



MicroNewton Technology Development Co., Ltd.
PASSION. PRECISION. CONVENIENCE. INNOVATION.

MicroNewton

PRODUCT MANUAL

STARTING FROM EXPERIMENTS, NOT JUST EXPERIMENTS

V6.1.0

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ABOUT US

MicroNewton was founded in 2016 and is headquartered in the Comprehensive Bonded Zone of Jinan, Shandong Province, China. We are a technology-driven enterprise dedicated to the research, development, and manufacturing of advanced engineering teaching and research equipment. Our core team comprises over 70 experienced professionals, and we hold more than 40 independent intellectual property rights, reflecting our strong technical capabilities and commitment to innovation. Over the years, we have earned prestigious honors including "High-Tech Enterprise of Shandong Province," "Specialized and Innovative SME," "Innovative SME," and "Technology-Based SME."

Our comprehensive product portfolio covers a wide range of disciplines, including Aerodynamics, Fluid Mechanics, Heat Transfer, Engineering Thermodynamics, New Energy & Energy Storage, Structural and Material Mechanics, as well as our cutting-edge Intelligent Dual-Drive AI Simulation Laboratory. We continuously develop and update our product lines to keep pace with emerging technologies and evolving educational needs. Additionally, we provide tailored customization options to meet the unique requirements of our diverse clientele.

At MicroNewton, we firmly uphold our corporate mission to contribute meaningful value to education worldwide. Our customer-first philosophy guides everything we do, ensuring satisfaction through high-quality products and attentive service. Supported by our deep industry expertise and dedication to excellence, we strive to drive progress in experimental instrumentation. Our solutions empower educational institutions and research organizations both in China and internationally, enabling innovation, interdisciplinary collaboration, and the development of future-ready talent.

MicroNewton has established a strong R&D foundation and efficient manufacturing operations, with steady growth in annual production capacity. The company consistently invests in innovation while driving digital transformation and smart manufacturing, enhancing the intelligence and automation of its products. Our equipment is widely used by leading universities and research institutions worldwide, and our global market presence continues to expand. We have built a multi-channel international sales and support network to provide timely, reliable service. With high-quality products and dedicated customer support, MicroNewton is well-positioned to become a leading domestic and internationally recognized provider of engineering experimental equipment.



STARTING FROM EXPERIMENTS, NOT JUST EXPERIMENTS

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CRAFTSMANSHIP CREATES QUALITY PRODUCTS, SERVICE WINS THE FUTURE

OBTAINED PATENTS

COPYRIGHTS OVER 20 ITEMS



- Wind Tunnel System Data Acquisition, Analysis and Digital Twin Software V1.0
- Wave Energy Generation System Data Acquisition and Analysis Software V1.0
- Multi-energy Complementary Air Conditioning System Data Acquisition and Analysis Software V1.0
- Multi-source Heat Pump Data Acquisition and Analysis Software V1.0
- Structural Mechanics Experimental System Data Acquisition, Analysis and Digital Twin Software V1.0
- H-eco Refrigeration Experiment Data Acquisition Software V1.0
- H-eco Energy and Power Engineering Simulation Software V1.0
- H-eco Thermodynamics Experiment Data Acquisition Software V1.0
- H-eco Fluid Mechanics Data Acquisition Software V1.0

INTELLECTUAL PROPERTY PATENTS OVER 20 ITEMS

- ZL202021959675.6 Aerodynamics Experimental Platform
- ZL202021844691.0 Multi-tube Manometer
- ZL202021844588.6 Flow Field Demonstration Device
- ZL202021844684.0 Bernoulli Equation Experimental Apparatus
- ZL202410338960.2 Air Source Heat Pump System and Its Control Method



ENTERPRISE QUALIFICATION

CORPORATE HONORS



- Specialized, Refined Differential and Innovative SME
- Innovative Small and Medium-sized Enterprise
- Technology-based Small and Medium-sized Enterprise



- National High-tech Enterprise
- Member of Shandong Energy Storage Society
- Member of Shandong Equipment Manufacturing Industry Association



ISO 9001 CERTIFICATION

- ISO 9001 Quality Management System Certification
- ISO 14001 Environmental Management System Certification
- ISO 45001 Occupational Health and Safety Management System Certification



CLOSE COOPERATION WITH OVER A HUNDRED DOMESTIC AND FOREIGN UNIVERSITIES

SELECTED PARTNER UNIVERSITIES (In No Particular Order)



Tsinghua University



Peking University



Sichuan University



Shandong University



University of Shanghai for Science and Technology



Shanghai Jiao Tong University



Tongji University



Zhejiang University



Fudan University



Beijing University of Aeronautics and Astronautics



Xi'an Jiaotong University



East China University of Science and Technology



Rocket Force University of Engineering



Naval Aviation University



Air Force Aviation University



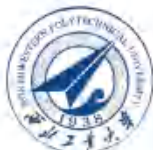
Southeast University



PLA Naval Submarine Academy



Chinese Academy of Sciences



Northwestern Polytechnical University



Dalian University of Technology



China University of Petroleum



China University of Mining and Technology



Jilin University



Nanjing University of Aeronautics and Astronautics



Xinjiang University



Tianjin University of Technology



Shandong Jianzhu University



Southern University of Science and Technology



Tianjin University



Guangdong University of Technology



Huazhong University of Science and Technology



Harbin Institute of Technology



Inner Mongolia Agricultural University



Qinghai University



North China University of Water Resource and Electric Power



University of Science and Technology Liaoning

NEW ENERGY&ENERGY STORAGE SERIES



HEAT TRANSFER SERIES



ENGINEERING THERMODYNAMICS SERIES



FLUID MECHANICS SERIES



AERODYNAMIC SERIES



AERODYNAMIC SERIES

This modular product series is developed in alignment with core topics from the aerodynamics curriculum, integrating fundamental theory with innovative design to support structured, hands-on experimentation.

It enables students to systematically explore key aerodynamic principles, master essential theoretical and analytical methods, and acquire practical skills in experimental operation and engineering simplification.

By bridging theoretical knowledge and real-world application, the system fosters students' ability to analyze physical phenomena, solve practical aerodynamic problems, and develop a solid foundation for advanced study and research.

AERODYNAMICS

01 Fundamental Equations of Fluid Motion

- Continuity Equation
- Momentum Equation
- Energy Equation

► Fundamental Module F100

02 Fundamental Theory of Low-Speed Airfoils and Wings

- Aerodynamic Characteristics of Flow Around Airfoils
- Aerodynamic Performance of Low-Speed Wings
- Lifting Line Theory

F111 Airfoil Pressure Distribution Module

► F116 Flight Demonstration Wind Tunnel
F130 Low-Speed Wind Tunnel

03 High-Speed Compressible Flow

- Speed of sound / Mach number / Stagnation state / Thrust reversal
- Flow characteristics in nozzles

F301 Nozzle Performance Test Bench

► ET202 Nozzle Pressure Distribution Apparatus

04 Compressible Flow Around Airfoils and Wings

- Subsonic flow around thin airfoils and wings
- Transonic flow around airfoils
- Supersonic flow around airfoils

► F380 Intermittent Supersonic Wind Tunnel

05 Boundary Layer Flow

- Characteristics of flat plate boundary layer flow
- Physical characteristics of turbulent boundary layers
- Flow characteristics in pipes

► F103 Flat Plate Boundary Layer Module

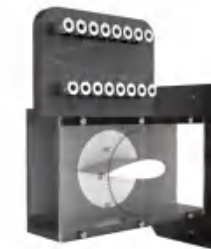
► F104 / F105 Circular Pipe Turbulent Flow / Square Bend Pipe Flow Module

► F106 / F303 Wall Effect Module / Gas Flow Friction Loss Apparatus



F101-Multi-Tube Manometer Module

Simultaneous display of 16-channel pressure measurements.



F111-Airfoil Pressure Distribution Module

Used for studying the pressure distribution along the cross-section of an airfoil.



F108A-Smoke Generator

Smoke generation device for flow field visualization and tracing.



F108-Flow Visualization Experiment Module

Used to visualize airflow.



F102-Bernoulli Equation Experiment Module

Used to verify Bernoulli's equation experimentally.



F103-Flat Plate Boundary Layer Experiment Module

Used to study the effects of different surface roughness on boundary layer thickness and velocity distribution.



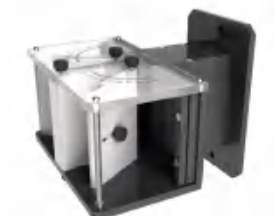
F104-Circular Pipe Turbulent Flow Experiment Module

Used to investigate the characteristics of turbulent flow in circular pipes.



F105-Square Bend Pipe Experiment Module

Used to study the flow characteristics of air passing through curved ducts.



F106-Wall Effect Experiment Module

Used to investigate wall effects (Coanda effect).

► F100 Basic Aerodynamics Experiment Bench



This product serves as the foundational test bench to be used with various aerodynamics experimental modules. Its main functions are to straighten airflow and regulate air volume.

It offers good expandability and flexibility, enabling a wide range of aerodynamics experiments by integrating different functional modules.



F107-Drag Force Analysis Experiment Module

Used to study drag forces around multiple modules.



► F130 Low-Speed Wind Tunnel

A fundamental platform for studying low-speed aerodynamic principles and verifying related theories. Compatible with various test units and models for conducting multiple experiments. Supports customization and experimental expansion.



► FR150 Extreme Aerospace Environment Wind Tunnel

Simulates extreme aerospace conditions.



► E504 Wind Turbine Power Generation System

Demonstrates wind-to-electricity conversion and effects of blade design.



► F380 Intermittent Supersonic Wind Tunnel

This product is widely used as a fundamental experimental platform for studying the basic aerodynamic principles of subsonic and supersonic flows, as well as for validating and developing related theories.



Wind Tunnel Product Series

The wind tunnel series includes flight demonstration wind tunnels, low-speed wind tunnels, supersonic wind tunnels, and environmental wind tunnels. We also offer customized wind tunnels tailored to specific test section dimensions and wind speeds based on customer requirements, enabling simulation of different wind speeds, varying temperature and humidity conditions, and dust environments.

