMENT SELECTION
High-quality, practical systems for real-world learning.

4. INSTALLATION & COMMISSIONING
Professional installation, testing and system verification.

5. INSTRUCTOR TRAINING
Comprehensive training for confident and effective teaching.

6. SUPPORT & AFTERCARE
Ongoing technical support and continuous improvement.

EXPANDABLE
Systems that grow with your needs and future technologies.

PRACTICAL
Hands-on learning with industry-relevant equipment and exercises.

SAFE
Designed with electrical safety as the tcop priority.

SUSTAINABLE
Energy-efficient solutions for a sustainable future.

MEASURABLE OUTCOMES
Improved skills, confidence and workforce readiness.

Partner with Technical Solutions to deliver powerful learning experiences and build a skilled, future-ready workforce.

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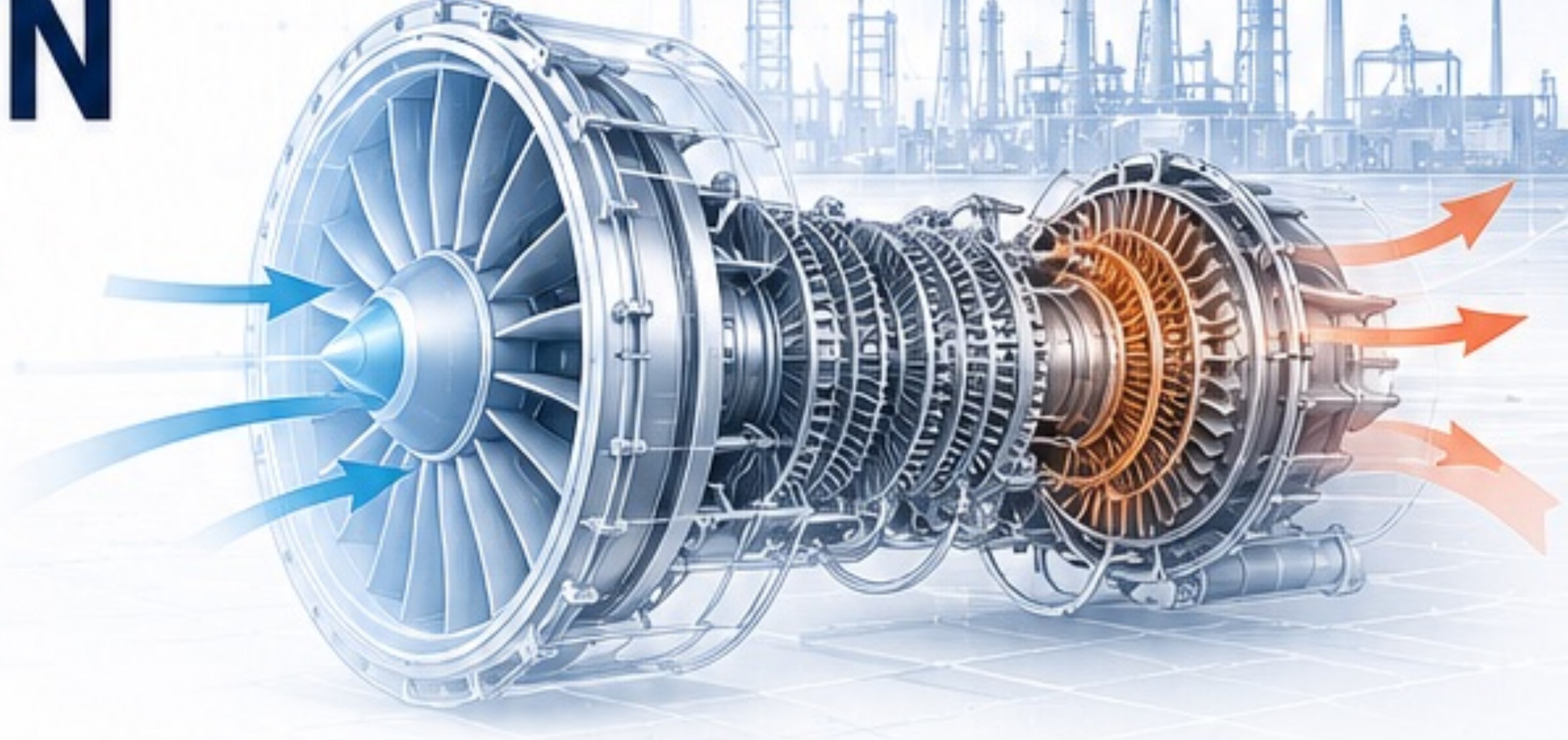
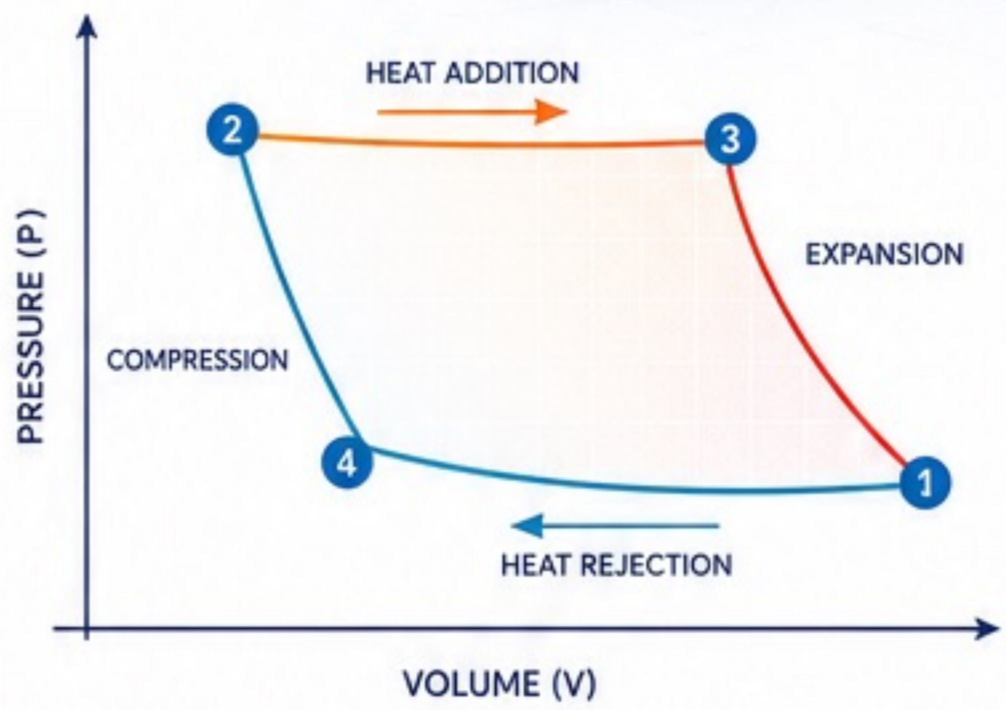
COMBUSTION ENGINES & TURBINES



Practical training in energy conversion and rotating machinery



THERMODYNAMIC CYCLE

- Compression
- Heat addition
- Expansion
- Heat rejection

Engine Test Beds	Petrol & Diesel Engines	Fuel Measurement	Exhaust Energy	Gas Turbines	Turbojet Principles	Safety Culture

REGENERATIVE ENGINE TEST SET

TURBOJET TRAINER

TWO-SHAFT GAS TURBINE

Delivered by Technical Solutions as a complete mechanical energy training laboratory.

INTERNAL COMBUSTION ENGINE TEST BEDS

Measuring real engine performance

Students measure speed, torque, brake power, fuel consumption, airflow and efficiency under controlled operating conditions.

REGENERATIVE ENGINE TEST SET

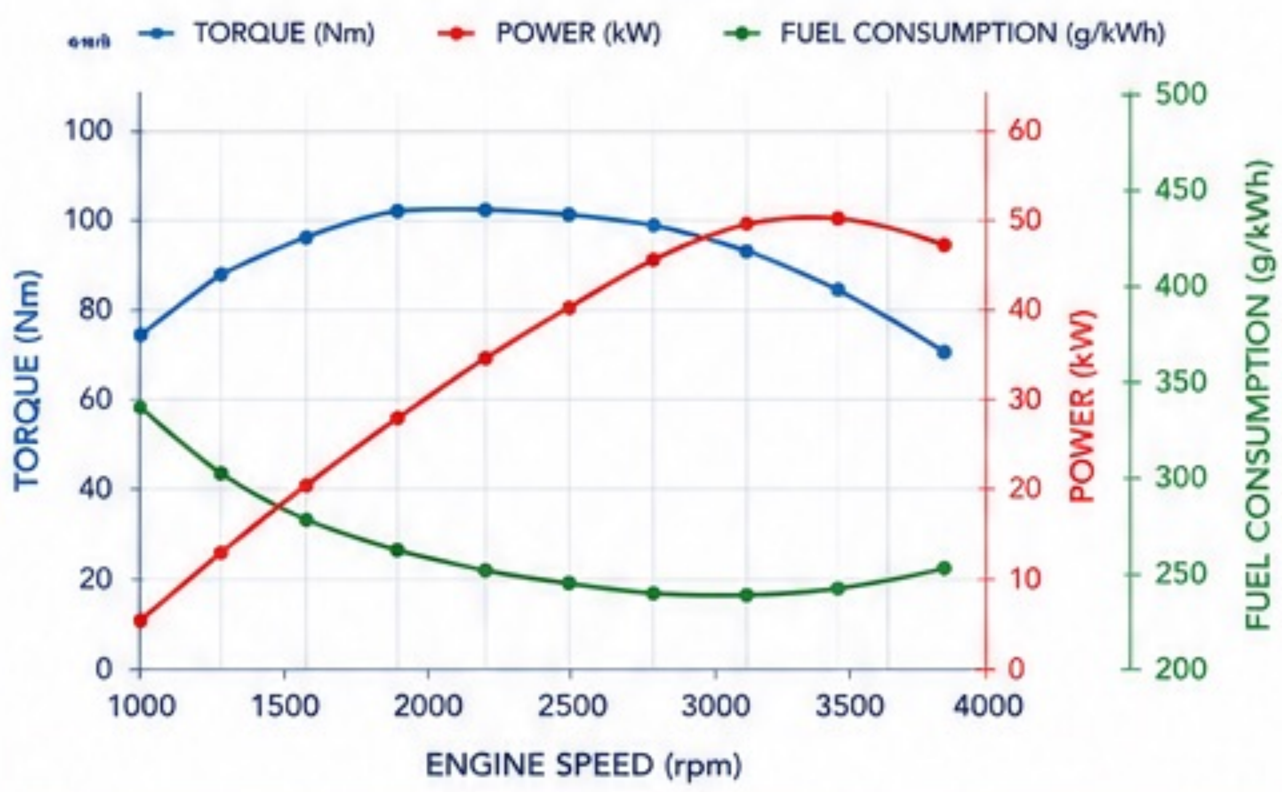
FOUR-STROKE PETROL ENGINE

Fuel Type	Petrol
Typical Power	5 – 7 kW
Speed Range	1000 – 4000 rpm
Measurements	Torque, Power, Fuel, Airflow

FOUR-STROKE DIESEL ENGINE

Fuel Type	Diesel
Typical Power	5 – 7 kW
Speed Range	1000 – 4000 rpm
Measurements	Torque, Power, Fuel, Airflow

ENGINE PERFORMANCE CURVES (TYPICAL)



- Test Accuracy
- Repeatable Results
- Real-World Data
- Safe Operation

PRACTICAL SKILLS DEVELOPED

- Engine starting and loading
- Torque measurement
- Power calculation
- Fuel consumption
- Petrol and diesel comparison
- Performance curves
- Safe engine operation

Technical Solutions plans engine laboratories with ventilation, exhaust handling and safety procedures.

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FUEL, AIRFLOW & EXHAUST ENERGY BALANCE

Understanding efficiency and energy losses

Students examine how fuel energy enters an engine, how much becomes useful mechanical work and how much is lost through exhaust, cooling and friction.

EXHAUST GAS CALORIMETER

- Exhaust Temperature
- Heat Flow Measurement
- Energy Loss Analysis

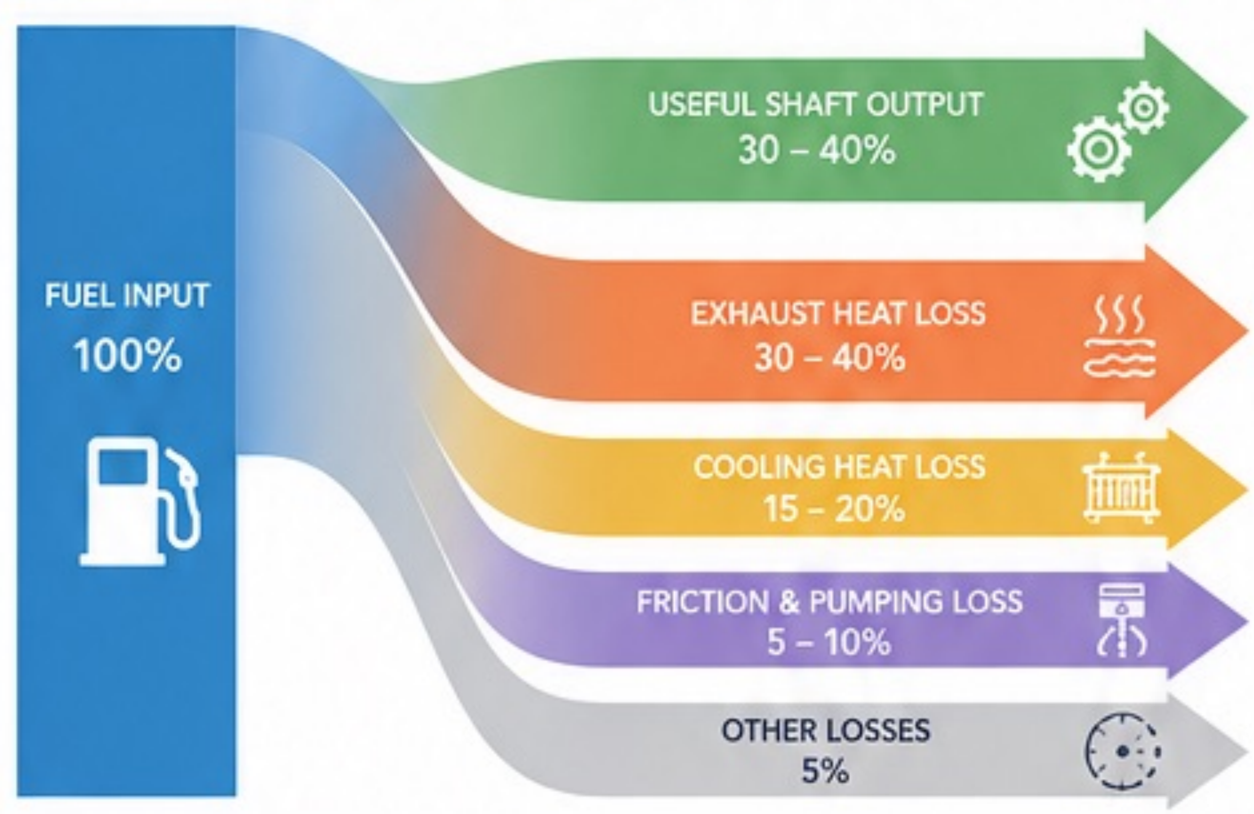
AUTOMATIC VOLUMETRIC FUEL GAUGE

- Accurate Fuel Measurement
- Real-Time Flow Rate
- Usage Recording

ENGINE DATA ACQUISITION

- Real-Time Data
- Performance Trends
- Data Logging & Export
- Diagnostics Support

ENGINE ENERGY BALANCE (TYPICAL)



Efficiency improves when losses are reduced and useful output is increased.

PRACTICAL SKILLS DEVELOPED

- Fuel flow measurement
- Airflow measurement
- Exhaust heat analysis
- Energy balance
- Specific fuel consumption
- Thermal efficiency
- Diagnostics awareness

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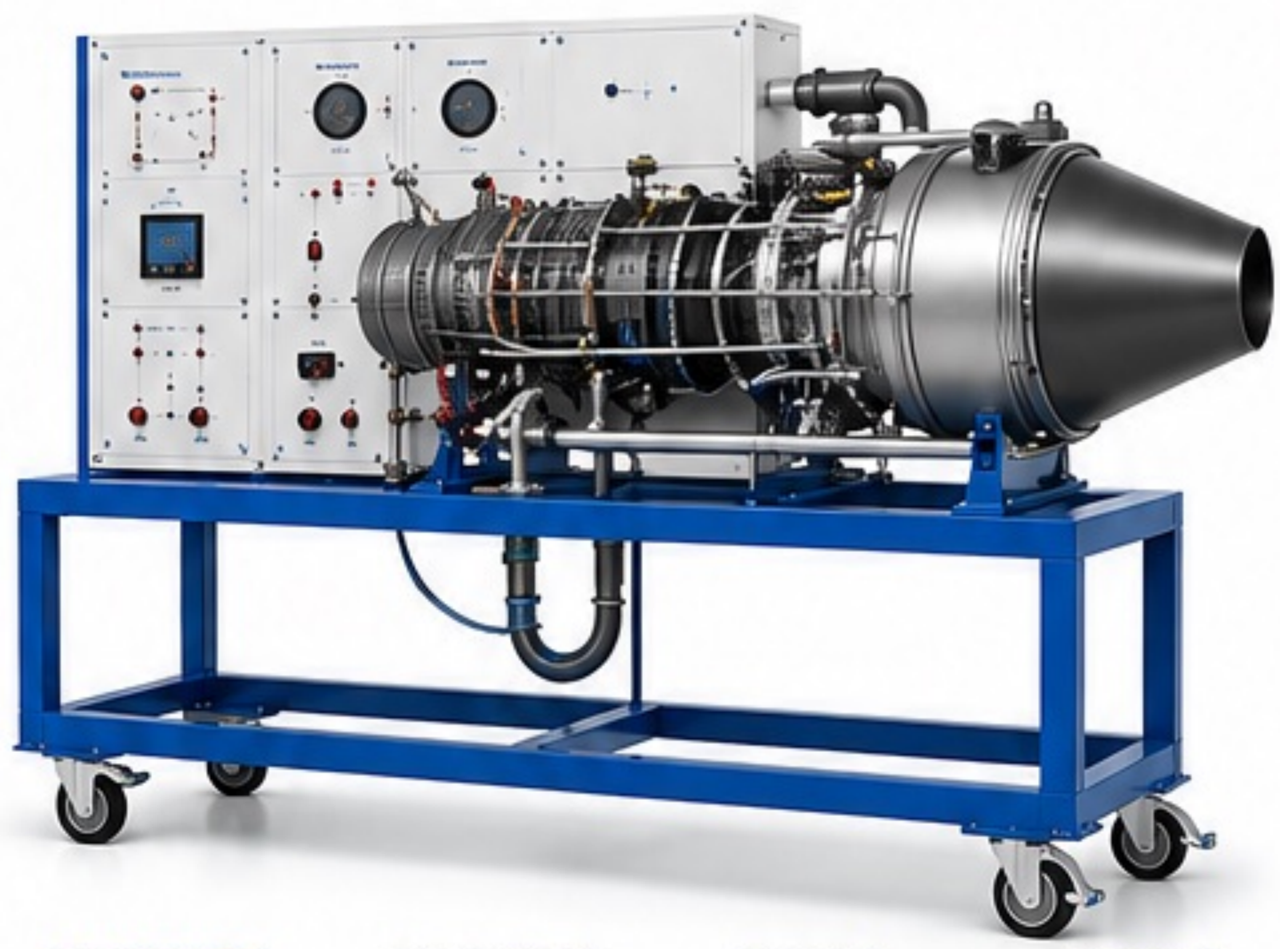
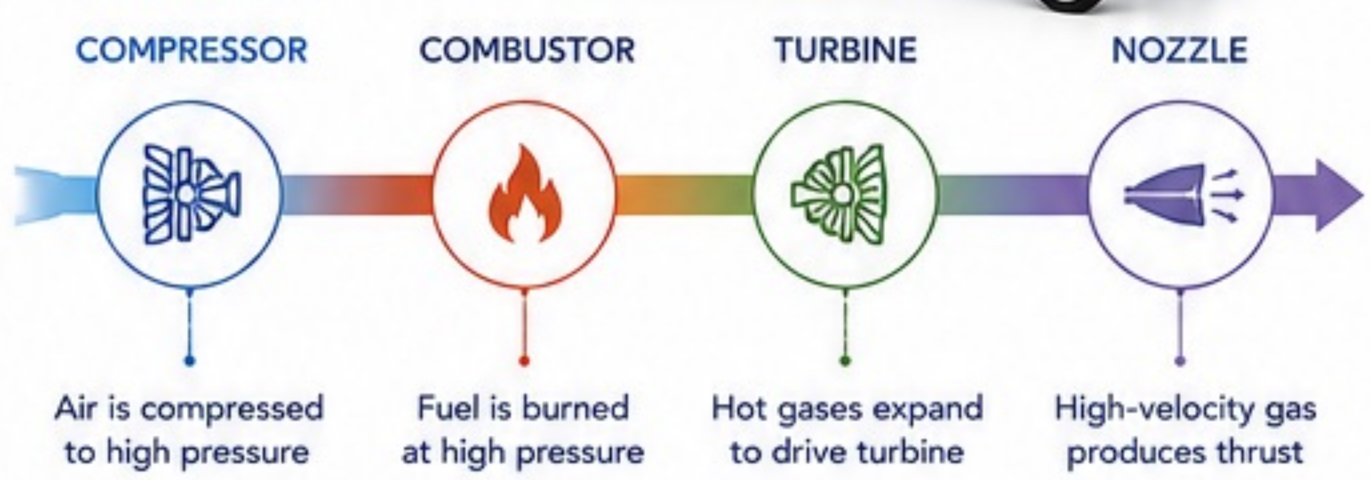
GAS TURBINE & TURBOJET FUNDAMENTALS

High-speed energy conversion in practice

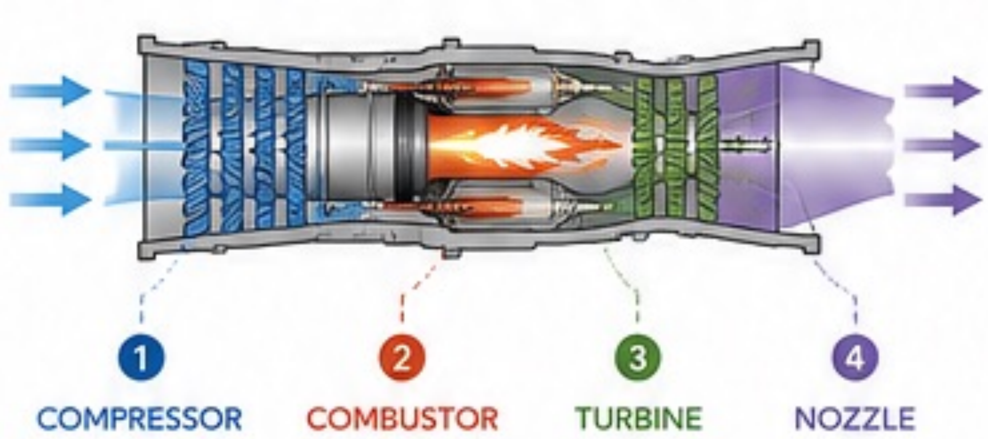
Students study compressors, combustion chambers, turbines, nozzles, thrust, shaft power, pressure ratio, fuel flow and heat balance.

TURBOJET TRAINER



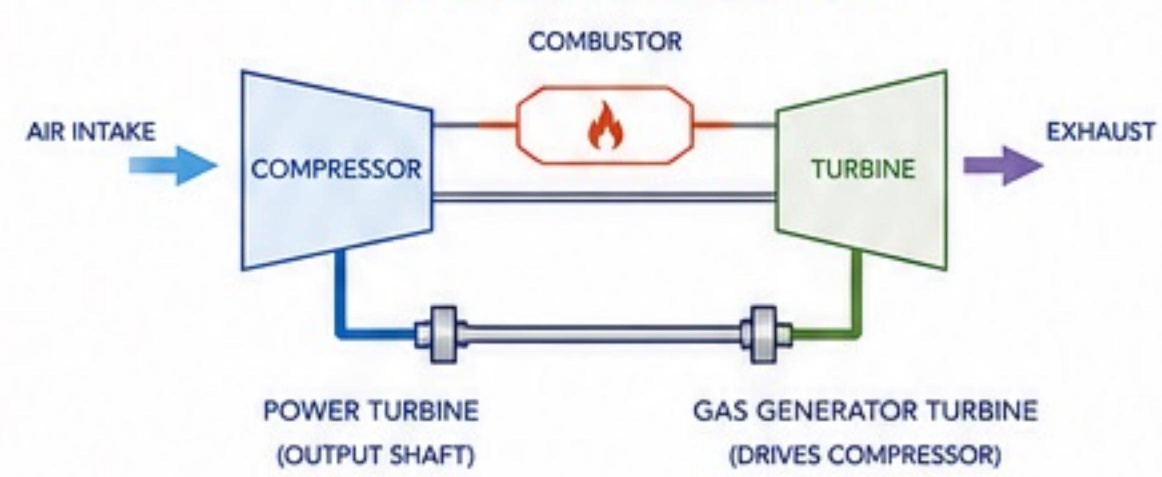


TURBOJET WORKING PRINCIPLE



TWO-SHAFT GAS TURBINE

TWO-SHAFT CONFIGURATION



- Shaft Power Measurement
- Pressure Ratio Analysis
- Exhaust Temperature
- Fuel Flow Measurement
- Performance Mapping
- Safe Operation and Control

PRACTICAL SKILLS DEVELOPED

- Gas turbine operation
- Compressor behavior
- Combustion performance
- Turbine expansion
- Thrust measurement
- Specific fuel consumption
- Heat balance analysis

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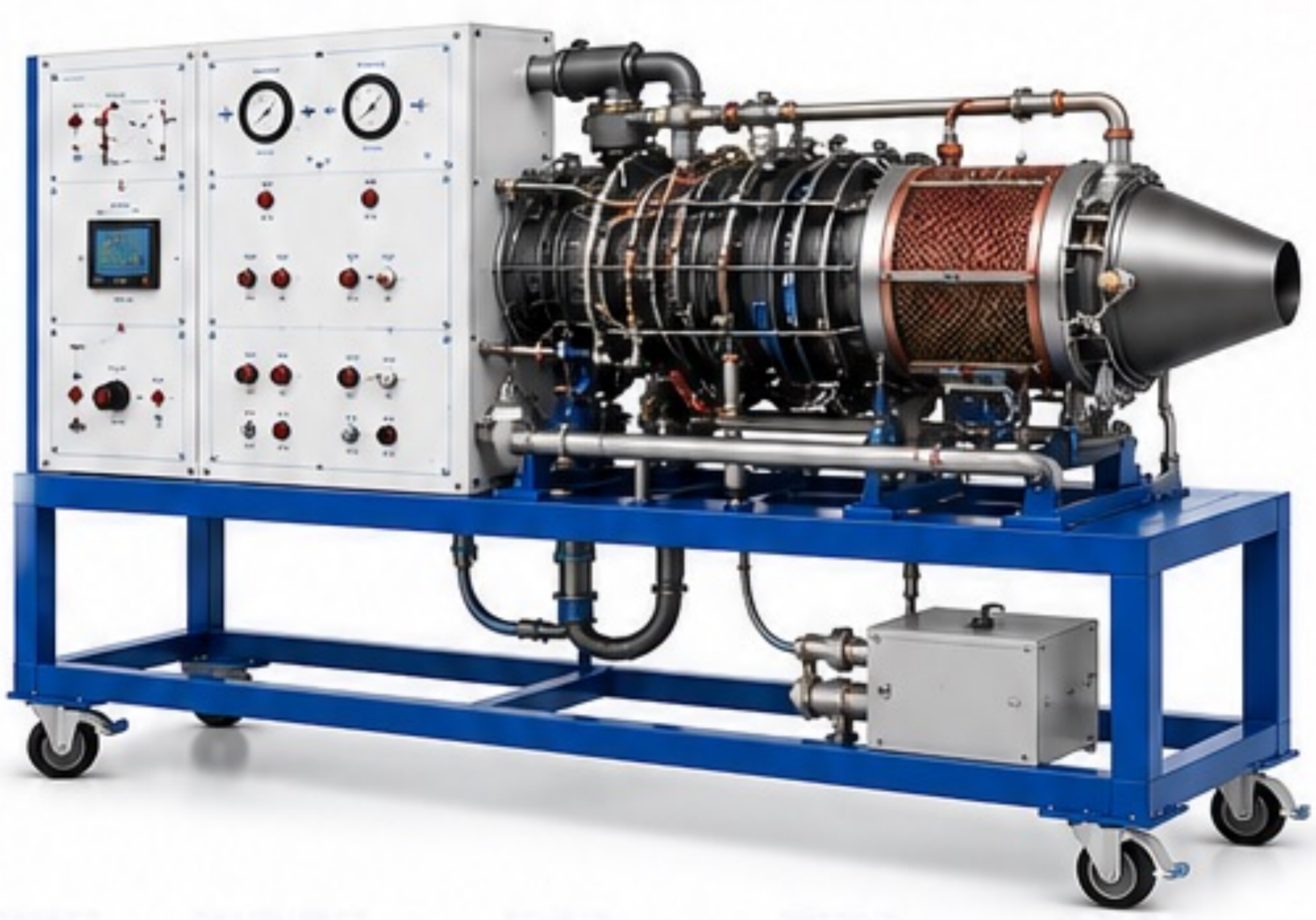
ADVANCED TURBINE STUDIES & SAFETY CULTURE

Professional discipline around high-energy systems

Students investigate reheat, nozzle behavior, pressure losses, fuel consumption, thermal efficiency and propulsive efficiency.

TURBOJET TRAINER WITH REHEAT



SAFETY FOCUS

PRE-START CHECKS
Verify systems, levels and instrumentation before operation.

SHUTDOWN PROCEDURES
Follow correct steps for safe and controlled shutdown.

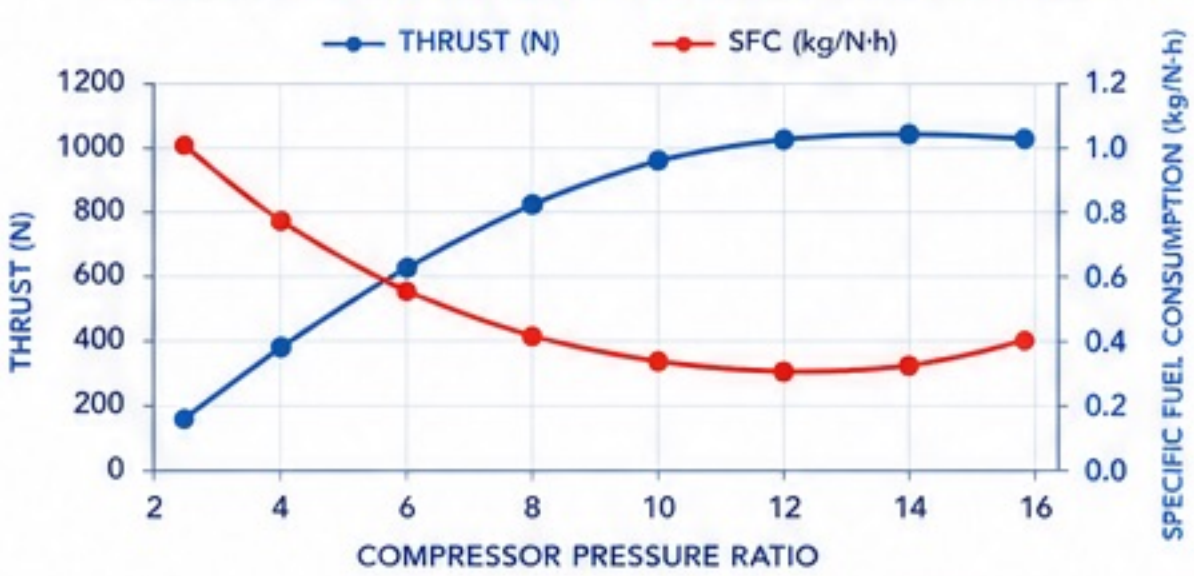
RESTRICTED ZONES
Keep clear of hot, rotating and high-energy components.