The wind tunnels can be equipped with independently developed testing units such as a three-component balance, smoke generators, and 32-way pressure measurement systems. These allow measurement of lift, drag, pitching moment, and observation of flow field changes around the model inside the wind tunnel.

We support customization of model accessories and offer a variety of wind tunnel experiments through the integration of different functional experimental modules.



► FR150D Low-Speed Icing Wind Tunnel

A research wind tunnel designed to study aircraft anti-icing and de-icing performance.



► F116 Flight Demonstration Wind Tunnel

An educational wind tunnel used to study fixed-wing aircraft wing performance and flight principles, including takeoff, cruise, stall, and landing.



► F301 Nozzle Performance Test Apparatus

Used to study the effects of inlet pressure and back pressure on nozzle jet velocity.

1. Demonstrates nozzle choking phenomenon
2. Investigates impact of intake pressure and ambient back pressure on jet velocity
3. Analyzes actual vs. theoretical jet velocity
4. Studies jet velocity variations under different inlet and back pressures
5. Examines nozzle efficiency
6. Explores relationships between jet thrust, inlet pressure, back pressure, and thrust per unit airflow
7. Supports custom nozzles and additional functions for extended applications

► F303 Gas Flow Friction Loss Experiment Apparatus

Used to study pressure losses of compressible fluids in various pipes and Reynolds numbers.

1. Investigates basic pipe friction characteristics
2. Studies pipe friction coefficients at different Reynolds numbers
3. Analyzes fluid friction coefficients in compressible flow
4. Examines pressure loss and recovery when flow direction changes suddenly
5. Studies pressure loss in pipe bends



► ET202 Nozzle Pressure Distribution Experiment Apparatus

Measures pressure distribution in convergent and convergent-divergent (Laval) nozzles and studies actual flow rates of compressible fluids.

1. Demonstrates nozzle choking phenomenon
2. Observes over-expansion and under-expansion with shock waves in the nozzle
3. Studies relationship between inlet pressure and flow velocity inside the nozzle
4. Examines effect of ambient back pressure on flow velocity inside the nozzle
5. Investigates combined impact of inlet pressure and back pressure on nozzle flow speed
6. Analyzes pressure distribution in three nozzle types under various inlet-to-outlet pressure ratios
7. Supports additional custom functions and expansions

FLUID MECHANICS SERIES

This modular product series is based on core fluid mechanics curriculum topics, integrating theory with innovation to facilitate comprehensive experiments. It helps students grasp fundamental concepts, principles, and equations of fluid mechanics, develop problem-solving skills, and apply fluid mechanics knowledge to engineering challenges. This foundation supports advanced studies, professional work, and research in the field.

FLUID MECHANICS

01 Fundamental Equations of Fluid Motion

- Continuity Equation
 - Energy Equation
 - Momentum Equation
- Fundamental Principle H100
 - H108 Momentum Equation Experimental Apparatus

02 Fluid Statics

- Concepts and Characteristics of Liquid Static Pressure
 - Pressure Calculation, Measurement, and Gauging
 - Vortex Surface Profile and Total Head Variation
- H201/H211 Fluid Statics Experimental Apparatus / Pressure Center
 - H105 Vortex Experimental Apparatus

03 Fundamentals of Fluid Mechanics

- Energy Equation
 - Streamlines and Pathlines
 - Laminar and Turbulent Flow, Reynolds Number
 - Flow Measurement Methods and Calculations
- H101 Bernoulli Experimental Apparatus
 - H012 Flow Field Demonstration Apparatus
 - H102 Reynolds Number Measurement Apparatus
 - H103/H104 Flow Measurement / Calibration Apparatus

04 Flow Resistance and Energy Loss

- Frictional Loss and Local Loss
- H130/H109 Flow Resistance / Local Loss Experimental Apparatus

05 Orifice, Nozzle, and Pipeline Flow

- Free Discharge from Orifice
 - Water Hammer in Pressurized Pipes
 - Cavitation Phenomenon
- H110 Orifice and Nozzle Comprehensive Experimental Apparatus
 - H106/H107 Pulsation and Water Hammer / Water Hammer Pump Experimental Apparatus
 - H210 Cavitation Experimental Apparatus

06 Pump Applications and Others

- Series and Parallel Connection of Centrifugal Pumps
 - Centrifugal Pump Performance Testing
- H265 Series and Parallel Pump Experimental Apparatus
 - H266 Programmable Centrifugal Pump Experimental Apparatus



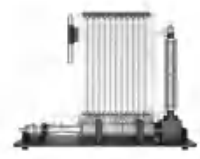
H101 - Bernoulli Experimental Apparatus

Observes pressure distribution in a Venturi tube and verifies Bernoulli's and continuity equations.



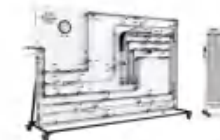
H102 - Reynolds Number Apparatus

Demonstrates laminar, transitional, and turbulent flows; measures Reynolds number.



H103 - Flow Measurement Experimental Apparatus

Demonstrates and studies the working principles of various flow meters.



H130 - Flow Resistance Experimental Apparatus

Studies frictional and local resistance losses in pipes and the use of flow meters such as orifice plates, Venturi tubes, and Pitot tubes, including local resistance calculations.

H100 Basic Fluid Mechanics Experiment Platform



This basic platform supports water circulation and flow control for fluid mechanics experiments. It features dual-level tanks for observing flow over various weirs and allows quantitative flow calibration. Highly expandable with modular compatibility.



H120 - Impulse Turbine

Investigates the working principle of impulse turbines and analyzes the relationship between inlet pressure, flow rate, torque, power, speed, and nozzle position.



H111 - INozzle and Jet Velocity Experimental Apparatus

Used to plot the horizontal jet trajectories produced by different orifice openings.



H110 - Orifice and Nozzle Comprehensive Experimental Apparatus

Studies flow characteristics of various orifice shapes, measuring parameters like contraction coefficient, velocity coefficient, and flow coefficient.



H106 - Pulsation and Water Hammer Experimental Apparatus

Investigates pulsating flow and water hammer phenomena in pipelines, including their causes and effects.



H109 - Local Loss Experimental Apparatus

Studies local head losses when fluid flows through different enlargements and sudden expansions in pipes.



H108 - Momentum Equation Apparatus

Measures impact force of water flow on plates; verifies momentum equation.



H107 - Water Hammer Pump Experimental Apparatus

Primarily used to study the water hammer effect and the water-lifting principle generated by it.



► H201 Hydrostatics Experimental Apparatus

Used to study basic physical concepts and principles in fluid statics.

1. Quantitative determination of density and specific gravity
2. Observation of capillary phenomena in tubes and between plates
3. Viscosity measurement of various liquids via falling-ball method
4. Demonstration and verification of Pascal's and Archimedes' laws
5. Stability study of boat-shaped float and determination of metacentric height
6. Verification of pressure center distribution in static fluids
7. Measurement methods for liquid level height
8. Demonstration and practice of various static pressure measurement methods
9. Calibration and operation of Bourdon pressure gauge



► H210 Cavitation Experimental Apparatus

Designed for cavitation studies in a Venturi model, used in Fluid Mechanics experiments.

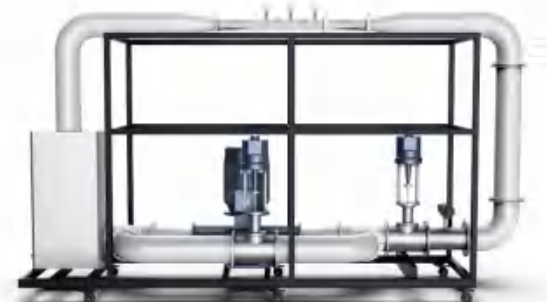
1. Study the effect of flow velocity on cavitation
2. Verify the continuity equation and observe how cavitation affects fluid characteristics
3. Measure and analyze pressure changes at the Venturi inlet and throat to determine cavitation conditions



► H300 2.5m Open Channel Flume Apparatus

A multifunctional open-channel flume designed for demonstrating various flow phenomena. Equipped with interchangeable models such as weirs, sluice gates, bridge piers, levees, wave makers, and floodplains. Customization supported.

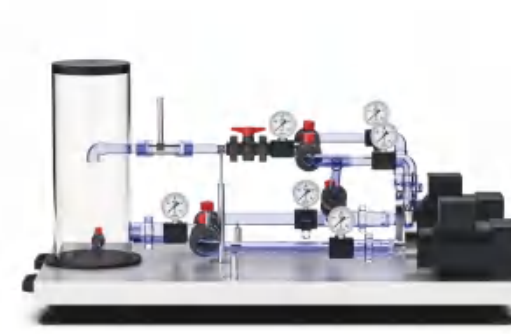
1. Influence of channel slope on flow regimes
2. Flow pattern changes over weirs
3. Flow transformation over floodplain structures
4. Flow around bridge piers
5. Flow through sluice gates
6. Flow dissipation with energy loss structures
7. Wave behavior against breakwaters



► H501 Compact Water Tunnel Test Platform

Composed of a contraction section, test section, diffuser, axial pump, rectifier, and flow stabilizer.

1. Resistance testing of various models and specimens
2. Provides low-turbulence, constant-speed flow fields for experiments in fluid mechanics and hydraulics
3. Supports extended applications such as surface friction resistance testing with adaptable materials for related disciplines



► H265 Series and Parallel Pump Test Bench

A compact, tabletop, fully self-contained centrifugal pump system supporting three operation modes: single pump, series, and parallel operation.

1. Measure head vs. flow rate characteristics
2. Study pump behavior in series operation
3. Study pump behavior in parallel operation
4. Investigate single pump performance
5. Demonstrate cavitation phenomenon



► H266 Programmable Centrifugal Pump Test Bench

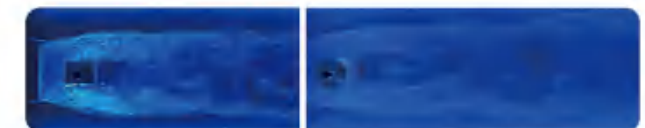
An advanced test system for both fundamental and applied turbomachinery analysis, supporting programmable control and data acquisition.