PERSONAL PROTECTION
Use appropriate PPE at all times in the laboratory.

EMERGENCY RESPONSE
Know procedures, alarms and evacuation routes.

INSTRUCTOR SUPERVISION
Experienced instructors ensure safe learning every time.

TURBOJET WITH REHEAT – TYPICAL PERFORMANCE



KEY LEARNING OUTCOMES

- Understand reheat and its effect on performance
- Analyze nozzle behavior and exhaust velocity
- Measure pressure losses across components
- Evaluate fuel consumption and thermal efficiency
- Improve propulsive efficiency and system awareness

Technical Solutions designs turbine laboratories with safety, layout and instructor readiness in mind.

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PROCESS CONTROL & PLC SYSTEMS

Preparing students for industrial automation

Sensors	Transmitters	Control Valves
Flow	Level	Pressure
Temperature	PID Control	PLC Programming
Alarms	Commissioning	

INTEGRATED PROCESS TRAINER

PLC TRAINER

PLC PROCESS

Technical Solutions connects training laboratories to real industrial automation practice.

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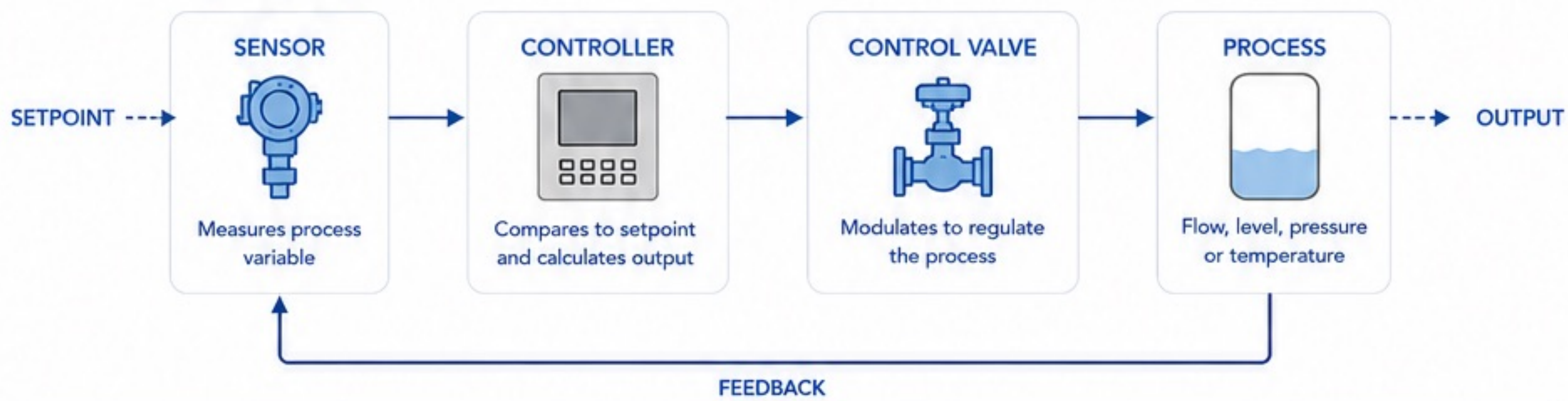
INTEGRATED PROCESS TRAINER

Flow, level, pressure and temperature in one learning platform

Students progress from open-loop observation to closed-loop control, PID tuning, disturbance response, ratio control, cascade control and multi-loop interaction.

INTEGRATED PROCESS TRAINER

CONTROL LOOP EXAMPLE



REAL-TIME MONITORING
Live process data and trends

MULTI-LOOP CONTROL
Interact multiple loops

ALARMS & SAFETY
Alarm indication and interlocks

DATA LOGGING & REPORTING
Record, review and analyze results

FLEXIBLE CONFIGURATION
Adaptable for many experiments

LEARNING PLATFORM
Theory to practice in one system

PRACTICAL SKILLS DEVELOPED

- Open-loop testing
- Closed-loop control
- PID tuning
- Flow control
- Level control
- Pressure control
- Temperature control
- Process data interpretation

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INDUSTRIAL INSTRUMENTATION MODULES

Learning the devices behind process control

Students study sensors, transmitters, control valves, flow meters, pressure devices, level measurement and temperature measurement.

FLOW PROCESS TRAINING SYSTEM

Flow measurement, control and monitoring

LEVEL PROCESS TRAINING SYSTEM

Level measurement, control and alarms

TEMPERATURE PROCESS TRAINING SYSTEM

Temperature measurement, control and monitoring

INSTRUMENT SIGNAL PATH

SENSOR

Detects process variable

→

TRANSMITTER

Converts and transmits standard signal (e.g. 4–20 mA)

→

CONTROLLER

Compares to setpoint and calculates output

→

CONTROL VALVE

Modulates to adjust process variable

→

PROCESS

Process responds to control action

FEEDBACK

PRACTICAL SKILLS DEVELOPED

- Sensor identification
- Transmitter calibration
- Signal interpretation
- Control valve behavior
- Loop checking
- Instrumentation troubleshooting

Technical Solutions connects instrumentation training to commissioning and maintenance skills.

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PLC PROGRAMMING & TWO-TANK CONTROL

From logic programming to physical process operation

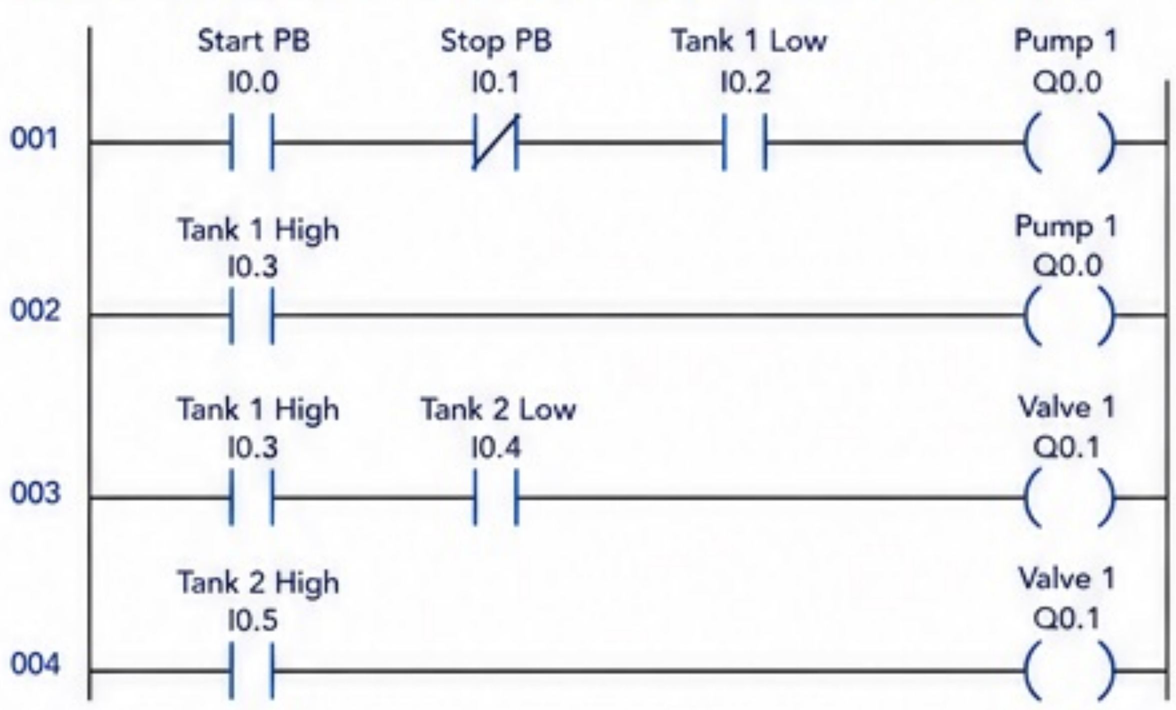
Students write logic that controls pumps, solenoid valves, sensors, alarms and tank filling sequences.

PLC TRAINER

TWO-TANK PROCESS

- Real PLC hardware
- Programming software
- I/O simulation and control
- Dual tank process
- Pump and valve control
- Alarms and indications

LADDER LOGIC EXAMPLE – TWO-TANK FILL SEQUENCE



SEQUENCE DESCRIPTION

- When Tank 1 level is low, Pump 1 starts
- When Tank 1 level is high, Pump 1 stops
- When Tank 1 is high and Tank 2 is low, Valve 1 opens to fill Tank 2
- When Tank 2 level is high, Valve 1 closes

PLC I/O MAPPING

DIGITAL INPUTS

ADDRESS	DEVICE	DESCRIPTION
I0.0	START PB	Start push button
I0.1	STOP PB	Stop push button
I0.2	TANK 1 LOW	Tank 1 low level switch
I0.3	TANK 1 HIGH	Tank 1 high level switch
I0.4	TANK 2 LOW	Tank 2 low level switch
I0.5	TANK 2 HIGH	Tank 2 high level switch

DIGITAL OUTPUTS

ADDRESS	DEVICE	DESCRIPTION
Q0.0	PUMP 1	Pump 1 motor
Q0.1	VALVE 1	Fill valve from Tank 1 to Tank 2
Q0.2	ALARM	High level alarm
Q0.3	BUZZER	Audible alarm

PRACTICAL SKILLS DEVELOPED

- PLC I/O mapping
- Ladder logic
- Timers and counters
- Pump control
- Valve control
- Alarm logic
- Interlocks
- Manual and automatic modes
- Fault diagnosis

Technical Solutions connects instrumentation training to commissioning and maintenance skills.

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COUPLED TANKS & MULTIVARIABLE CONTROL

Understanding interaction between control loops

Students observe how one control decision can improve one variable while disturbing another part of the system.

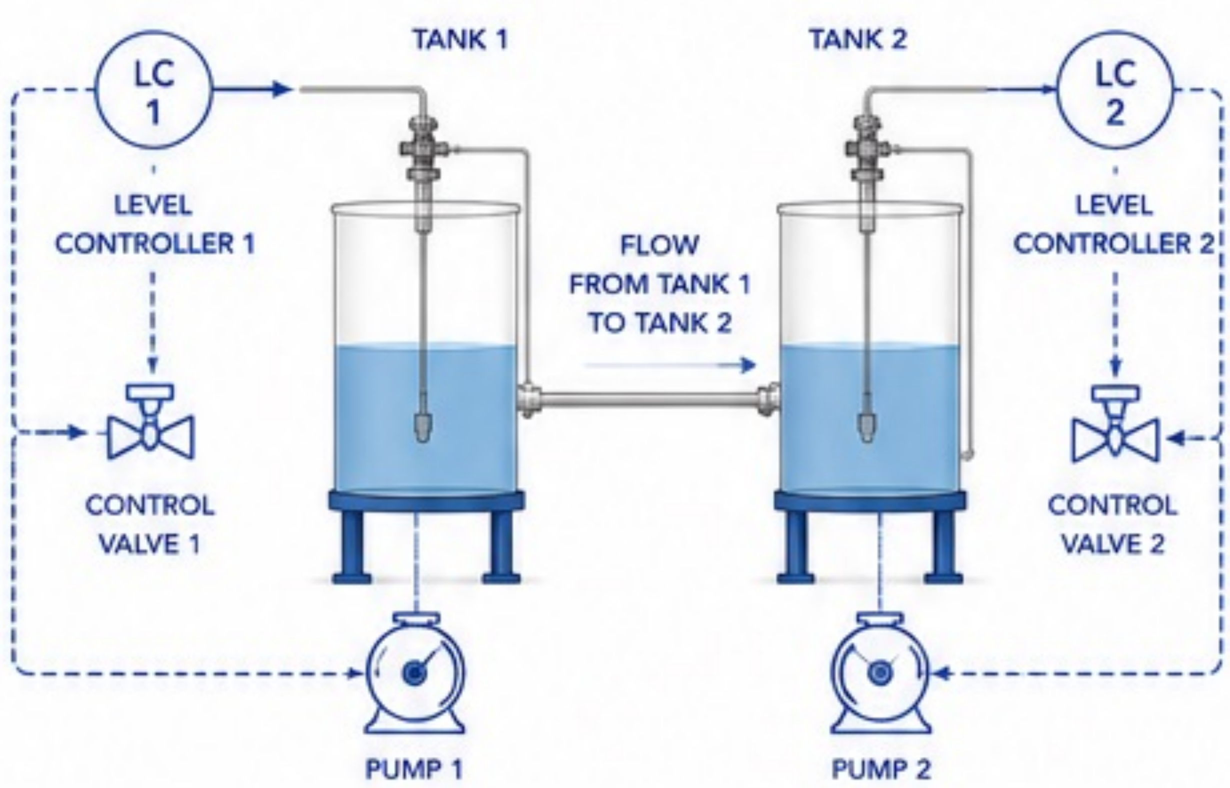
COUPLED TANKS APPARATUS

- Two interacting tank system
- Flow between tanks
- Level measurement
- Pump and valve control

MULTIVARIABLE COUPLED TANKS

- Multi-tank interaction
- Multiple loops and variables
- Advanced process behavior
- Real-time monitoring

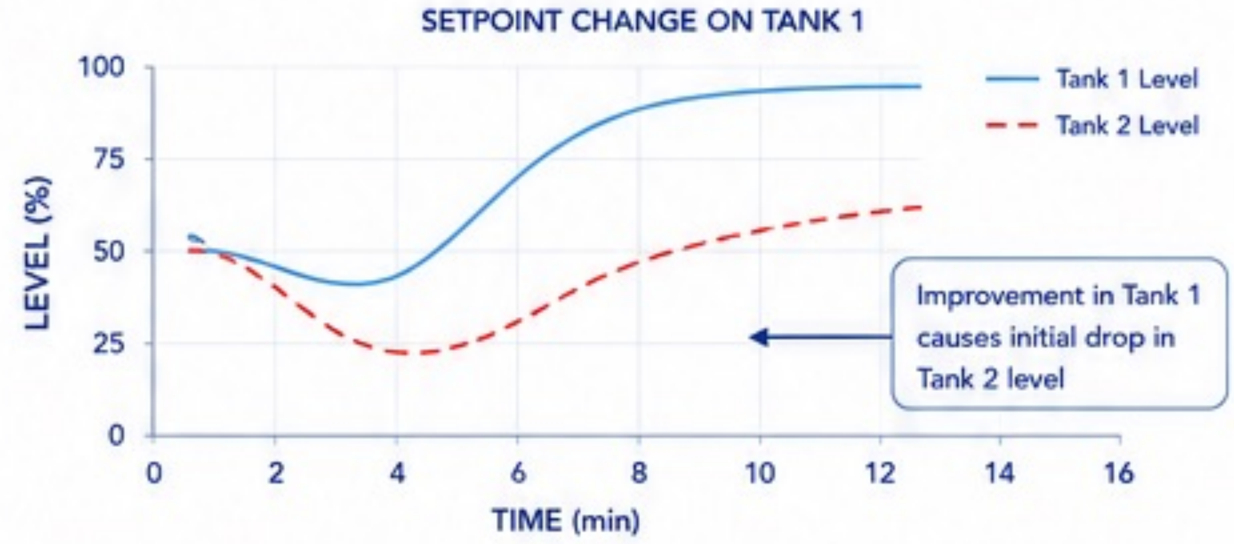
INTERACTING LOOPS

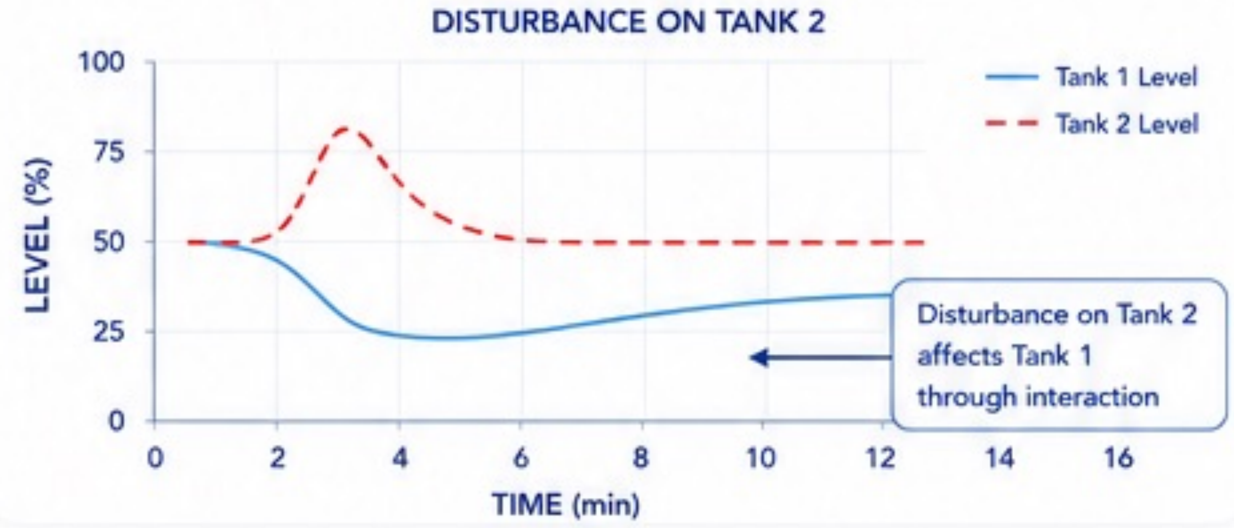


INTERACTION EXAMPLE

Opening Control Valve 1 increases level in Tank 2 but may reduce level in Tank 1.
Controllers must work together to maintain setpoints.

DYNAMIC RESPONSE EXAMPLES





PRACTICAL SKILLS DEVELOPED

- Liquid level dynamics
- Interacting loops
- Disturbance testing
- Time delay observation
- Controller tuning
- Multivariable control awareness
- Advanced troubleshooting

Technical Solutions teaches process behavior as an integrated system.

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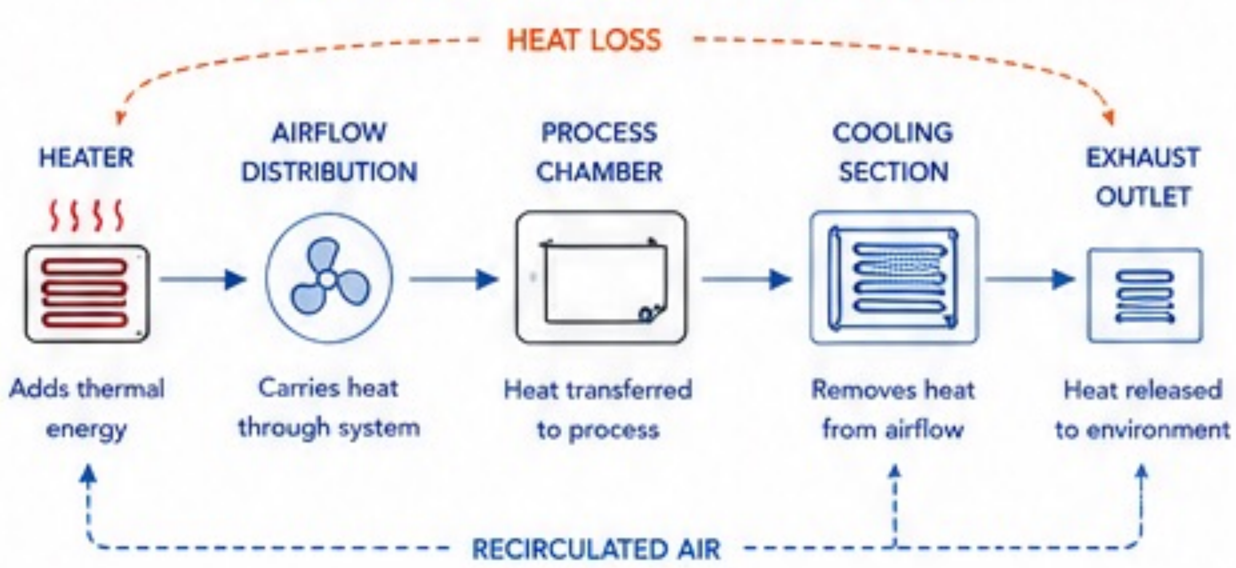
THERMAL PROCESS CONTROL

Temperature control, time delay and industrial heating

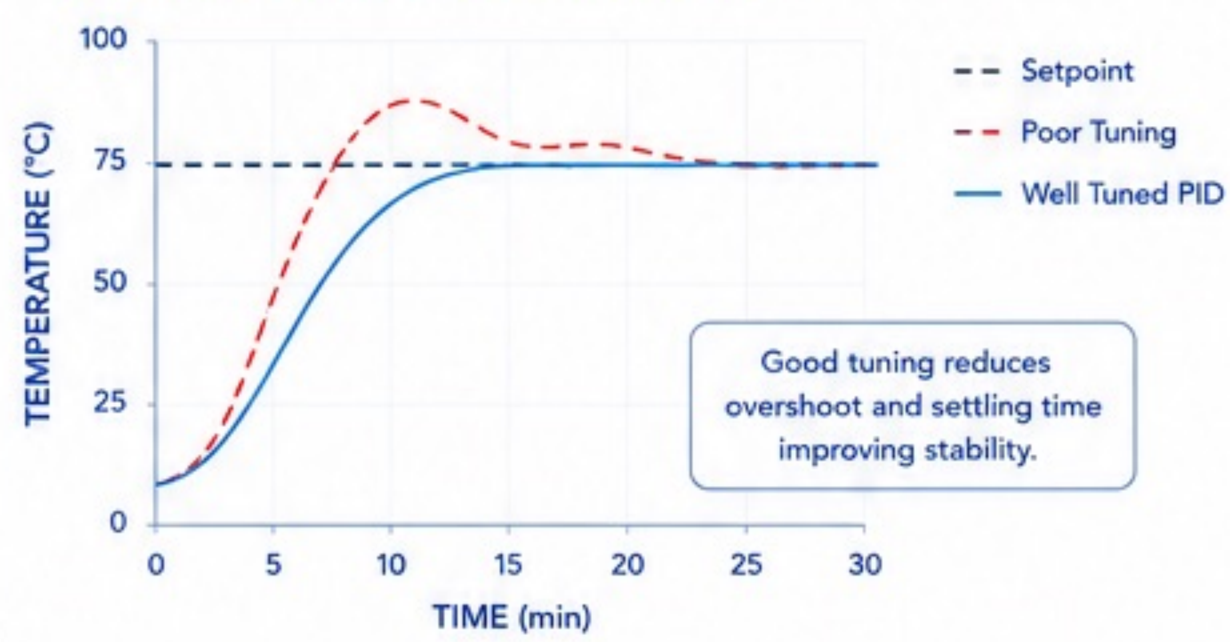
Students investigate heating, cooling, airflow, temperature sensing, on/off control, PID control, thermal inertia and system stability.

THERMAL CONTROL PROCESS APPARATUS

HEAT FLOW THROUGH THE SYSTEM



TEMPERATURE RESPONSE EXAMPLE



PID TUNING FOCUS AREAS

P — PROPORTIONAL
Controls response speed and offset

I — INTEGRAL
Eliminates steady-state error over time

D — DERIVATIVE
Reduces overshoot and improves stability

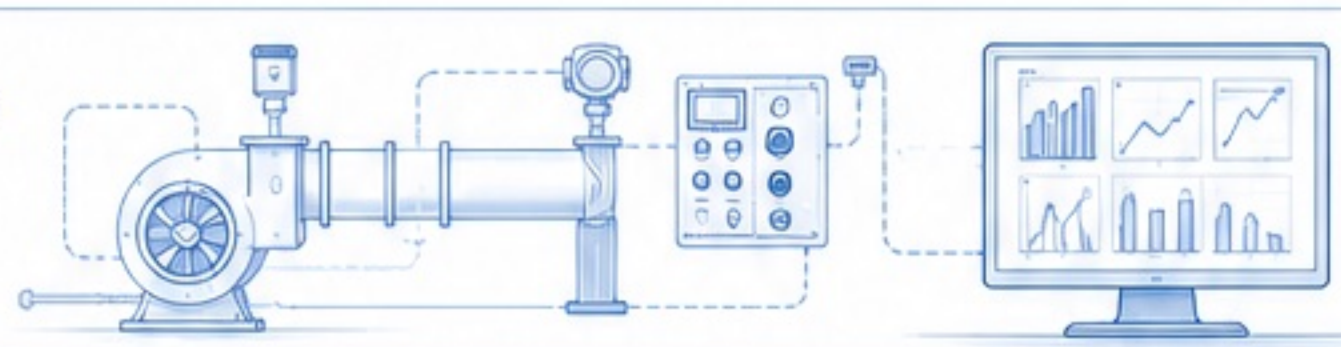
RESPONSE
Understand rise time, overshoot and settling

OPTIMIZE
Adjust P, I, D for best overall performance

PRACTICAL SKILLS DEVELOPED

- Temperature measurement
- Heating and cooling control
- PID tuning
- Time delay observation
- Overshoot control
- Stability assessment
- HVAC and process heating awareness

Technical Solutions teaches process behavior as an integrated system.



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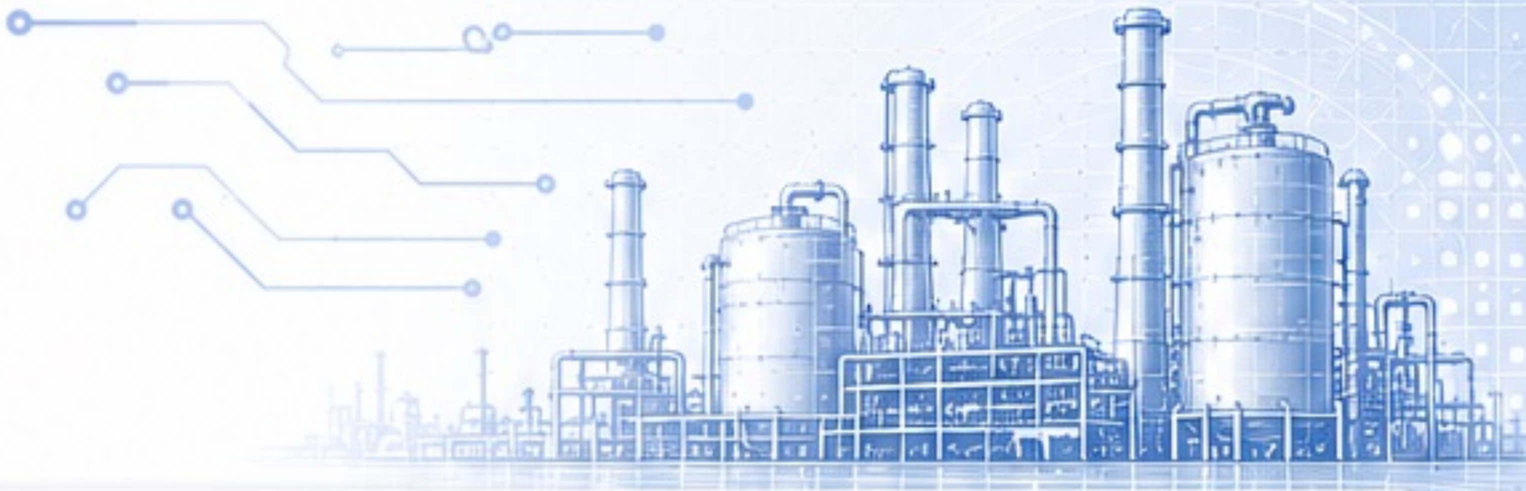
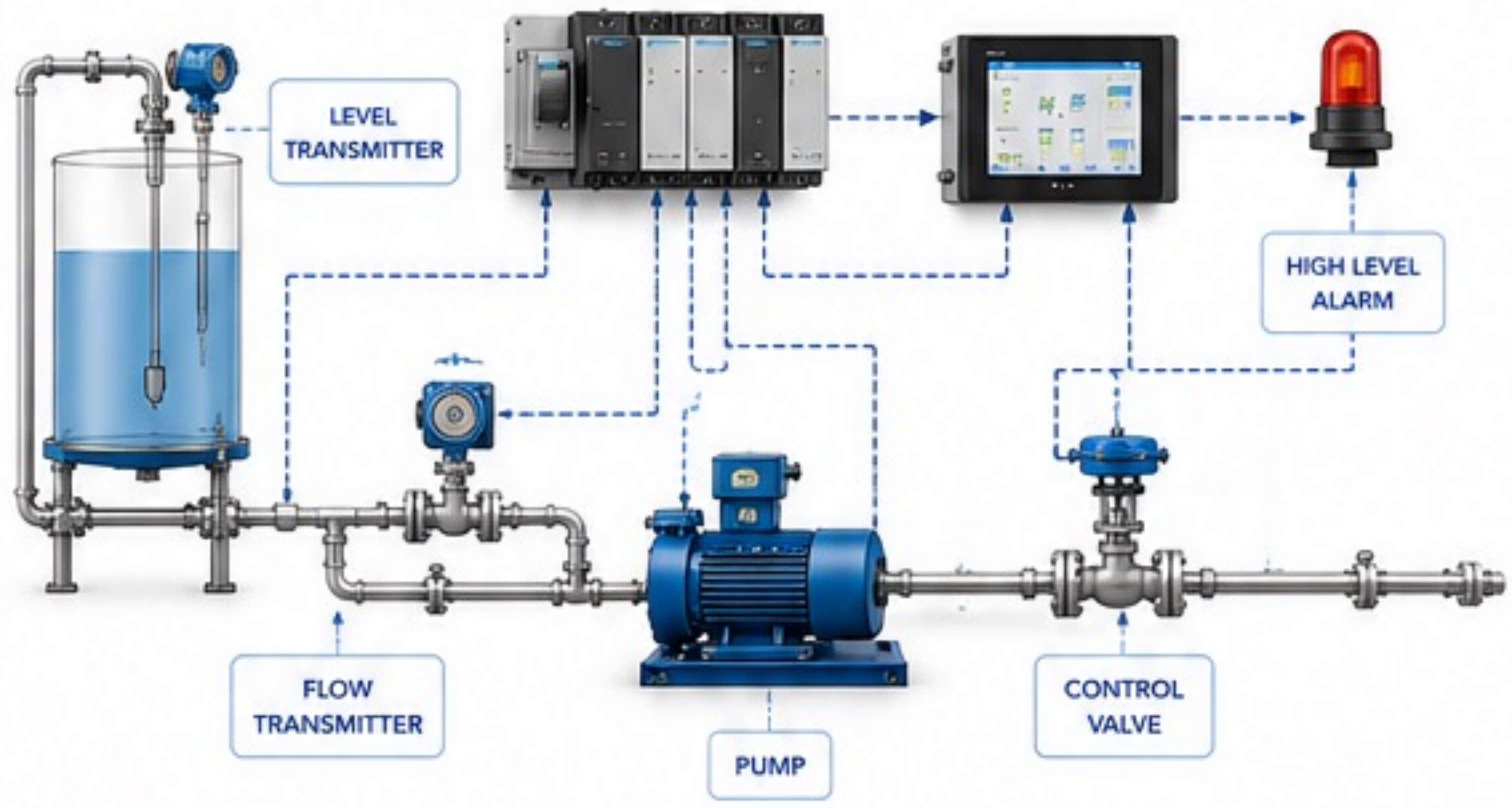


AUTOMATION INTEGRATION & CAPSTONE PROJECTS

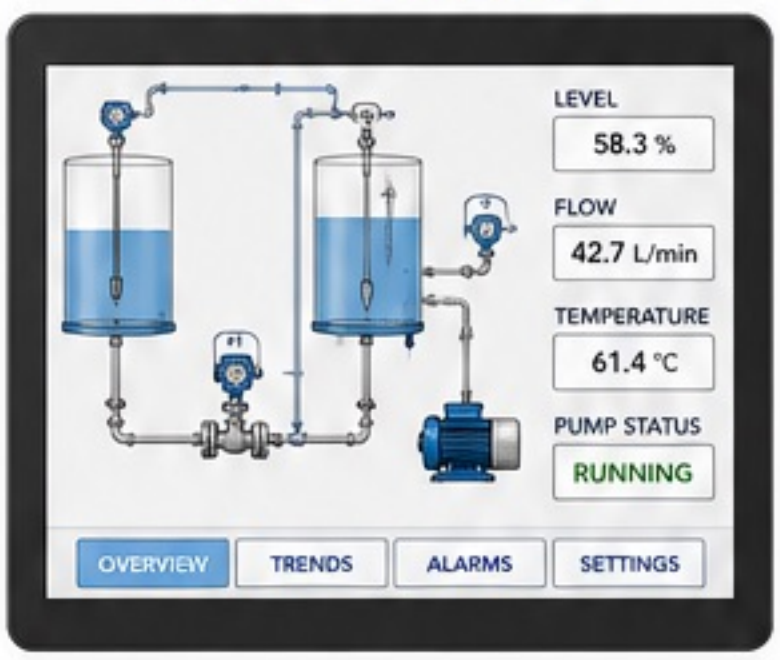
Turning laboratory skills into industrial competence

Students combine instrumentation, PLC programming, control logic, documentation and troubleshooting.