1. Analyze turbomachinery: Euler's equation, impeller velocity triangles, ideal pump curves
2. Study pump performance under varying flow rates and speeds: power consumption, efficiency
3. Explore pump selection, modeling, and similarity scaling based on known speed and dimensions
4. Identify pump operating points under different pressure conditions
5. Conduct energy-saving experiments by adjusting speed and system load
6. Design and evaluate custom impeller blade profiles for specific applications

► H012 Flow Field Demonstration Apparatus

Used to demonstrate laminar, turbulent, and transitional flow states. Includes various models (airfoil, S-shape, cylinder, etc.) with expansion options, showing vortex formation and Kármán vortex street.

1. Visualizes 2D flow
2. Demonstrates flow around objects and streamlines
3. Shows boundary layer separation
4. Demonstrates vortex formation and Kármán vortex streets
5. Qualitatively observes velocity distribution in laminar and turbulent flows
6. Simulates airflow patterns



• Vortex Formation and Kármán Vortex Street Phenomenon



• Laminar Flow Phenomenon



• Transitional Flow Phenomenon



• Turbulent Flow Phenomenon

HEAT TRANSFER SERIES

This modular series, based on heat transfer curriculum, enables easy and systematic experiments. It helps students master heat transfer modes, measurement skills, experiment design, data analysis, and engineering calculations, laying a solid foundation for advanced study and research.

HEAT TRANSFER

01 Conduction

Steady state
Transient

- 1D steady axial conduction
- 1D steady radial conduction
- Multilayer cylindrical wall conduction
- Transient conduction in solids
- Use of nomographs
- Transient calculations for plates, cylinders, spheres

- ▶ TH101 Linear Conduction
- ▶ TH102 Radial Conduction
- ▶ TH107 Liquid and Gas Thermal Conductivity
- ▶ TH106 Transient Conduction

02 Convection

Single-phase convection
Phase-change convection

- Air natural convection around tubes
- Condensation / Boiling
- Film boiling

- ▶ TH104 Convection and Radiation
- ▶ TH111 Boiling Heat Transfer
- ▶ TH300 Film Boiling Heat Transfer

03 Radiation

Thermal radiation
Optical radiation

- Planck's law
- Wien's displacement law
- Stefan-Boltzmann law
- Lambert's law
- Kirchhoff's law

- ▶ TH103 Radiation Heat Transfer

04 Integrated Applications

Heat exchangers
Heat pipes and others

- Plate heat exchangers
- To be expanded

- ▶ TH200 Basic Heat Exchanger Test Bench



TH101-Linear Conduction Module

Study 1D steady-state conduction; analyze axial heat transfer and temperature distribution in rod-shaped materials.



TH102-Radial Conduction Module

Measures steady radial temperature distribution through cylindrical walls.



TH103-Radiation Heat Transfer Module

Verifies laws and principles of thermal and optical radiation.



TH111-Pool Boiling Heat Transfer Module

Studies convection, bubble boiling, and transition boiling in pool boiling.

▶ TH100 Heat Transfer Base Unit



This product serves as a fundamental experimental platform designed to support various modules in the Heat Transfer Series. It provides functions such as data acquisition, display, storage, and adjustable power output. It is capable of collecting parameters including temperature, pressure, current, voltage, power, flow rate, wind speed, illuminance, and radiation intensity.

With excellent expandability and flexibility, it enables a wide range of heat transfer experiments through the integration of different functional modules.



TH110-Convection on Plates, Pins, and Fins Module

Compares heat transfer efficiency of flat plates, pin fins, and extended fins under natural and forced convection.



TH104-Convection & Radiation Heat Transfer Module

Explores combined heat transfer by natural/forced convection and radiation.



TH105-Fin Surface Heat Transfer Module

Studies fin surface heat transfer and steady-state temperature profile under natural convection and radiation.



TH107-Thermal Conductivity of Liquids and Gases Module

Measures thermal conductivity of non-corrosive liquids and non-combustible gases.



TH106-Transient Conduction Module

Observes transient heat conduction and core temperature variation over time in metal bodies.



TH201- Double Pipe Heat Exchanger

Used to study the principles and process of convective heat transfer in concentric tube heat exchangers.



TH202-Plate Heat Exchanger

Used to study flow characteristics and heat transfer mechanisms within plate-type exchangers.

TH200 Heat Exchanger Base Unit



Base unit designed to support various heat exchanger modules. Provides water circulation, power control, and data acquisition functions (temperature, pressure, flow).

Highly expandable and customizable.



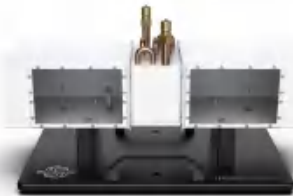
TH203-Shell-and-Tube Heat Exchanger

Designed for investigating convective heat transfer behavior in shell-side and tube-side flows.



TH204-Jacketed Heat Exchanger

Focuses on examining the heat transfer performance in jacketed vessel configurations.



TH205-Water-Air Fin Tube Heat Exchanger

Analyzes convective heat transfer between water and air and evaluates the effect of fin structures on heat transfer efficiency.

TH300 Film Boiling Heat Transfer Apparatus

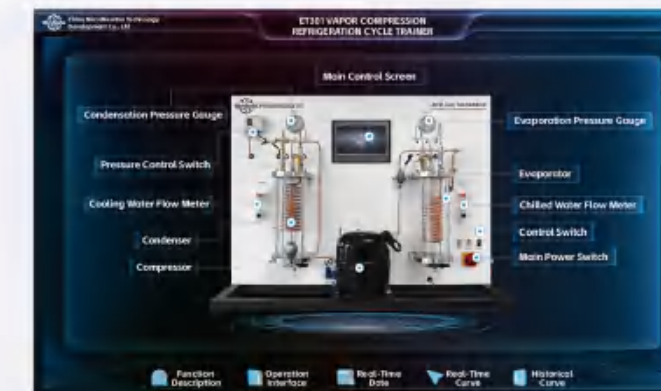
Investigates film boiling phenomena of water droplets under different drop heights, sizes, and surface structures.

1. Observe the Leidenfrost effect on smooth and rough surfaces
2. Study droplet motion on grooved surfaces with various tilt angles
3. Plot droplet lifetime and geometric changes over time
4. Compare directional movement of droplets across different structures

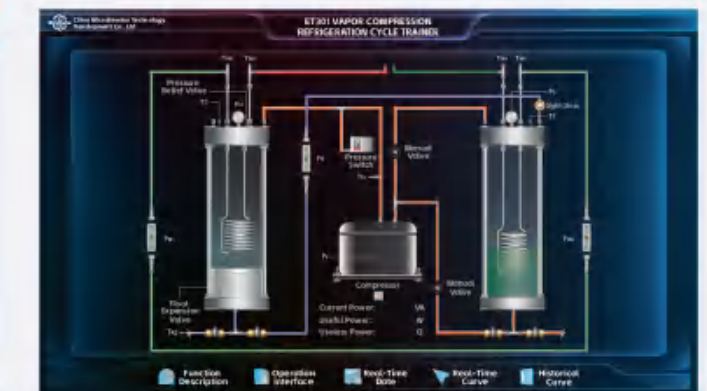


PRODUCT UI INTERFACE

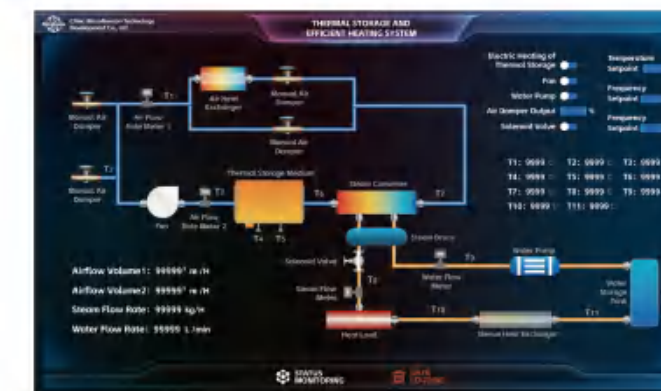
Vapor Compression Refrigeration Cycle Trainer



Vapor Compression Refrigeration Cycle Trainer



Thermal Storage and High-Efficiency Heating System



Steam Absorption Refrigeration Experiment System



Stacked Flow Battery Testing Platform



LNG Cold Energy Recovery System



ENGINEERING THERMODYNAMICS SERIES

This modular product series is designed based on the Engineering Thermodynamics syllabus, combining core theory with practical innovation. It enables students to systematically conduct experiments, understand heat and energy conversion principles, and apply thermodynamic analysis to real-world problems.

Students gain essential skills in temperature, heat, and flow measurement, as well as experiment design and data analysis. The system lays a solid foundation for advanced learning, professional work, and scientific

ENGINEERING THERMODYNAMICS

01 First Law of Thermodynamics

- Basic Energy Equations
- Energy Transfer & Conversion
- Direction of Energy Conversion

► Basic Thermodynamics Module ET100

02 Second Law of Thermodynamics

03 Properties & Processes of Gases and Steam

- Gas State Equation
- Constant Volume / Pressure / Temperature Processes
- Specific Heat Ratio
- Adiabatic Index
- Properties of Water Vapor
- Gas Flow and Compression – Flow Characteristics in Nozzles

- ET101 Ideal Gas Experimental Module
- ET101 Ideal Gas Experimental Module
- ET104 Air Adiabatic Index
- ET105 Saturated Steam P-T
- ET202 Nozzle Pressure Distribution Unit

04 Steam Power Cycles

- Rankine Cycle
- Steam Power System Analysis

► ET201 Rankine Cycle Trainer

05 Refrigeration Cycles

- Vapor Compression Refrigeration Cycle
- Heat Pump Cycle
- Other Refrigeration Types

- ET301 Vapor Compression Trainer
- R306 3-Source Heat Pump System
- R216/R108 Absorption/Thermoelectric Refrigeration

06 Ideal Gas Mixtures & Moist Air

- Moist Air
- Wet-Bulb Temperature
- Moist Air Processes & Applications
- Specific Heat Measurement

► ET103 Constant Pressure Specific Heat

► ET100 Basic Thermodynamics Workbench



This product serves as a fundamental experimental platform designed to support various modules of the Engineering Thermodynamics series by providing data acquisition, display, storage, and power output regulation functions. It can collect parameters such as temperature, pressure, current, voltage, power, and flow rate.