INTEGRATED SYSTEM EXAMPLE



HMI PROCESS OVERVIEW



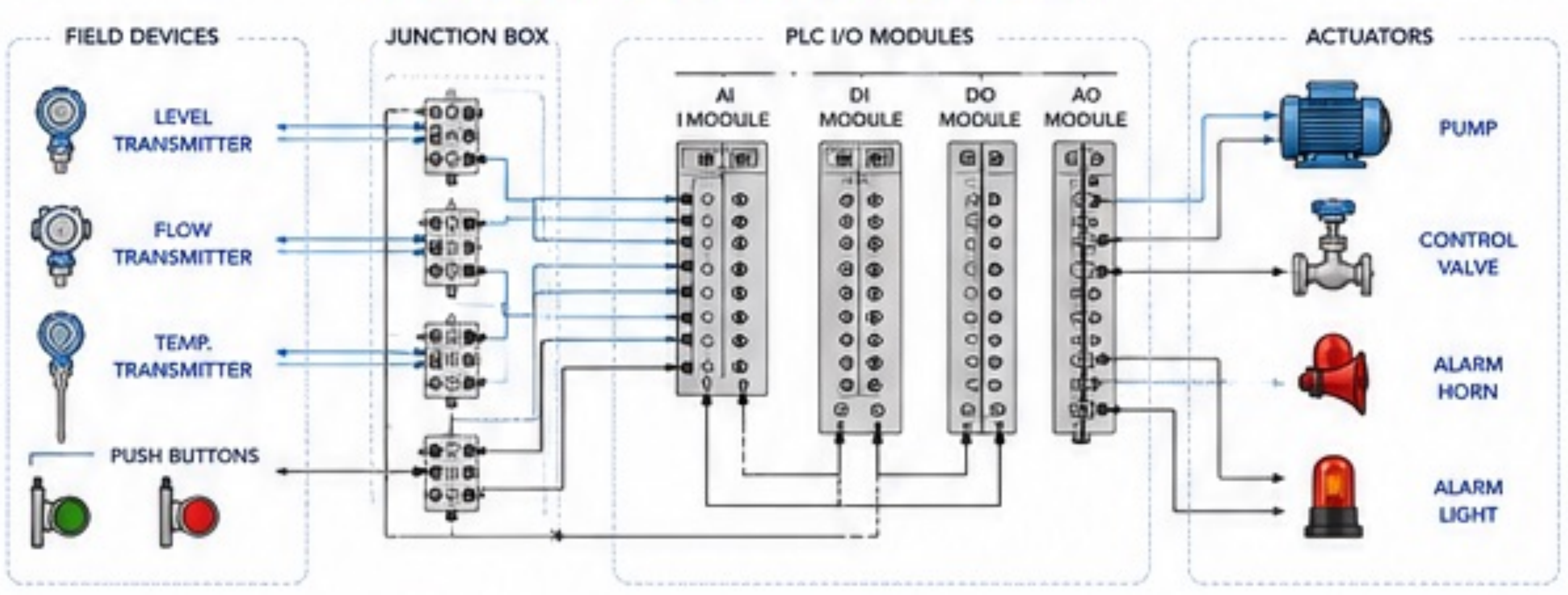
ALARM LIST EXAMPLE

TIME	TAG	DESCRIPTION	STATUS
10:24:13	LT-101	High Level Tank 1	ACTIVE
10:23:07	FT-101	Low Flow	CLEARED
10:20:45	TT-101	High Temperature	CLEARED
10:18:32	P-101	Pump 1 Failure	CLEARED
10:15:01	LT-102	Low Level Tank 2	CLEARED

I/O LIST EXAMPLE

TAG	DESCRIPTION	ADDRESS
DIGITAL INPUTS		
PB-START	Start Push Button	I0.0
PB-STOP	Stop Push Button	I0.1
LS-T1-HH	Tank 1 High Level Switch	I0.2
LS-T1-LL	Tank 1 Low Level Switch	I0.3
LS-T2-HH	Tank 2 High Level Switch	I0.4
PMP-FAIL	Pump Failure	I0.5
ANALOG INPUTS		
LT-101	Tank 1 Level Transmitter	IW0
FT-101	Flow Transmitter	IW2
TT-101	Temperature Transmitter	IW4
DIGITAL OUTPUTS		
PMP-101	Pump 1 Motor	Q0.0
CV-101	Control Valve	Q0.1
ALM-HORN	Alarm Horn	Q0.2
ALM-LIGHT	Alarm Light	Q0.3

TYPICAL WIRING DIAGRAM (OVERVIEW)



COMMISSIONING CHECKLIST

- ☑ Verify I/O wiring and terminations
- ☑ Power up PLC and check communications
- ☑ Verify sensor readings on HMI
- ☑ Test pumps, valves and actuators
- ☑ Check alarm indications and reset
- ☑ Loop test each control loop
- ☑ Tune controllers and record settings
- ☑ Validate sequences and interlocks
- ☑ Run disturbance tests
- ☑ Document results and obtain approval

CAPSTONE DELIVERABLES

- I/O lists
- Wiring diagrams
- Control logic
- Alarm tables
- Commissioning checklists
- Tuning records
- Fault reports
- Technical presentations

Technical Solutions supports project-based learning through engineering-style documentation.

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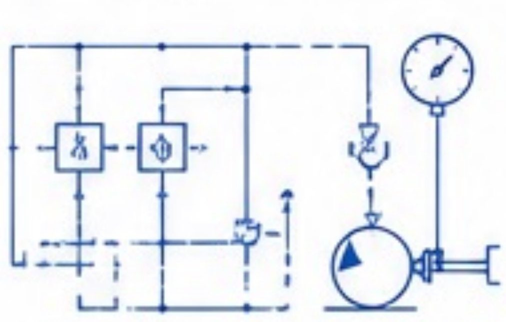
WATER & FLUID MECHANICS

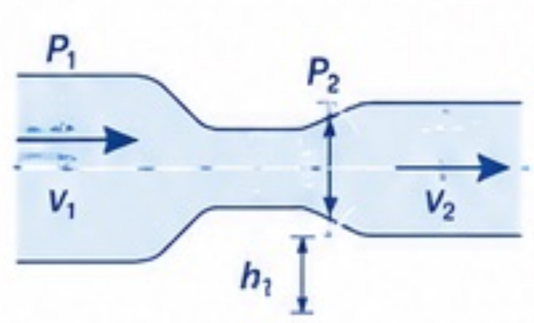
Practical fluid engineering for infrastructure and industry

Flow Measurement	Pressure	Bernoulli	Pipe Losses	Hydrostatics	Pumps	Turbines	Open Channels	Water Hammer

DIGITAL HYDRAULIC BENCH

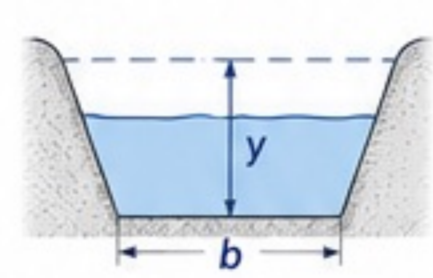


BERNOULLI'S THEOREM APPARATUS



PELTON TURBINE

OPEN CHANNEL FLUME



Technical Solutions connects fluid mechanics training to water systems, infrastructure, pumping and industrial applications.

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HYDRAULIC BENCH, BERNOULLI & FLOW MEASUREMENT

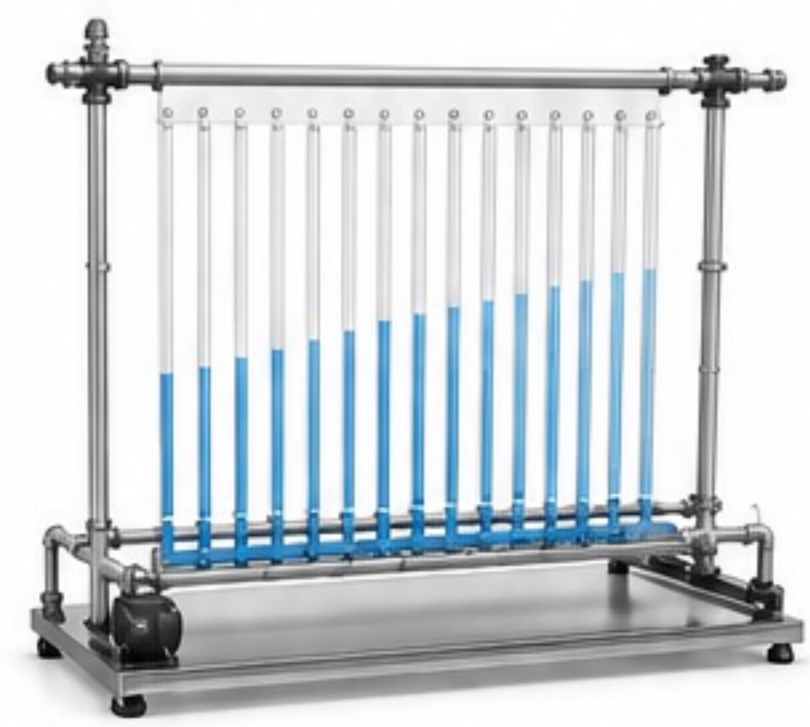
The foundation of fluid mechanics training

Students study flow rate, pressure variation, energy behavior, Bernoulli's equation and flow measurement methods.

DIGITAL HYDRAULIC BENCH

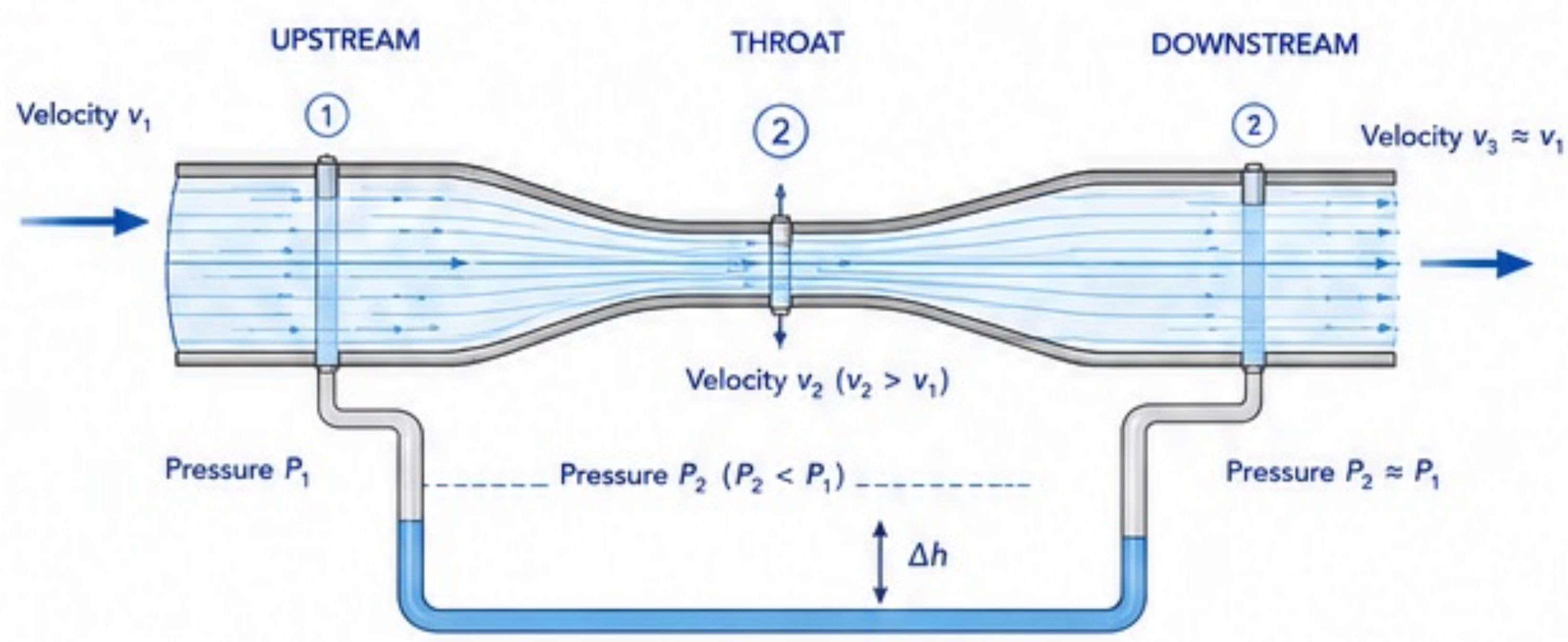
- Pressure measurement
- Flow rate measurement
- Control valves
- Pump and recirculation

BERNOULLI'S THEOREM APPARATUS



- Manometer array
- Flow path visualization
- Precise level measurement
- Data collection

VENTURI TUBE – PRINCIPLE AND MEASUREMENT



BERNOULLI'S EQUATION

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2$$

Where:

P = Pressure (Pa)

v = Velocity (m/s)

z = Elevation head (m)

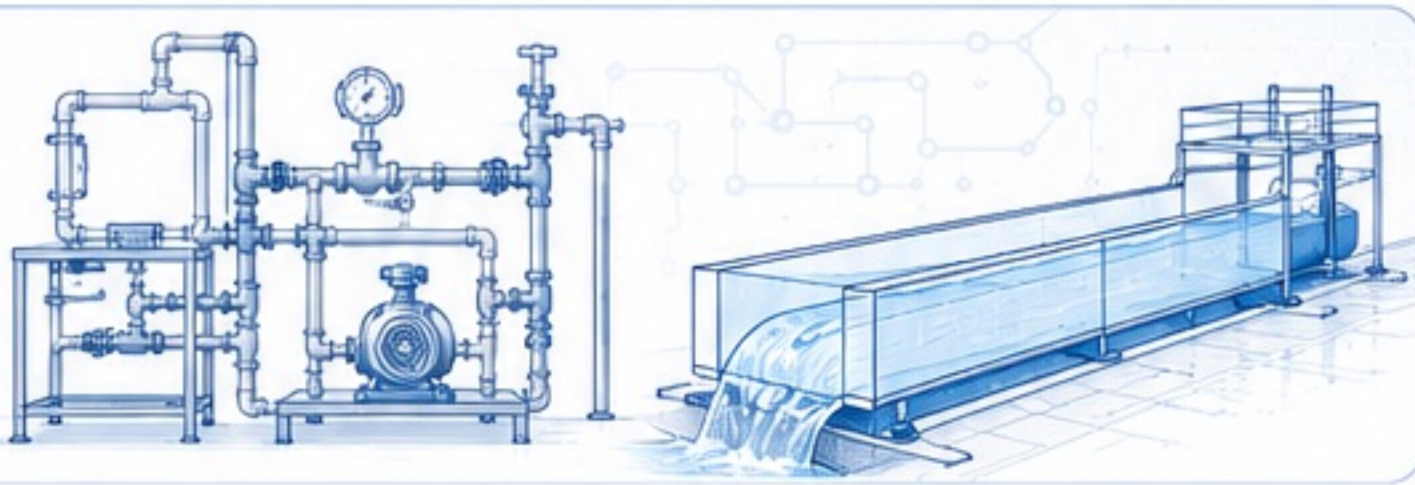
γ = Specific weight (N/m³)

g = Acceleration due to gravity (m/s²)

PRACTICAL SKILLS DEVELOPED

- Hydraulic bench operation
- Flow measurement
- Pressure measurement
- Bernoulli verification
- Venturi meter use
- Manometer reading
- Data recording

Technical Solutions plans hydraulic laboratories for safe water supply, drainage and teaching workflow.



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PIPE FRICTION, FITTINGS & FLOW VISUALIZATION

Understanding pressure losses and flow regimes

Students measure pressure loss across pipes, bends, valves, fittings and restrictions while observing laminar, transitional and turbulent flow.

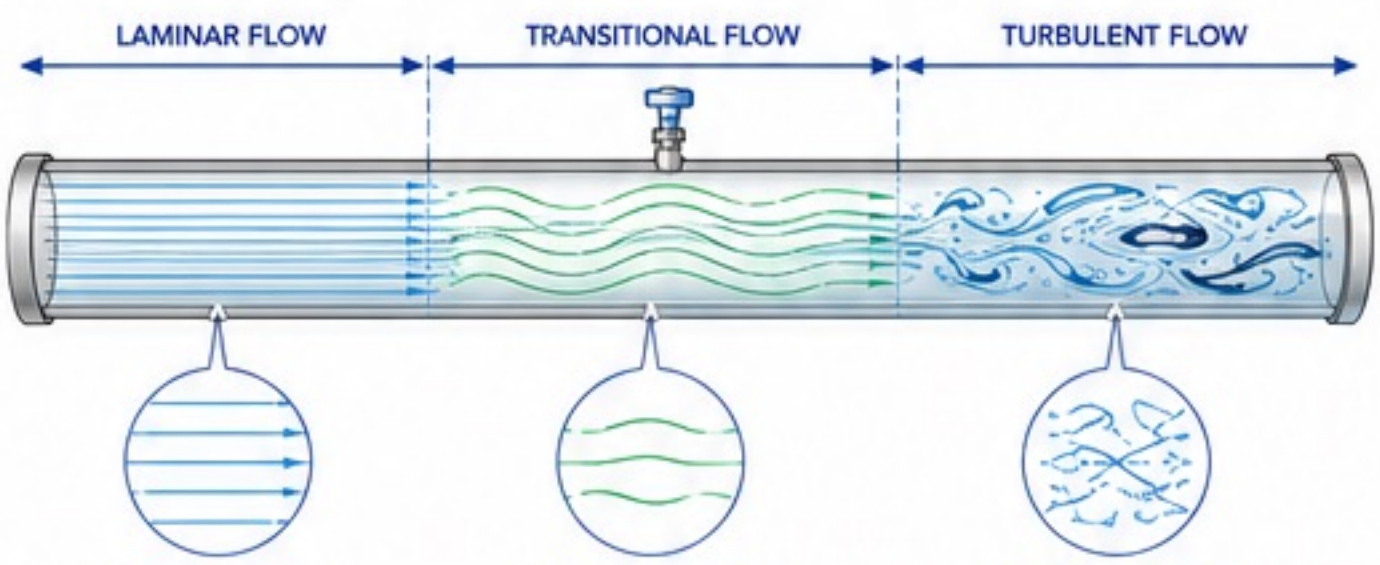
FLUID FRICTION APPARATUS

- Pressure measurement
- Bends and fittings
- Valve effects
- Head loss analysis
- Data collection

OSBORNE REYNOLDS APPARATUS

- Flow regime visualization
- Dye injection
- Reynolds number
- Laminar to turbulent
- Observation recording

FLOW REGIMES – FROM LAMINAR TO TURBULENT

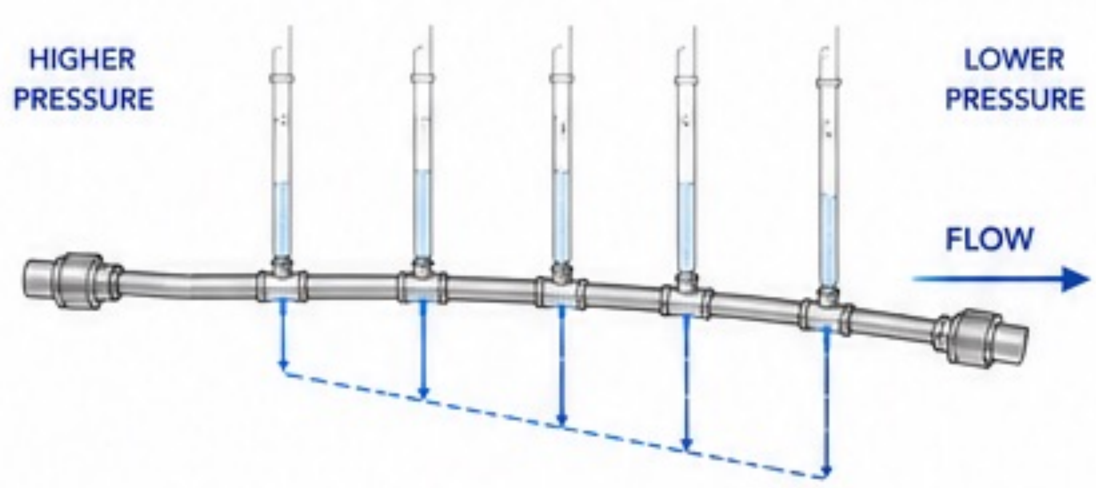


Smooth, orderly layers

Unstable, changing patterns

Chaotic, high mixing and energy loss

PRESSURE DROP ALONG A PIPE

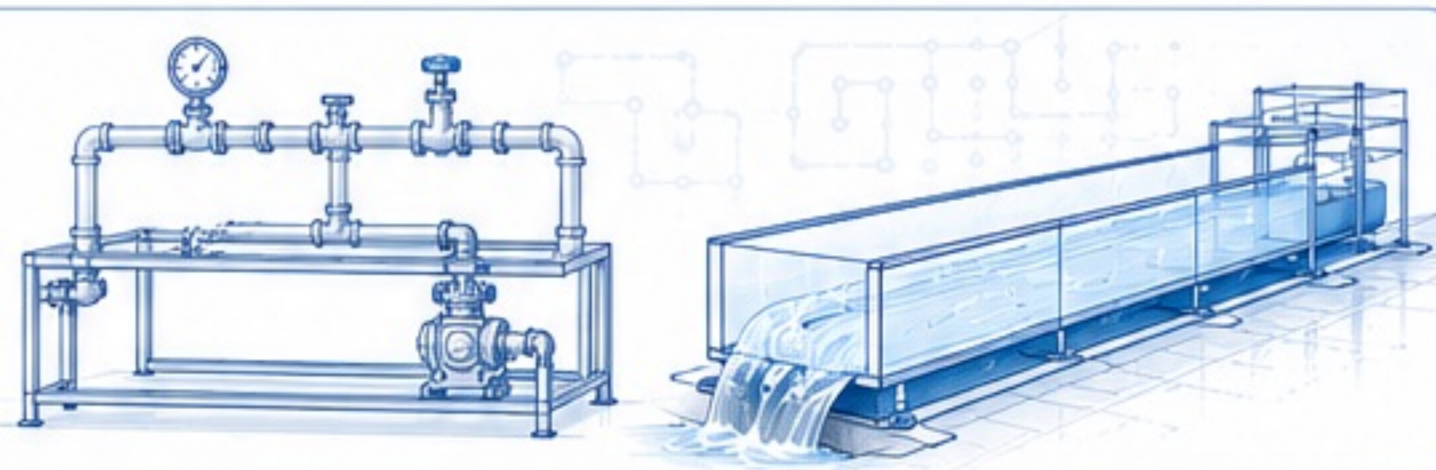


Pressure decreases along the flow direction due to friction and system losses.

PRACTICAL SKILLS DEVELOPED

- Pipe friction measurement
- Fitting loss comparison
- Valve effects
- Re Reynolds number
- Laminar flow
- Turbulent flow
- System efficiency awareness

Technical Solutions plans hydraulic laboratories for safe water supply, drainage and teaching workflow.



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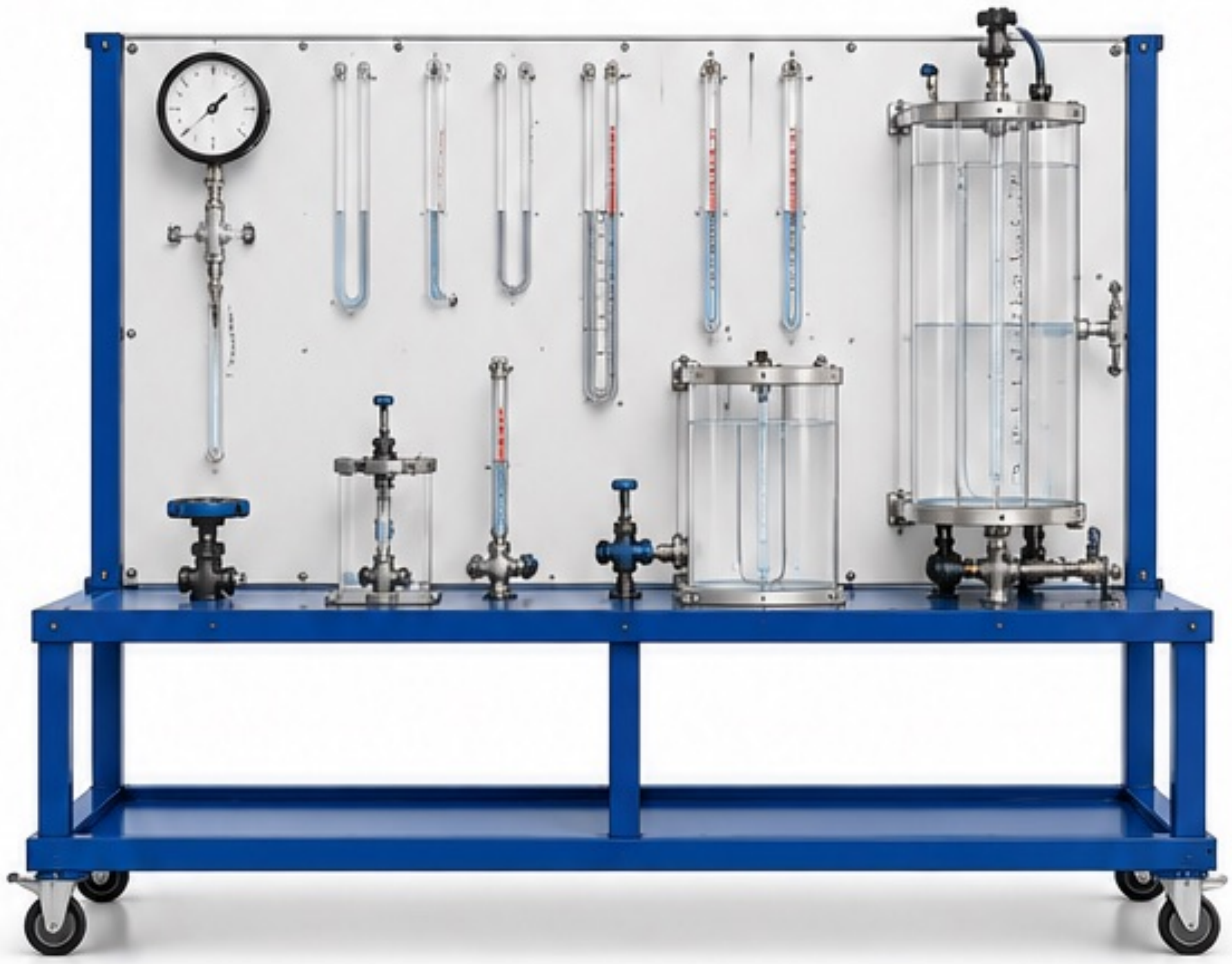
HYDROSTATICS & PROPERTIES OF FLUIDS

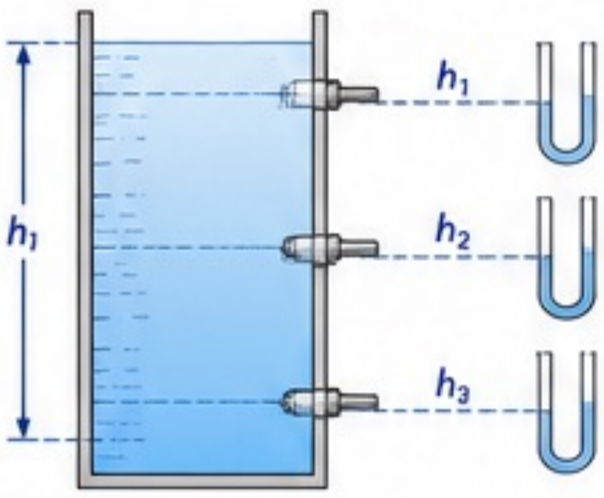
Pressure, buoyancy and fluid behavior at rest

Students investigate pressure variation with depth, manometry, center of pressure, buoyancy, density, specific gravity, viscosity and stability.

HYDROSTATICS AND PROPERTIES OF FLUIDS APPARATUS

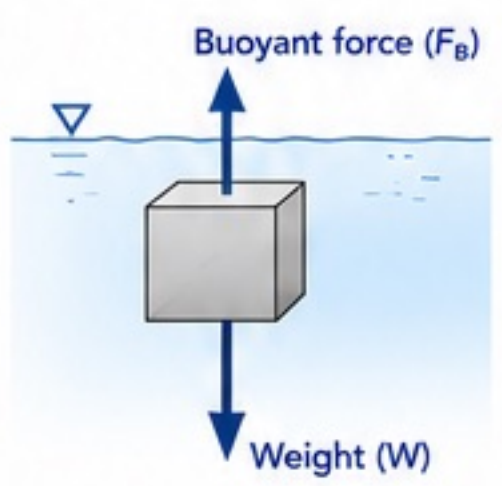


PRESSURE WITH DEPTH



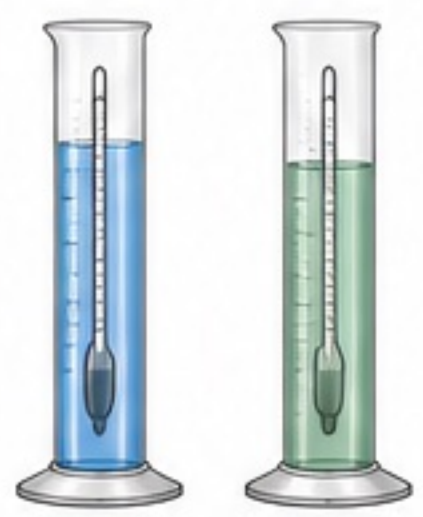
Pressure increases linearly with depth ($P = \rho g h$)

BUOYANCY PRINCIPLE



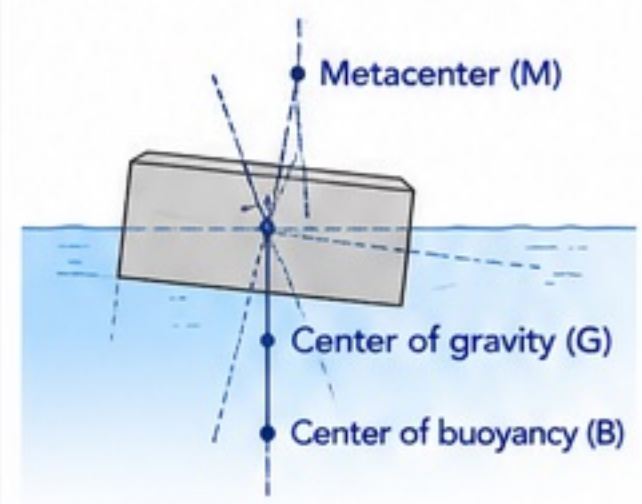
An object experiences an upthrust equal to the weight of displaced fluid.

DENSITY & SPECIFIC GRAVITY



Density and specific gravity determine how fluids compare to water.