The platform is equipped with a built-in LCD touchscreen and preloaded with multiple Engineering Thermodynamics experiment modules (customization and expansion supported). It displays internal structural diagrams and real-time data from measurement points, as well as dynamic experiment curves. Experimental data can be exported in formats such as video and Excel. In addition to working with Engineering Thermodynamics modules, the platform can also be used independently as a data acquisition tool.



► ET101-Ideal Gas Law Experiment Module

Designed for theoretical analysis and experimental study of the ideal gas law in engineering thermodynamics.



► ET103-Constant Pressure Specific Heat Experiment Module

For theoretical analysis and experimental study of the specific heat of gases at constant pressure.



► ET104-Adiabatic Index of Air Experiment Module

For analysis and experimental study of the adiabatic (isentropic) index of air.



► ET105-Saturated Steam P-T Experiment Module

Used to study the pressure-temperature relationship of saturated water/steam.



► ET201 Rankine Cycle Experimental Setup

This setup includes the main components of the Rankine cycle: steam boiler, high-efficiency turbine generator, condenser, feedwater tank, and feedwater pump.

1. Study the complete Rankine cycle principles
2. Analyze steam boiler energy conversion efficiency
3. Investigate steam P-V diagrams in the cycle
4. Examine effects of condensate reheating and feedwater injection
5. Demonstrate the full operating cycle of a steam power plant
6. Evaluate fuel consumption, boiler efficiency, and condenser heat exchange performance



► R260 Air Conditioning Experimental Unit

For studying the refrigeration cycle and air-conditioning process, with temperature and humidity measurement and psychrometric chart analysis.



► R903 Multifunctional High-Temperature Heat Pump Experimental System

With two different evaporator configurations (air-cooled and water-cooled), it can produce hot water above 60 °C and can be coupled with thermal storage equipment to provide a heat source.



► R262 Innovative Heat and Mass Exchanger Performance Testing System

It can perform air treatment processes such as heating, humidifying, cooling, and dehumidifying, and can measure, display, control, and adjust the air temperature and humidity. This system provides intuitive teaching conditions for students in the HVAC field.



► R109 Compressor Performance Test Bench

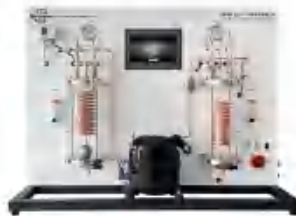
For testing compressor capacity, power consumption, and efficiency under different operating conditions.



Refrigeration and Air Conditioning Series

This product series focuses on the study of refrigeration cycles and heat pump systems. It covers multiple refrigeration methods, including vapor absorption, vapor compression, and semiconductor cooling. The series meets teaching needs in industrial refrigeration, commercial cold chains, building air conditioning, and new energy vehicle thermal management.

All units come standard with LCD screens displaying internal operating principles, real-time measurement data, and dynamic experimental curves. Data export in spreadsheet format is supported for easy analysis and processing.



► ET301 Vapor Compression Refrigeration Cycle Device

For demonstrating the vapor compression cycle and refrigerant phase change process.



► R105 Modular Basic Refrigeration Training System

For basic experiments on refrigeration cycles and system operation.



► R108 Thermoelectric Refrigeration Experimental Unit

For studying semiconductor thermoelectric cooling and different power-driven configurations.



► R216 Vapor Absorption Refrigeration System

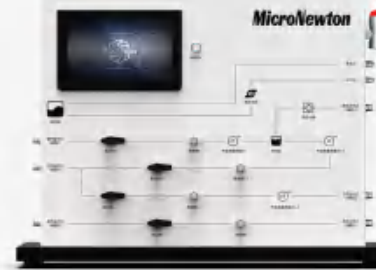
For experiments on absorption refrigeration performance and waste-heat recovery applications.



► R306 Air-Water-Ground Triple-Source Heat Pump System

Designed for teaching and experimental research in Engineering Thermodynamics and Heat Pump Technology.

► E300 Comprehensive Combustion Experimental System



Designed for combustion course teaching and energy engineering applications, this modular system allows flexible switching between gas types, burners, and experimental modules. It supports real-time data acquisition of flow and pressure for calculation and analysis, making it ideal for teaching, training, and research purposes.



► E301-Flame Counterflow Experimental Module

Used to study laminar counterflow premixed and diffusion flames, and to measure convective field parameters such as flame stretch rate in response to different flame types.



► E303-Flat Flame Burner

Enables combustion experiments with various gases or pulverized coal to study different fuel characteristics.



► E302-Flame Propagation Experimental Module

Designed to study laminar premixed and laminar diffusion flames. Enables measurement of premixed flame propagation speed and diffusion flame height.



► E305-Pulverized Coal Particle Combustion Visualization Experimental Apparatus

Used for in-depth study of coal combustion characteristics and optimization, as well as analysis of the gaseous components generated during combustion.

FLAME COMBUSTION PHENOMENON



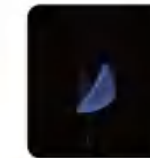
Planar Counterflow Diffusion Flame



Premixed Flame in a Variable-Diameter Tube



Planar Counterflow Premixed Flame



Premixed Flame in a Uniform-Diameter Tube



Bunsen Burner Premixed Flame



Oscillating Premixed Flame in a Rijke Tube



► ET401 Gas Turbine Experimental System

A miniaturized gas turbine setup including compressor, combustion chamber, high-speed turbine, and control system.

1. Demonstrates a complete gas power cycle
2. Studies energy conversion and efficiency in each stage
3. Analyzes effects of gas flow and temperature on efficiency
4. Explores how flow and temperature impact thrust performance

NEW ENERGY & ENERGY STORAGE SERIES

This modular product series, based on energy-related engineering curricula, enables efficient energy experiments. It helps students analyze natural phenomena, solve practical energy problems, and understand energy system design, while fostering innovation for future energy conservation and carbon reduction efforts.

New Energy & Energy Storage Series

01 New Energy

Solar Energy Utilization	- Solar Collectors - Solar Thermal Systems	- E801A/E801B/E801C Parabolic/Flat Plate/Vacuum Tube Solar Collector Units - Customizable
Solar Photovoltaic Utilization	- Solar Photovoltaic Power Generation - Solar Photovoltaic/Thermal (PVT)	- E801F Solar Photovoltaic Unit - E801D Solar Photovoltaic-Thermal Unit
Wind Energy Utilization	Wind Power Generation Systems	E504 Solar Photovoltaic-Thermal Unit
Biomass Energy	- Biomass Pyrolysis - Biomass Combustion	- Customizable - Customizable
Ocean Energy	- Tidal Energy - Wave Energy - Ocean Current/Temperature Difference Energy	- Customizable - Customizable - Customizable
Geothermal Energy	- Shallow Geothermal - Hydrothermal Resources	- R306 Air-Water-Ground Triple Source Heat Pump Experimental System - Customizable

02 Energy Storage

Mechanical Energy Storage	- ES101 Micro Compressed Air Energy Storage Experimental System - ES102 Small Pumped Storage Demonstration Experimental Device - ES103 Small Flywheel Energy Storage Experimental System	- Cross-time and Flexible Regulation - Multi-power Source Switching
Electromagnetic Energy Storage	ES104 Small Supercapacitor Energy Storage Experimental Device	- Switchable Capacitors - Multi-power Source Switching - Multi-load Switching
Chemical Energy Storage	- ES105 Stacked Flow Battery Module Testing Platform - ES106 Battery Performance Testing Platform - ES107 Electrolytic Hydrogen Fuel Cell Experimental Device	- Different Flow Fluids Replacement - Supports Multiple Battery Types - Equipped with Battery Thermal Management System - Alkaline Water Electrolysis Hydrogen Production Technology - Electrolyzer Directly Connected to Hydrogen Fuel Cell, No Hydrogen Storage Tank
Latent Heat Energy Storage	ES108 Phase Change Energy Storage Experimental/Testing System	- Dual Flow Battery - Single Deposition Flow Battery - Dual Deposition Wave Flow Battery - Metal/Air Flow Battery - Different Materials, Various Composite Structures - Temperature Distribution Characteristics - Solid-Liquid Phase Change Composite Structures

03 Multi-energy Complementary and Sustainable Energy Systems

- Hybrid Energy Series
- Integrated Energy Series
- E401
- Customized



ES101-Micro Compressed Air Energy Storage Experimental System

Based on a standard compressed air energy storage system, composed of a compressor, air storage tank, and turbine generator set. Output can connect to the main energy storage unit and supports multi-module coupling.



ES102-Small Pumped Storage Demonstration Device

Based on the standard layout and operation principle of a real pumped storage power station. The pump simulates the height difference, with frequency regulation, output connected to the energy storage module.

Enables demonstration of pumped storage principles, energy storage efficiency analysis, peak-valley operation experiments. Can be combined with other modules to build distributed energy systems.



ES103- Small Flywheel Energy Storage Experimental System

Supports flywheel energy storage operation demonstration and power conversion calculations; can integrate with gas modules for distributed energy system setup.



ES104-Small Supercapacitor Energy Storage Experimental Device

Demonstrates supercapacitor energy storage principles and tests capacitor charge-discharge performance.



ES105-Stacked Flow Battery Module Testing Platform

A typical redox battery that converts chemical energy and electrical energy via redox reactions of ions with different valences.

Supports swapping different flow liquids such as all-vanadium, zinc-iron, zinc-rust, iodine, organic solution, electrolytic hydrogen, methanol, etc. Compares charge-discharge performance of different flow liquids; outputs connect to main energy storage and battery testing units.

ES108-Phase Change Energy Storage Experimental System

Used to study the heat storage and release characteristics of phase change materials.



ES109-Phase Change Thermal Storage Visualization Experiment Device

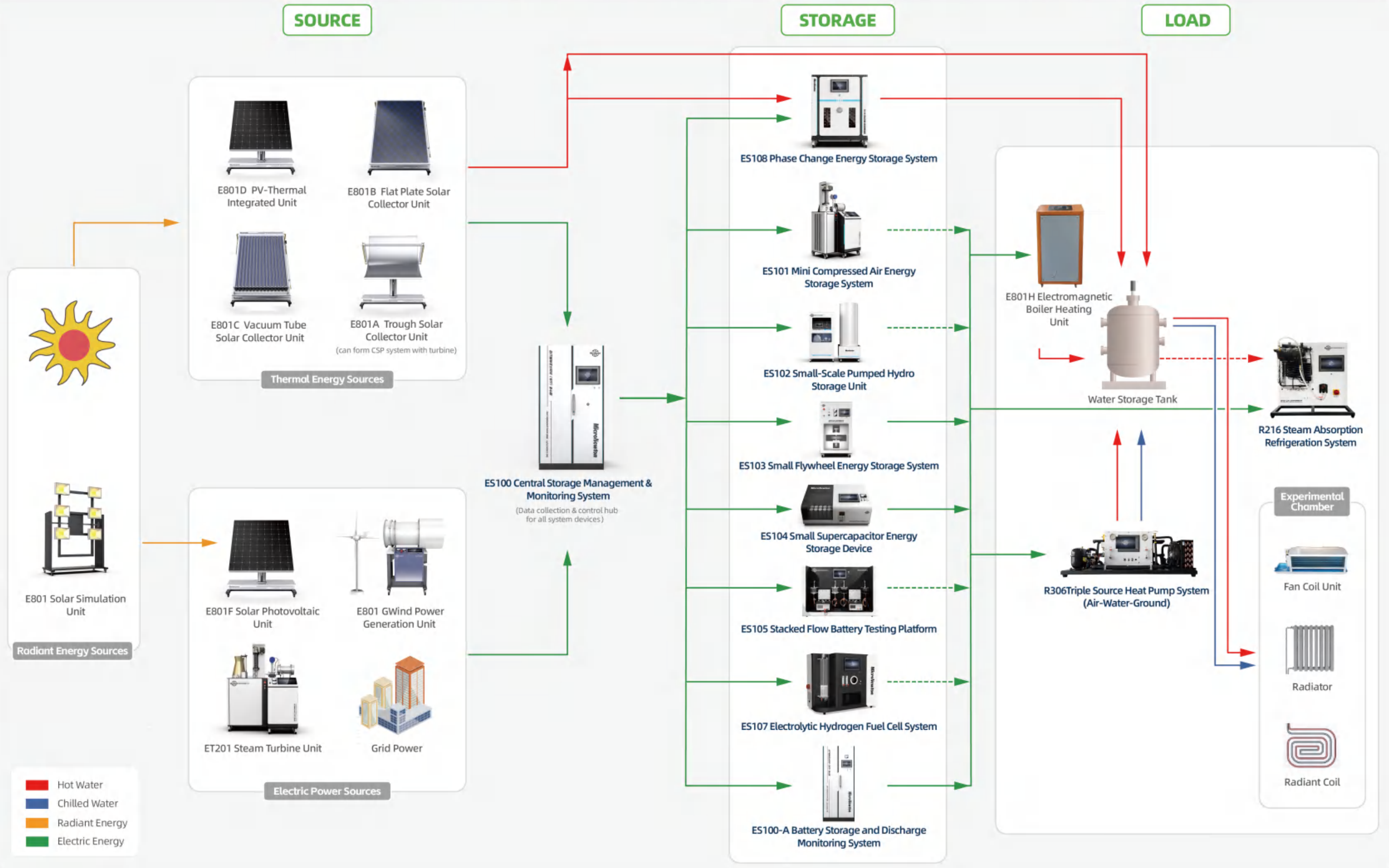
This experiment helps to understand the phase change behavior of phase change materials (PCMs) during heat storage and release. Through a visualization window, the melting and solidification of paraffin can be directly observed, and methods for comparing the thermal performance of materials with different phase change temperatures (e.g., Paraffin No. 45 and No. 37) can be mastered.



ES107-Electrolytic Hydrogen Fuel Cell Device

Used for understanding the structure and principles of hydrogen electrolysis systems, analyzing electrolytic hydrogen efficiency, and testing hydrogen fuel cell output characteristics.

► **MicroNewton** INTEGRATED MULTI-ENERGY COMPLEMENTARY EXPERIMENTAL PLATFORM



MATERIALS MECHANICS SERIES

This Mechanics of Materials product series adapts to the core teaching curricula of mechanical, energy, aerospace, civil engineering and advanced manufacturing. Focusing on the three core mechanical properties of strength, stiffness and stability, it integrates modern engineering innovation into experimental teaching.

Compliant with standard teaching syllabi, the product range covers full essential knowledge, including basic tension, compression, bending, torsion and shear deformation, as well as complex experiments of bending-torsion combination, asymmetric bending, column buckling, fatigue, creep and impact loading.

Adopting advanced testing technology and integrated multifunctional design, the equipment helps students grasp component load-bearing performance and failure mechanisms, meets engineering demands for new material evaluation and structural safety analysis, and cultivates engineering talents with solid mechanical literacy and problem-solving capabilities.

01 Basic Mechanical Properties

► MS01 Material Testing Apparatus

02 Basic Deformation and Internal Force Testing

- MS02 Axial Loading Apparatus
- MS03 Torsion of Shafts Apparatus
- MS04 Beam Shear & Moment Apparatus
- MS05 Beam Bending Apparatus

03 Complex Loading and Combined Deformation

- MS06 Thin-Walled Pressure Vessel Apparatus
- MS07 Unsymmetrical Beam Apparatus
- MS08 Combined Bending & Torsion Apparatus

04 Stability, Fatigue and Dynamics

- MS10 Buckling of Struts Apparatus
- MS11 Impact Loading Apparatus
- MS12 Rotating Fatigue Testing Machine

05 Special Mechanical Behavior

- MS09 Curved Beam & Cable Apparatus
- MS13 Creep Testing Apparatus

06 Portable Demonstration of Mechanics Principles

- MS14 Universal Materials Testing System

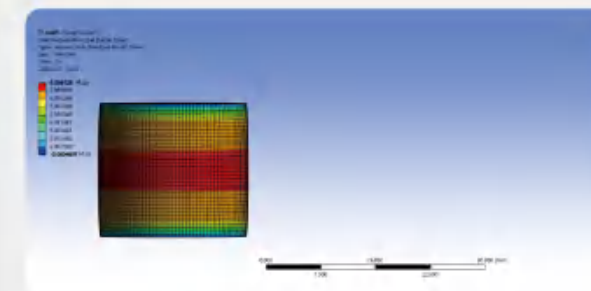


► MS01 Material Testing Apparatus

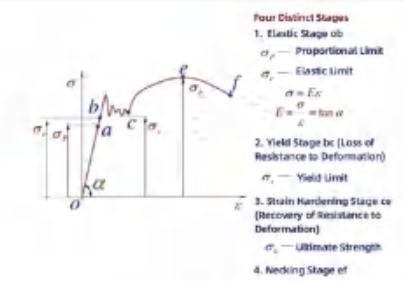
- This precision tester adopts computerized electronic universal testing technology for low-load, high-precision material tests.
- Rated at a maximum 10 kN test force, its fully digital closed-loop system delivers accurate, wide-range loading speed and force readings with sensitive load and displacement detection.
- It performs tension, compression, bending and shear tests on miniature delicate samples such as metal wires, plastic films, fibers and biological tissues. Suitable for lab teaching and industrial quality control across aerospace, chemical, cable, textile, food & pharmaceutical packaging sectors.
- Equipped with dedicated control software, it supports stress, strain, cyclic and user-programmable control. It auto-calculates elastic modulus, yield strength and outputs test reports meeting GB, ISO and ASTM standards, ideal for material mechanical research.

Specimen Material	Acquisition Channels	Error Range	Testing Machine Class
Carbon steel, Stainless steel	5 channels	±5%	Class 1
Display	Product Dimensions (mm)	Product Weight	Input Power Supply
10.1-inch	700 x 370 x 1500	Approx. 200 kg	Single-phase three-wire, 220 V

I FINITE ELEMENT SIMULATION ANALYSIS



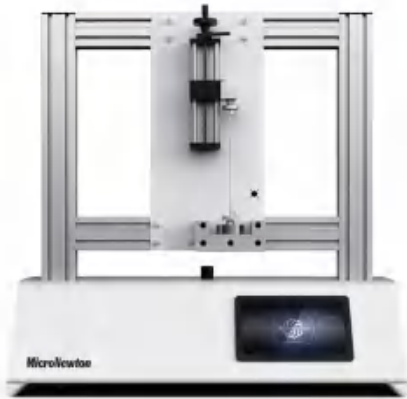
Compression - Elastic Strain



Stress - Strain Curve

I EXPERIMENTAL FUNCTIONS

1. **Tensile Test:** Determines the modulus of elasticity (E), yield strength, tensile strength, percentage elongation after fracture, and percentage reduction of area.
2. **Compression Test:** Determines the compressive strength and modulus of elasticity of brittle materials (e.g., small wood blocks, rigid plastics, foam)
3. **Bending Test:** Performs three-point or four-point bending tests to determine the flexural strength and flexural modulus of materials
4. **Shear Test:** Determines the shear strength of rivets, pins, or adhesive joints using dedicated shear fixtures