STABILITY OF FLOATING BODIES

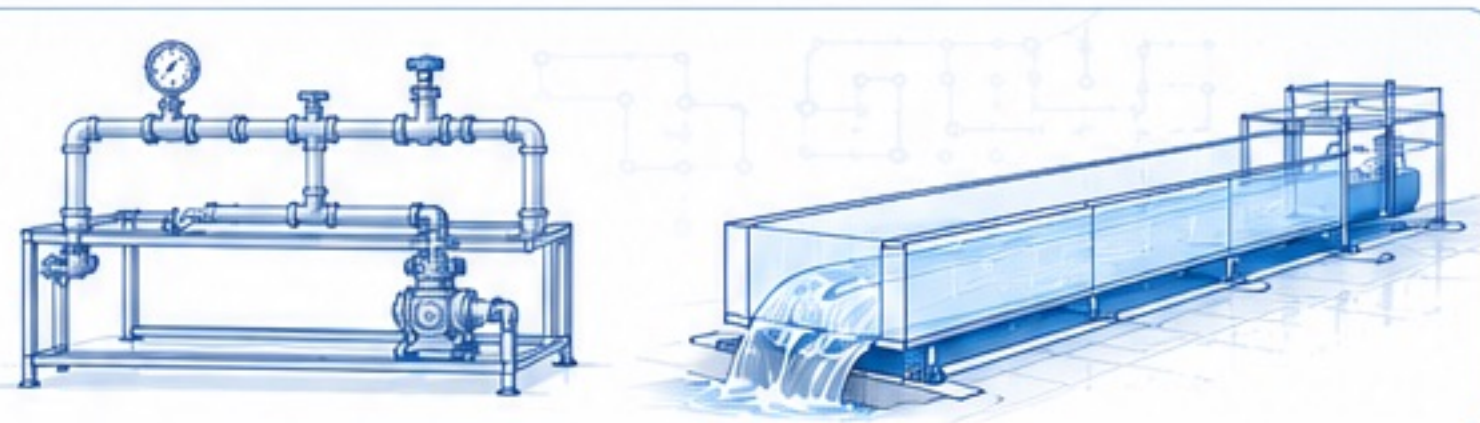


Stability depends on the relationship between G, B and M.

PRACTICAL SKILLS DEVELOPED

- Pressure-depth measurement
- Manometer use
- Buoyancy testing
- Density measurement
- SG Specific gravity
- Viscosity awareness
- Stability of floating bodies

Technical Solutions plans hydraulic laboratories for safe water supply, drainage and teaching workflow.



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PUMPS, TURBINES & ENERGY TRANSFER

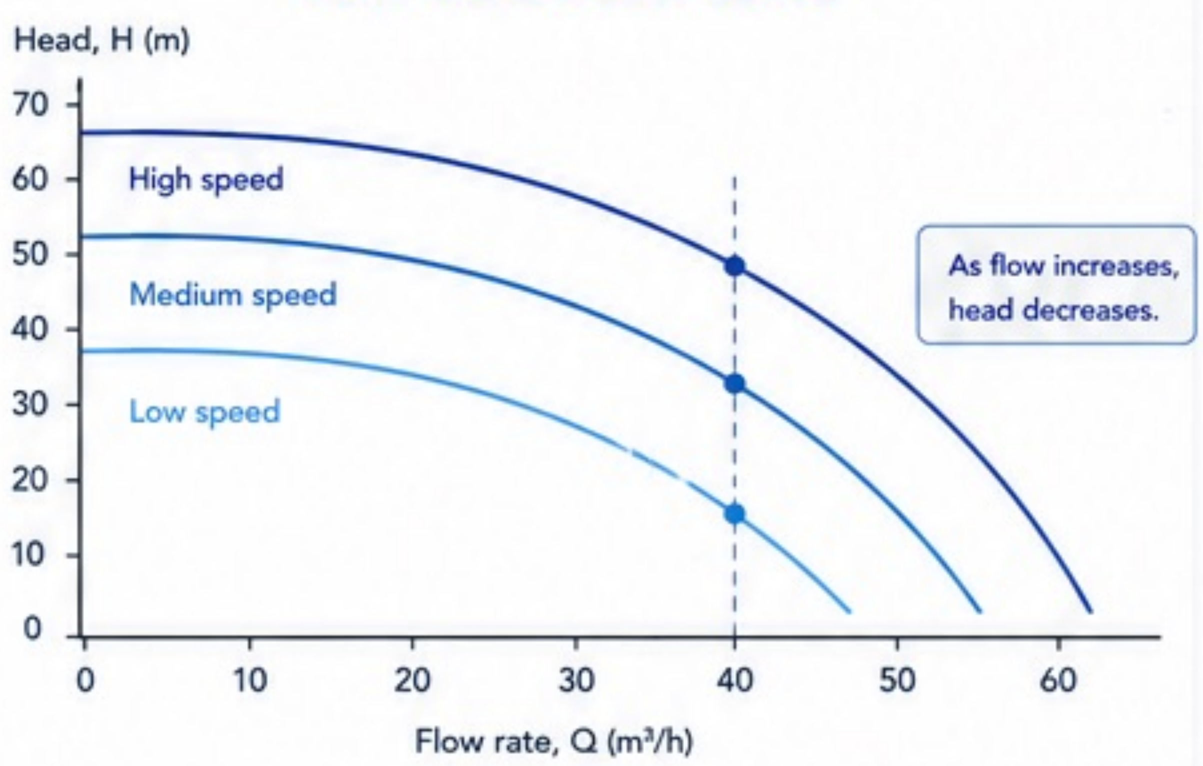
Connecting fluid flow to mechanical power

Students learn how pumps add energy to fluids and how turbines extract energy from moving water.

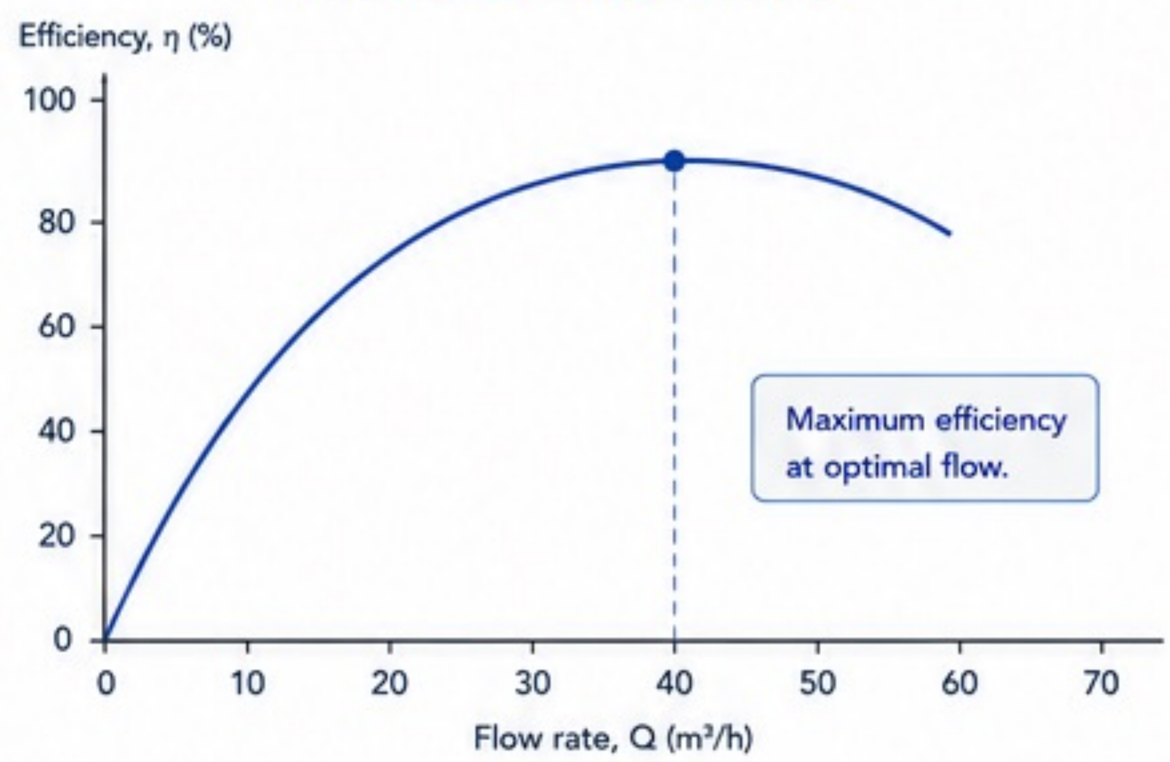
VARIABLE SPEED SERIES AND PARALLEL PUMPS

PELTON TURBINE

PUMP HEAD–FLOW CURVE



TURBINE EFFICIENCY CURVE



PRACTICAL SKILLS DEVELOPED

- Pump curves
- Head and flow measurement
- Efficiency calculation
- Series pump operation
- Parallel pump operation
- Cavitation awareness
- Turbine torque
- Hydraulic power

Technical Solutions connects training to water, industry, power and maintenance applications.

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OPEN CHANNELS, FLUMES & WATER TRANSIENTS

Training for channels, rivers, drainage and pipeline surge

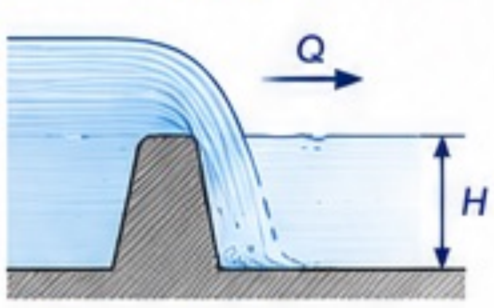
Students study open-channel behavior and sudden pressure waves that can affect pipelines, valves and pumps.

OPEN CHANNEL FLUME

WATER HAMMER APPARATUS

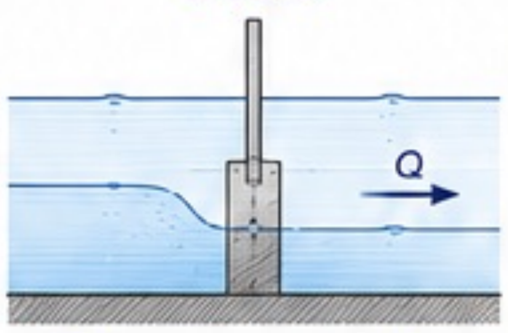
OPEN CHANNEL PHENOMENA

WEIRS



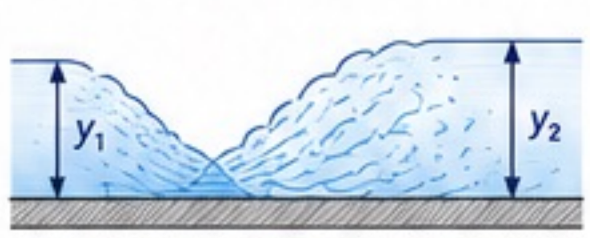
Measure head over weir and discharge.

SLUICES



Study gate opening effects on flow rate and head.

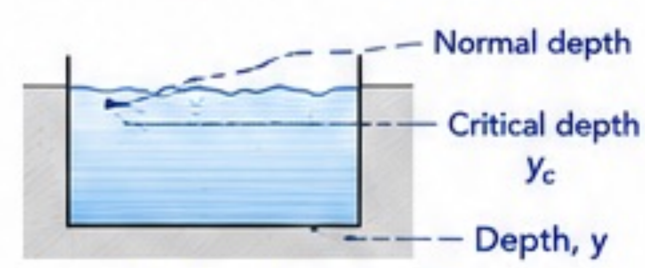
HYDRAULIC JUMP



$y_2 > y_1$

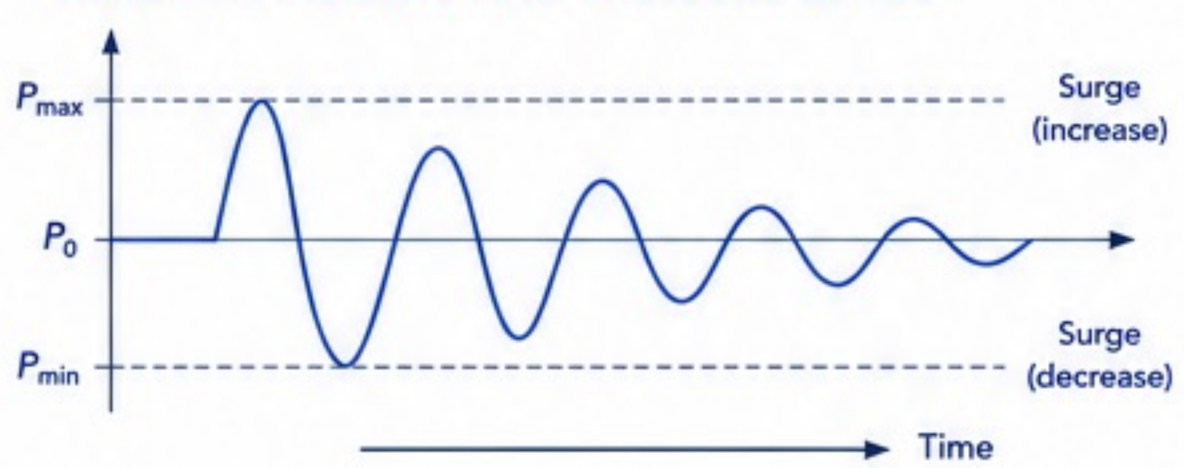
Observe energy dissipation and sequent depths.

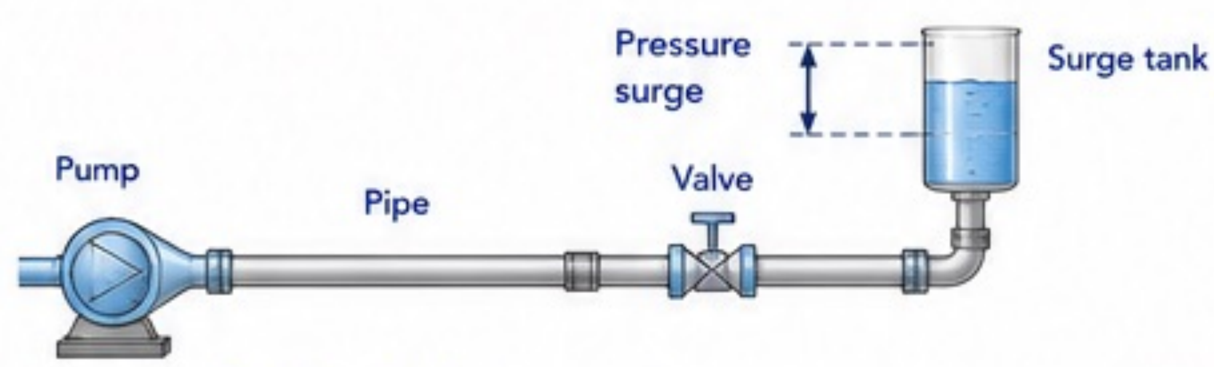
CHANNEL FLOW PROFILES



Analyze depth profiles in open channels.

WATER TRANSIENTS AND PRESSURE SURGE





Sudden valve closure creates pressure waves that travel and reflect in the pipeline.

PRACTICAL SKILLS DEVELOPED

- Flume operation
- Weir experiments
- Sluice behavior
- Hydraulic jumps
- Flow profiles
- Water hammer observation
- Pressure surge awareness
- Infrastructure applications

Technical Solutions connects training to water, industry, power and maintenance applications.