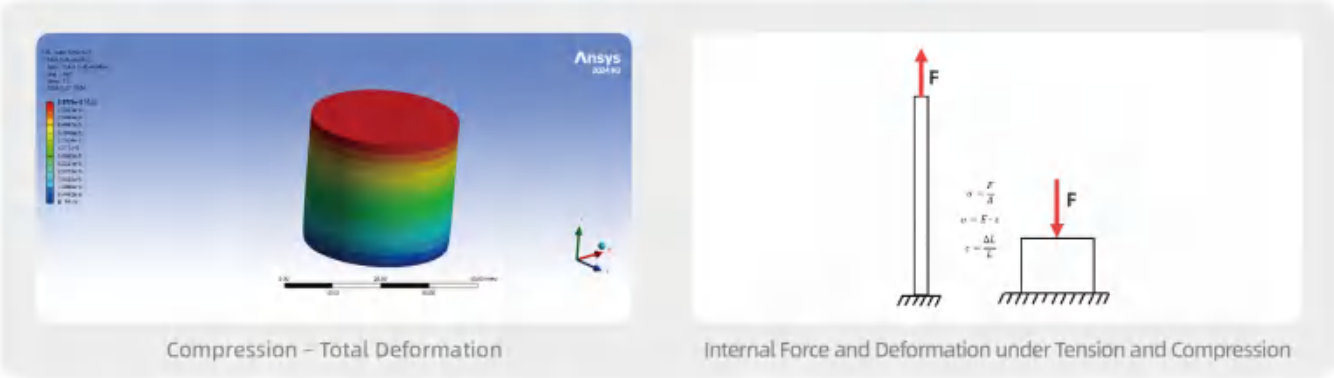


► MS02 Axial Loading Apparatus

- Utilizing multi-channel strain measurement, this apparatus focuses on high-precision quantitative analysis of local stress/strain non-uniformity near load points and cross-sectional discontinuities.
- It visually demonstrates Saint-Venant's Principle, showing end-effect attenuation and stress concentration mechanisms, enabling exploration of the "plane section assumption" and its limitations.
- Equipped with specialized specimens (bars with holes, notches, variable cross-sections) and eccentric loading, it verifies the superposition principle, determines elastic modulus and Poisson's ratio, and investigates neutral axis migration under eccentric tension/compression. It is a core device for cultivating micro-stress analysis skills and engineering safety awareness.

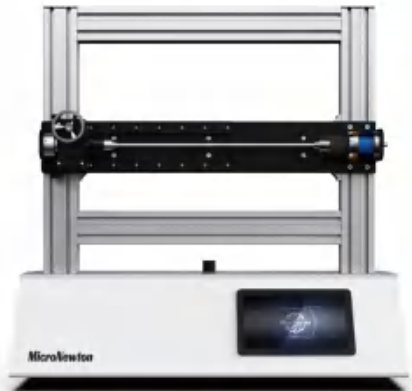
Specimen Material	Acquisition Channels	Error Range	Input Power Supply
Aluminum alloy, POM, Silicone	5 channels	±5%	Single-phase three-wire, 220 V
Display	Product Dimensions(mm)	Product Weight	Loading range
10.1-inch	950 × 300 × 950	Approx. 30 kg	0-400 N

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. **Verification of Saint-Venant's Principle:** The core teaching function of this apparatus
2. **Study of Stress Concentration:** Observe the strain surge phenomenon at geometric discontinuities using specimens with holes, notches, or sudden cross-sectional changes
3. **Determination of Axial Tensile and Compressive Strain Distribution:** Arrange multiple measuring points along the bar axis to record the strain gradient from the loading end to the stable region
4. **Eccentric Tension and Compression Test:** Verify the superposition principle and separate the axial force component and bending moment component from strain gauge readings
5. **Precise Determination of Elastic Modulus E and Poisson's Ratio μ :** calculate E and μ of the material using longitudinal and transverse strain gauge data in the uniformly stressed zone

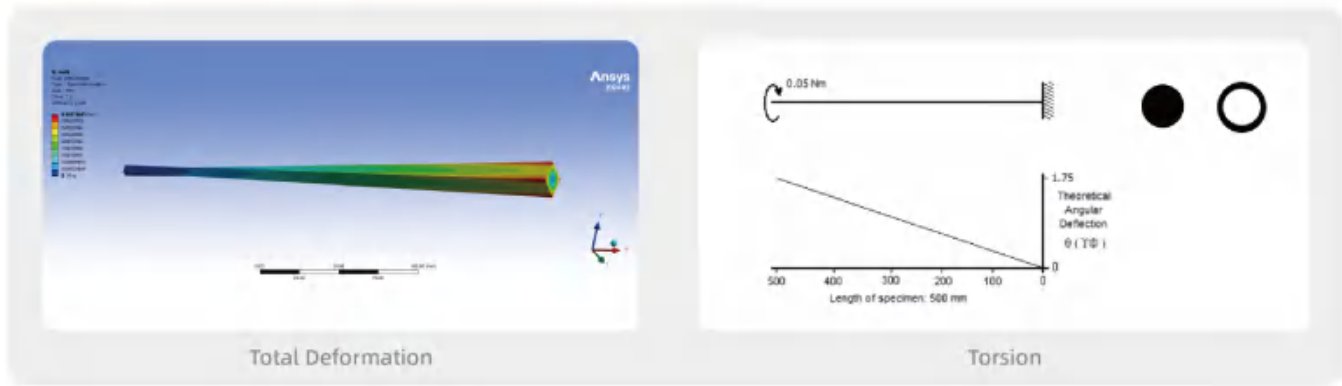


► MS03 Torsion of Shafts Apparatus

- Designed for studying stress distribution and deformation of circular shafts and non-circular bars under torsion.
- Its core lies in verifying shear Hooke's Law and the plane section assumption for circular shafts via high-precision torque measurement and multi-point strain/rotation observation, while revealing the significant torsional resistance difference between open and closed thin-walled bars.
- A key teaching aid for understanding transmission shaft design and torsional stiffness of thin-walled structures (e.g., aircraft fuselages, automobile frame rails).

Specimen Material	Acquisition Channels	Error Range	Loading range
Aluminum alloy, Brass	5 channels	±5%	0-50N·m
Display	Product Dimensions(mm)	Product Weight	Input Power Supply
10.1-inch	950 × 300 × 950	Approx. 30 kg	Single-phase three-wire, 220 V

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

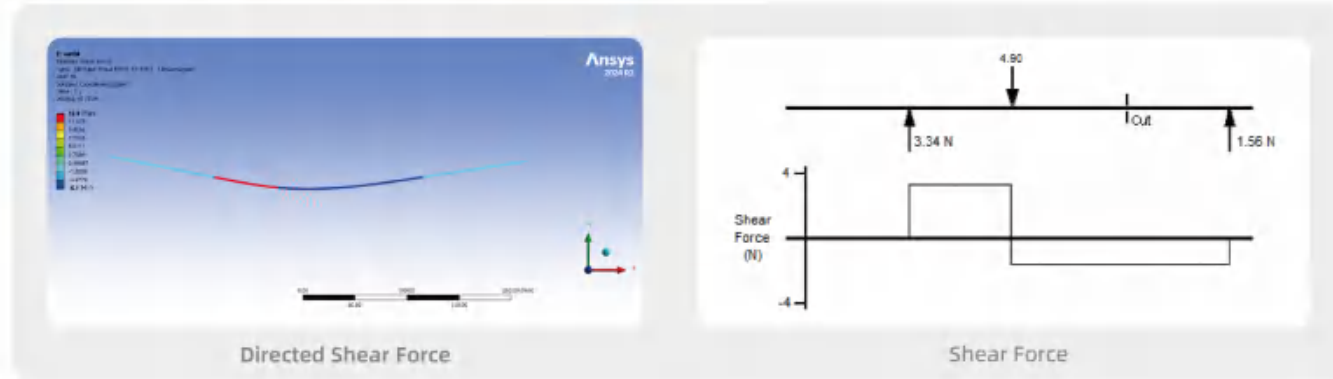
1. **Determination of Shear Modulus G:** Calculate G from applied torque and measured twist angle
2. **Verification of Shear Hooke's Law:** Confirm linear shear stress-strain relationship within the elastic range
3. **Circular Shaft Torsion Theory (Plane Section Assumption):** Observe longitudinal/circumferential line deformation to verify cross-sections remain plane and radii straight
4. **Non-Circular Torsion (Warping):** Compare rectangular bar behavior and observe cross-sectional warping
5. **Open vs. Closed Thin-Walled Bars (Key Highlight):** Compare torsional stiffness of identical-dimension, same-wall-thickness open and closed sections



► MS04 Beam Shear & Moment Apparatus

- A specialized teaching instrument for quantitative measurement of bending moment and shear force at beam sections under stationary or moving loads.
- Its advanced "cut-section" sensor enables direct internal force readout, serving as a core device for verifying the section method, plotting influence lines, and understanding the most unfavorable load positions.
- The high-end version integrates support reaction transducers for synchronous equilibrium verification.

I FINITE ELEMENT SIMULATION ANALYSIS



► MS05 Beam Bending Apparatus

- A multifunctional platform integrating both deformation and internal force testing.
- Equipped with a high-precision beam with pre-bonded strain gauges and a static strain indicator, it accurately determines the linear normal stress distribution along the cross-section height in pure bending, while a displacement system maps the deflection curve and determines elastic modulus.
- Supports simply supported and cantilever boundary conditions, intuitively demonstrating core mechanics theories—an ideal teaching aid for verifying the bending normal stress formula and stiffness design.



I FINITE ELEMENT SIMULATION ANALYSIS



► MS06 Thin-Walled Pressure Vessel Apparatus

- Designed for thin-walled shell mechanics, this apparatus uses a high-precision aluminum alloy cylinder to simulate a pressure vessel.
- Applying internal pressure via a hydraulic system, it accurately measures circumferential/axial stresses and radial deformation under complex loading. Integrated strain indicators and displacement sensors intuitively demonstrate membrane theory, the biaxial stress state, Mohr's circle, and Poisson's ratio.
- An ideal teaching device for verifying strength design and deformation laws of thin-walled structures across mechanical, chemical, and mechanics engineering programs.