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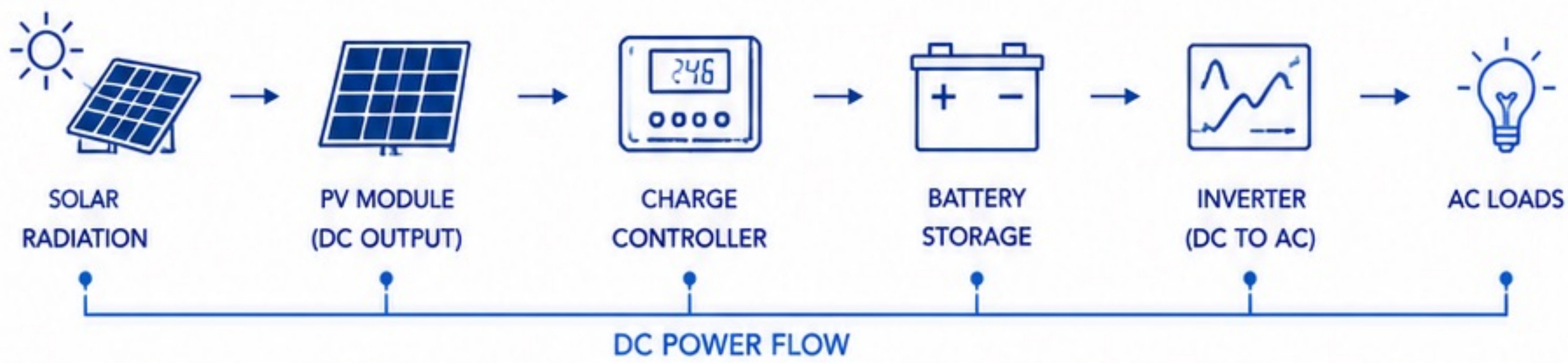
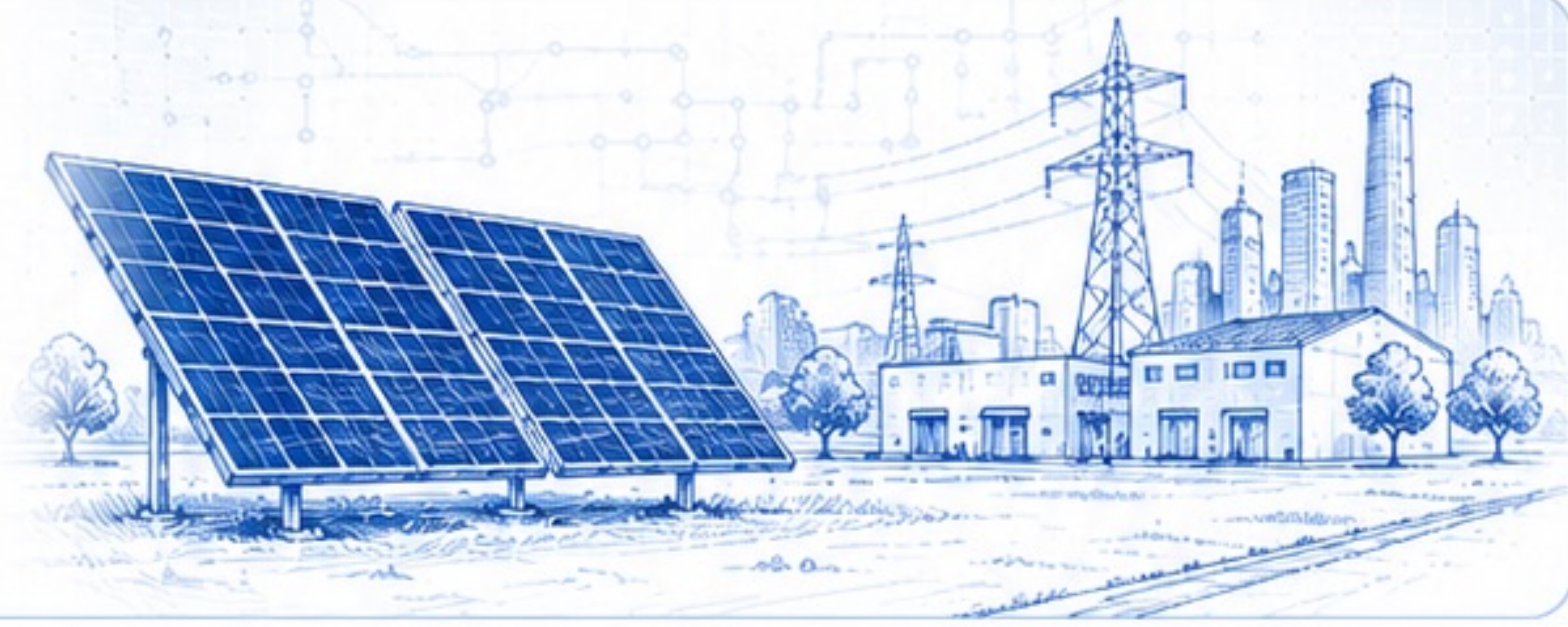
SOLAR PV SYSTEMS

Practical renewable energy training for Libya's future

- Solar Radiation
- PV Output
- Panel Angle
- Battery Storage
- Charge Control
- Inverters
- Loads
- System Protection



Technical Solutions connects renewable energy training to real PV design, operation and maintenance.



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PV PANEL CHARACTERISTICS & SOLAR RADIATION

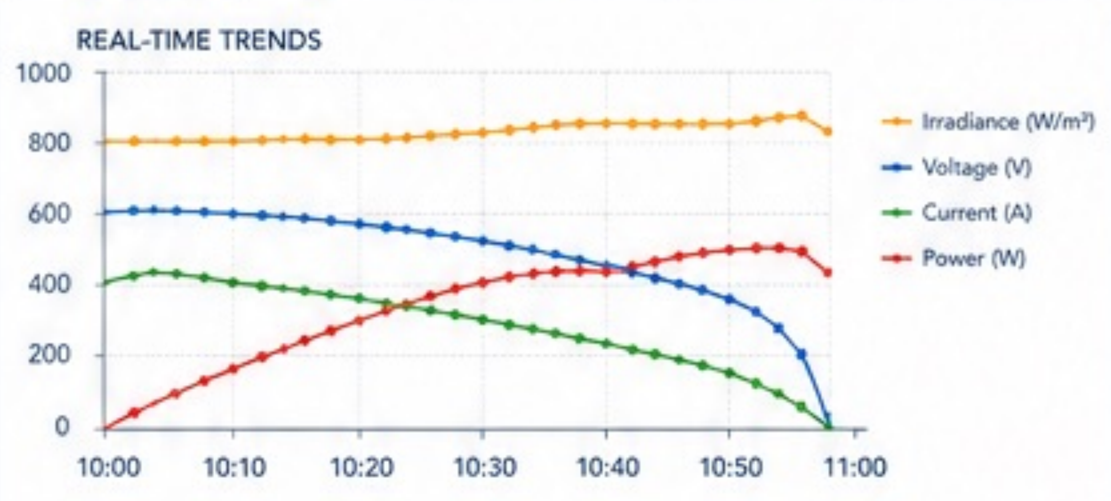
Measuring how light becomes electrical power

Students measure voltage, current and power under different radiation levels, panel angles, shading conditions and load settings.

DATA ACQUISITION & MONITORING

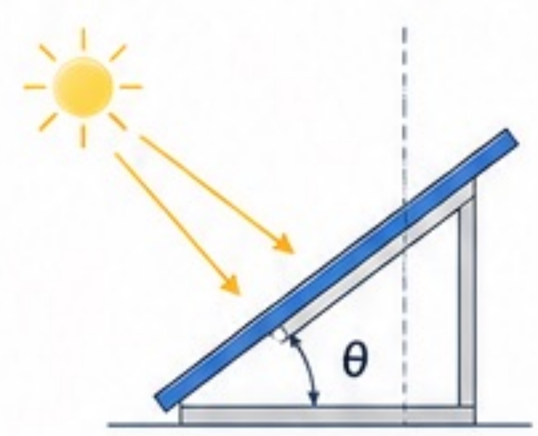
Irradiance	PV Voltage	PV Current	PV Power	Temperature
824 W/m²	24.6 V	3.25 A	79.9 W	34.2 °C

REAL-TIME TRENDS



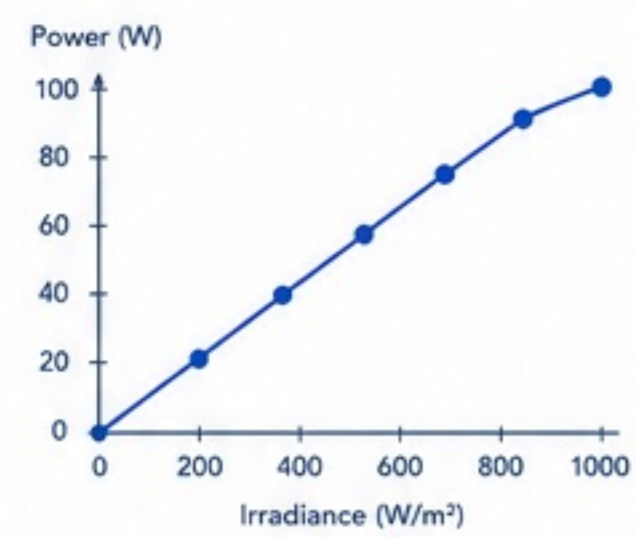
Live View | Data Log | Export | Settings

SOLAR ANGLE & IRRADIANCE



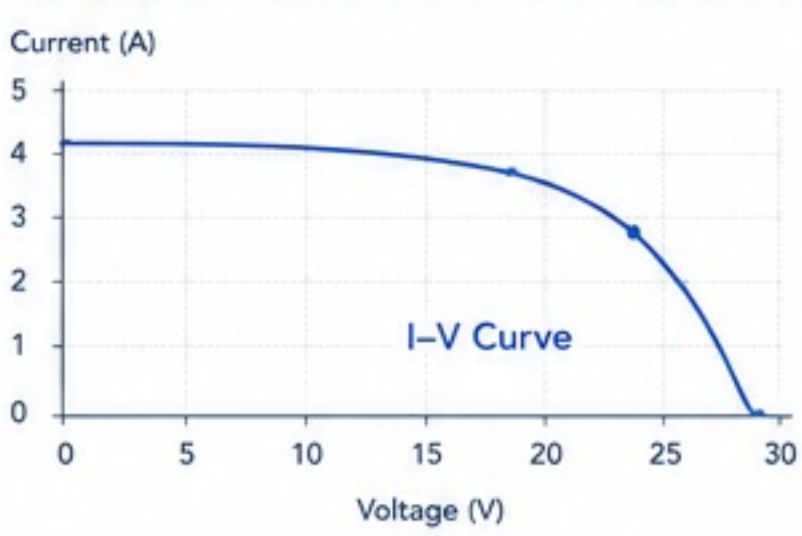
Adjust panel angle (θ) to maximize solar irradiance and energy output.

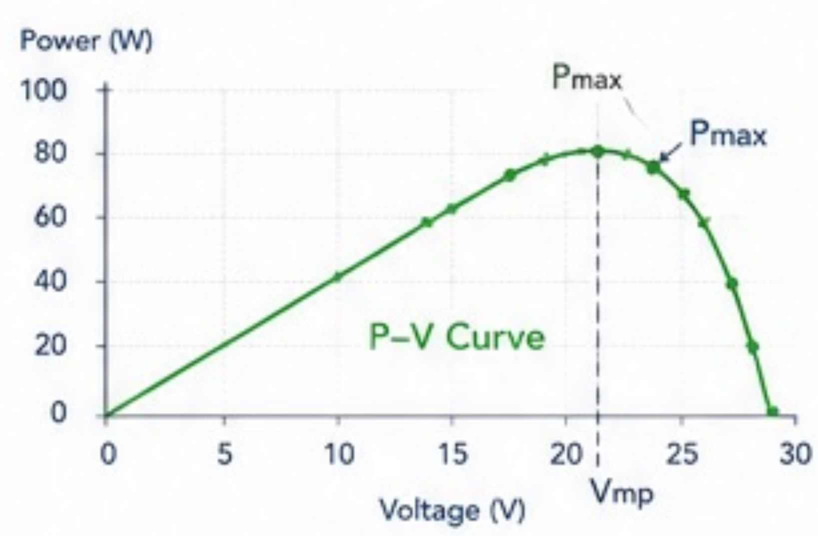
IRRADIANCE VS POWER



Power output increases with higher solar irradiance.

VOLTAGE–CURRENT–POWER CURVES





- I–V Curve shows the relationship between current and voltage.
- P–V Curve shows the power output at each voltage.
- V_{mp} = Voltage at maximum power
- P_{max} = Maximum power output

PRACTICAL SKILLS DEVELOPED

- Solar radiation measurement
- Panel angle adjustment
- Voltage and current measurement
- Power calculation
- PV curve plotting
- Shading effects
- Load behavior analysis

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BATTERIES, CHARGE CONTROL, INVERTERS & LOADS

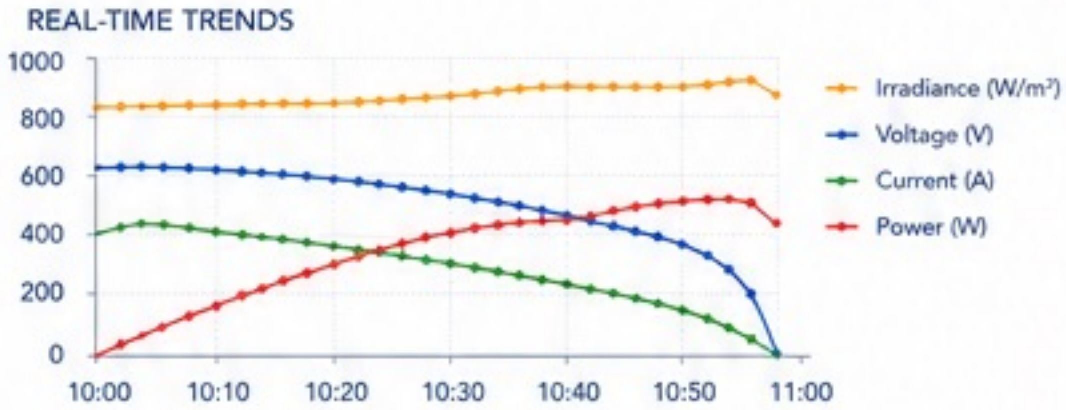
From solar generation to useful electrical supply

Students follow the complete PV energy path from sunlight to storage, control, conversion and practical load operation.

DATA ACQUISITION & MONITORING

Irradiance	PV Voltage	PV Current	PV Power	Temperature
824 W/m²	24.6 V	3.25 A	79.9 W	34.2 °C

REAL-TIME TRENDS



Live View | Data Log | Export | Settings

SYSTEM PROTECTION
Fuse, overload and reverse polarity protection.

SAFE CONNECTION
Secure terminals and clear circuit identification.

REAL-TIME MONITORING
Measure and analyze system performance instantly.

RELIABLE OPERATION
Designed for safe, hands-on learning and practice.

PV ENERGY PATH

SOLAR PANEL

Solar radiation is converted to DC electrical power.

CHARGE CONTROLLER

Regulates voltage and current to charge the battery safely.

BATTERY STORAGE

Stores energy for use when solar power is low.

INVERTER

Converts DC power to AC power for AC loads.

AC / DC LOADS

Provides electrical power to DC and AC loads as required.

PRACTICAL SKILLS DEVELOPED

- Battery charging
- Charge controller operation
- DC load testing
- Inverter operation
- AC load testing
- System protection
- Safe PV connection practice

TECHNICAL SOLUTIONS
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SOLAR PV LABORATORY
DELIVERED BY TECHNICAL SOLUTIONS

SOLAR LIGHT BANK
Adjustable intensity for accurate solar radiation simulation.

A complete training platform for renewable energy education

Technical Solutions delivers PV laboratories with equipment, measurement procedures, safety guidance, instructor training, spare parts planning and maintenance support.

Students learn PV measurement, battery storage, charge control, inverter operation, load testing and performance analysis.

Supporting Libya's renewable energy capability.

- SAFE & RELIABLE EQUIPMENT
- ACCURATE MEASUREMENT
- STRUCTURED LEARNING
- INSTRUCTOR TRAINING
- MAINTENANCE SUPPORT
- SPARE PARTS PLANNING
- PERFORMANCE FOCUSED

PV SKILLS PATHWAY

1. **SOLAR RADIATION** — Measure sunlight intensity.
2. **PV PANEL** — Capture energy and generate DC power.
3. **CHARGE CONTROLLER** — Regulate voltage and protect the battery.
4. **BATTERY STORAGE** — Store energy for continuous supply.
5. **INVERTER** — Convert DC power to AC power efficiently.
6. **LOADS** — Operate DC and AC loads safely and reliably.
7. **PERFORMANCE REPORT** — Analyze results and improve system efficiency.

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LET'S BUILD YOUR POLYTECHNIC LABORATORY

Technical Solutions supports institutions from early concept through full laboratory operation.

Engineering · Procurement · Installation · Commissioning · Training · Maintenance

Technical Solutions

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Contact us to schedule
a laboratory needs assessment.