I FINITE ELEMENT SIMULATION ANALYSIS

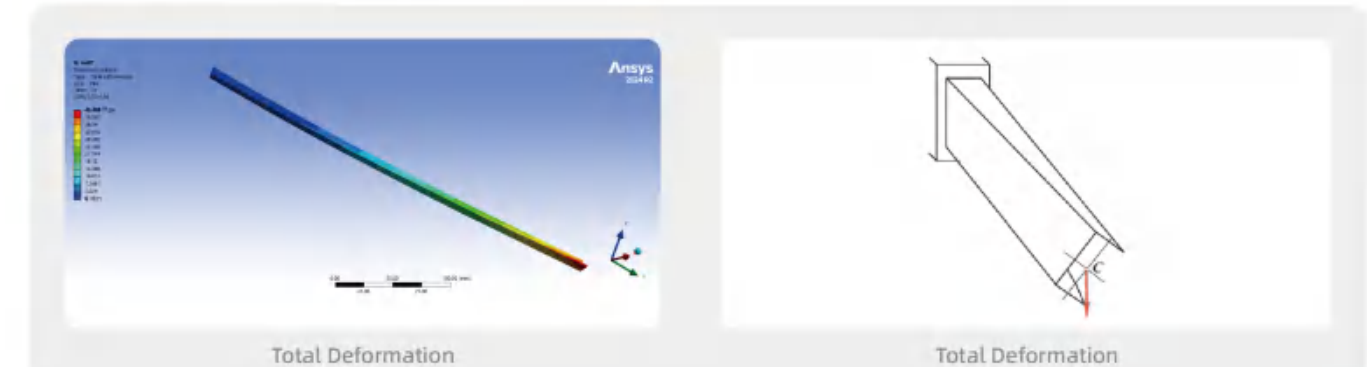


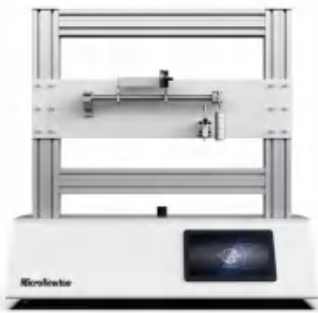
► MS07 Unsymmetrical Beam Apparatus

- An advanced teaching instrument for studying mechanical behavior of complex cross-section beams under bending.
- Its core focus is asymmetry-induced phenomena: the shear center, principal axis orientation, and coupled bending-torsion effects.
- A key apparatus for understanding why channel, angle, and Z-sections are prone to twisting under load.



I FINITE ELEMENT SIMULATION ANALYSIS

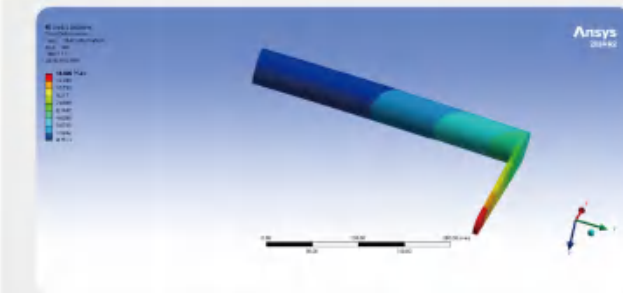




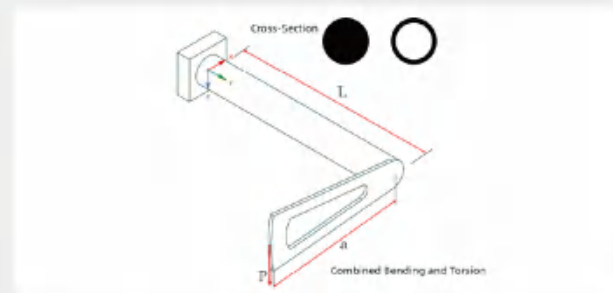
► MS08 Combined Bending & Torsion Apparatus

- Core test apparatus for combined bending (M) and torsion (T) mechanical research.
- It delivers adjustable bending and torque to mimic transmission shafts, crankshafts and loaded cantilevers, aiming to verify the 3rd & 4th strength theories and analyze principal stresses.

I FINITE ELEMENT SIMULATION ANALYSIS



Cylinder - Total Deformation



Combined Bending and Torsion

I EXPERIMENTAL FUNCTIONS

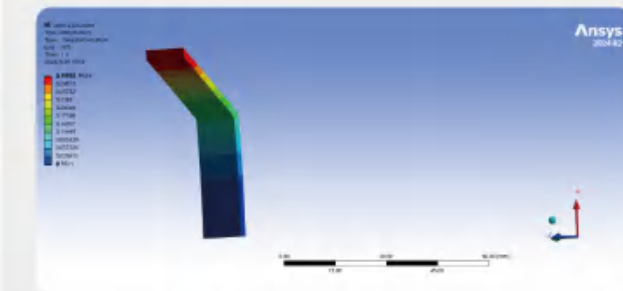
- ① Combined Bending-Torsion Stress Analysis
- ② Principal Stress & Direction Measurement
- ③ Verification of the relationship between internal force diagrams and external forces

► MS09 Curved Beam & Cable Apparatus

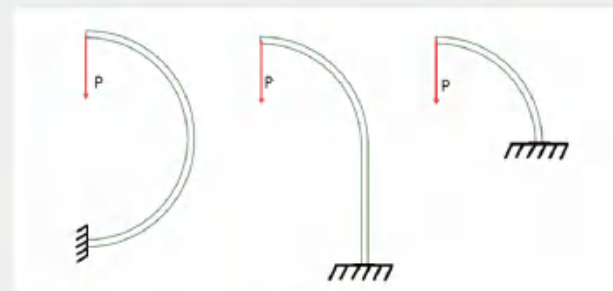
- An advanced teaching aid for studying curvature effects on structural deformation.
- Its core explores geometric nonlinearity, verifying Castigliano's Second Theorem and the unit load method for curved bars, while visually demonstrating complex displacement phenomena from axial force, shear, and bending moment coupling under load.



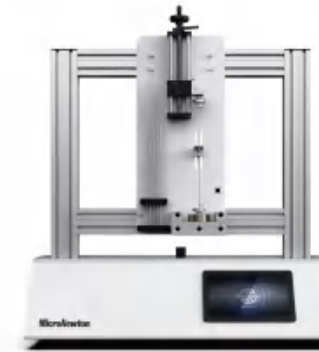
I FINITE ELEMENT SIMULATION ANALYSIS



Curved Bar - Total Deformation



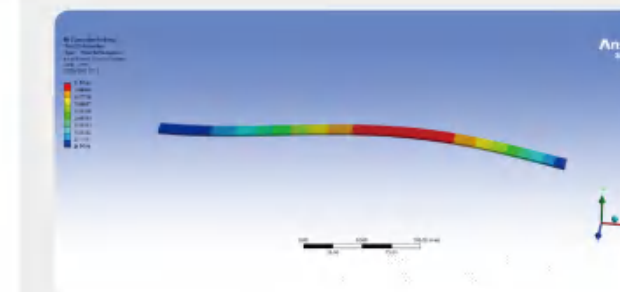
Curved Bar



► MS10 Buckling of Struts Apparatus

- A core apparatus for studying slender column stability.
- It focuses on sudden lateral buckling occurring at stresses far below the material's yield limit.
- A specialized instrument for verifying Euler's formula, studying boundary condition effects on critical load, and observing post-buckling behavior.

I FINITE ELEMENT SIMULATION ANALYSIS



14 N - Total Deformation

Support Condition	One end free One end fixed	Both ends pinned	One end pinned One end fixed	Both ends fixed
Diagram				
μ	2	1	0.7	0.5
Critical Pressure	$P_{cr} = \frac{\pi^2 EI}{(2l)^2}$	$P_{cr} = \frac{\pi^2 EI}{l^2}$	$P_{cr} = \frac{\pi^2 EI}{(0.7l)^2}$	$P_{cr} = \frac{\pi^2 EI}{(0.5l)^2}$

Column Buckling

I EXPERIMENTAL FUNCTIONS

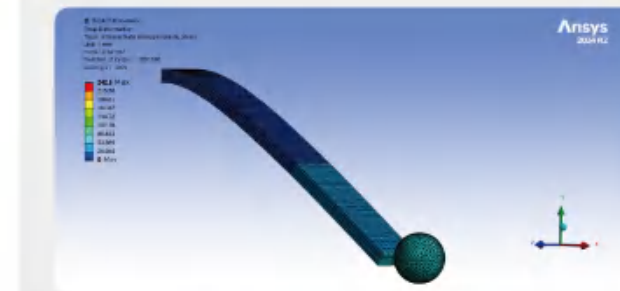
- ① Determination of critical load
- ② Observation of large-deflection post-buckling behavior
- ③ Verification of Euler's formula
- ④ Stress distribution testing (high-end version feature)

► MS11 Impact Loading Apparatus

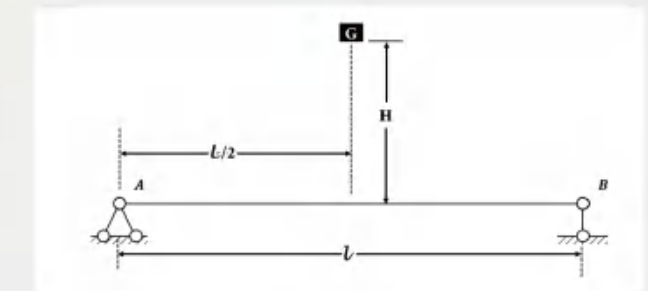
- A core apparatus for studying dynamic load effects and validating the energy method applied to impact problems.
- Unlike static loading experiments, it focuses on inertial effects from rapidly varying loads. Its core objective is determining the dynamic load factor—the ratio of maximum response under impact to that under static loading—and verifying the theoretical formula $\delta_d = K_d \cdot \delta_{st}$



I FINITE ELEMENT SIMULATION ANALYSIS



Impact - Total Deformation



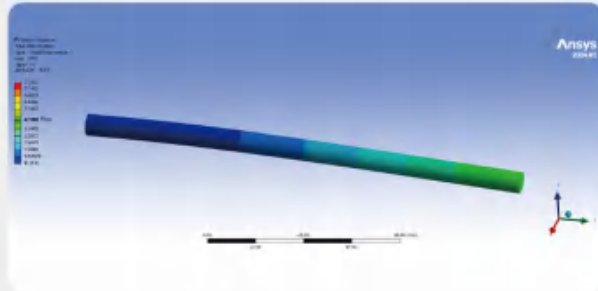
Impact



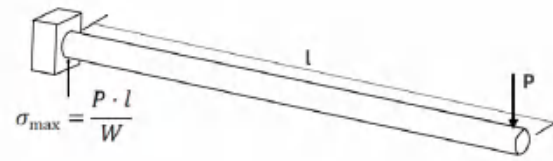
► MS12 Rotating Fatigue Testing Machine

- A key apparatus for studying material failure under alternating loads.
- It focuses on cumulative damage, revealing why metals fracture after millions of cycles at stress far below the yield limit. Core objectives: plot the S-N curve, determine the fatigue limit, and observe typical fatigue fracture surface characteristics.

I FINITE ELEMENT SIMULATION ANALYSIS



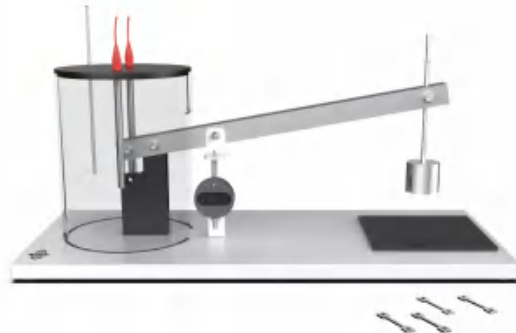
Total Deformation



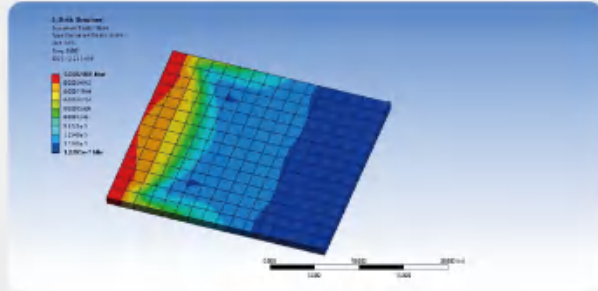
Rotating Fatigue

► MS13 Creep Testing Apparatus

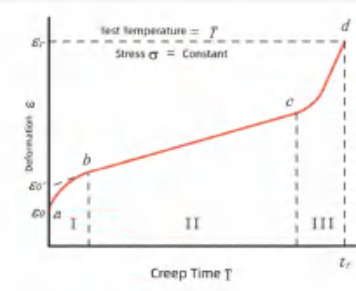
- Designed for mechanics and engineering materials instruction, helping students intuitively understand creep.
- Under preset temperature and constant load, it displays the entire slow, time-dependent deformation process in real time, dynamically plotting the creep curve.
- Through hands-on operation, students grasp the three creep stages and their influencing factors, transforming abstract theory into visual cognition—an ideal platform for teaching high-temperature material properties.



I FINITE ELEMENT SIMULATION ANALYSIS



Creep Deformation



Creep Curve

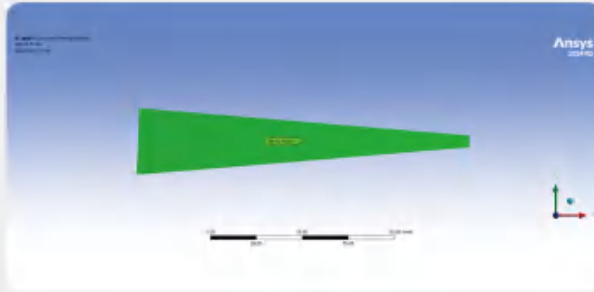


► MS14 Universal Materials Testing System

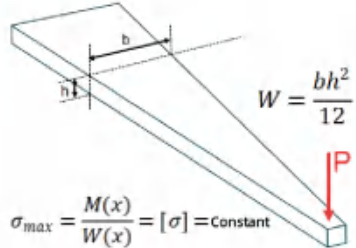
- This multi-functional tester breaks the limits of single-function equipment. Adopting a mainframe plus modular design, it conducts tension, compression, torsion, bending, column buckling and constant-strength beam tests, with optional WNT_2D_DIC for displacement and strain measurement.
- Lightweight, portable and space-saving, it covers core material mechanics experiments at low cost, ideal for comparative research and skill training.

Specimen Material	Acquisition Channels	Error Range	Measurement Method
Aluminum alloy, POM , Rubber, Carbon steel	10 channels	±5%	Optical measurement, Electrical measurement
Display	Product Dimensions (mm)	Product Weight	Loading range
10.1-inch	960 × 250 × 730	Approx. 30 kg	0-50 N

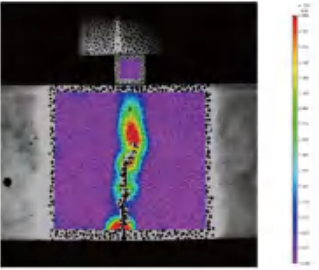
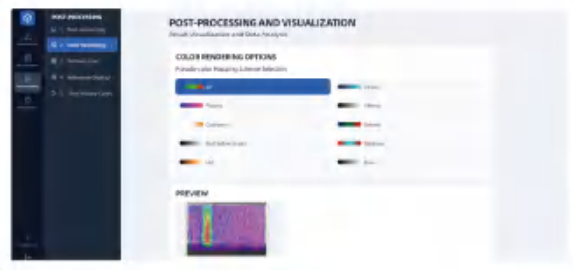
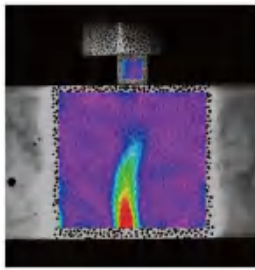
I FINITE ELEMENT SIMULATION ANALYSIS



Stress



Constant-Strength Beam



WNT_2D_DIC deformation measurement and processing

I EXPERIMENTAL FUNCTIONS

- ① Tension & compression test
- ② Torsional bar force & deformation test
- ③ Beam bending test
- ④ Combined bending-torsion test
- ⑤ WNT_2D_DIC deformation measurement & analysis
- ⑥ Constant-strength beam stress test
- ⑦ Column buckling critical load & stress test

STRUCTURAL MECHANICS SERIES

01 Structural Statics

Statically Determinate Beam Internal Force Analysis	• Beam	▶ MST01 Simply Supported Beam Apparatus
	• Rigid Frame	▶ MST02 Rigid Frame Apparatus
	• Arch	▶ MST03 Three-Hinged Arch Apparatus
	• Truss	▶ MST04 Planar Truss Apparatus
Statically Determinate Structure Displacement Analysis		▶ MST05 Beam Deflection Apparatus
		▶ MST06 Multi-Load Beam Apparatus
Statically Indeterminate Structure Analysis	Force Method	▶ MST07 Indeterminate Frame Apparatus
		▶ MST08 Two-Hinged Arch Apparatus
		▶ MST09 Hingeless Arch Apparatus
		▶ MST10 Multi-Span Bridge Beam Apparatus
		▶ MST11 Indeterminate Truss Apparatus
		▶ MST12 Thermal Structural Loading Apparatus
		▶ MST13 Indeterminate Beam Apparatus
		▶ MST14 Indeterminate Frame Apparatus
	Displacement Method	

02 Structural Dynamics

• Beam	▶ MST18 Free Vibration Apparatus
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03 Special Topics in Structural Mechanics

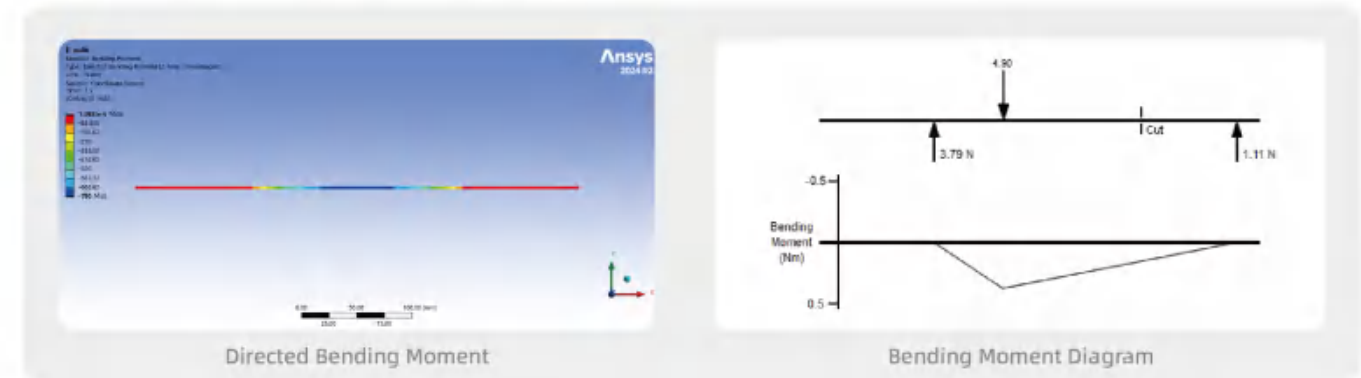
Influence Line	• Beam	▶ MST06 Multi-Load Beam Apparatus
	• Truss	▶ MST17 Truss Influence Line Apparatus
Plastic Limit Load		▶ MST15 Beam Ultimate Load Machine
		▶ MST16 Frame Ultimate Load Machine
Suspension Bridge		▶ MST19 Cable Tension Apparatus



▶ MST01 Simply Supported Beam Apparatus

- A precision teaching system for structural mechanics, comprising independent shear force and bending moment testing modules.
- Each module includes a cut-section beam, dual supports, and a base frame, with the beam disconnected at a predetermined section to simulate internal force testing.
- Using a force-arm bridge connection for stability and accuracy, integrated force sensors acquire real-time shear force and bending moment data, enabling intuitive verification of internal force distribution in statically determinate beams for teaching and research.

I FINITE ELEMENT SIMULATION ANALYSIS

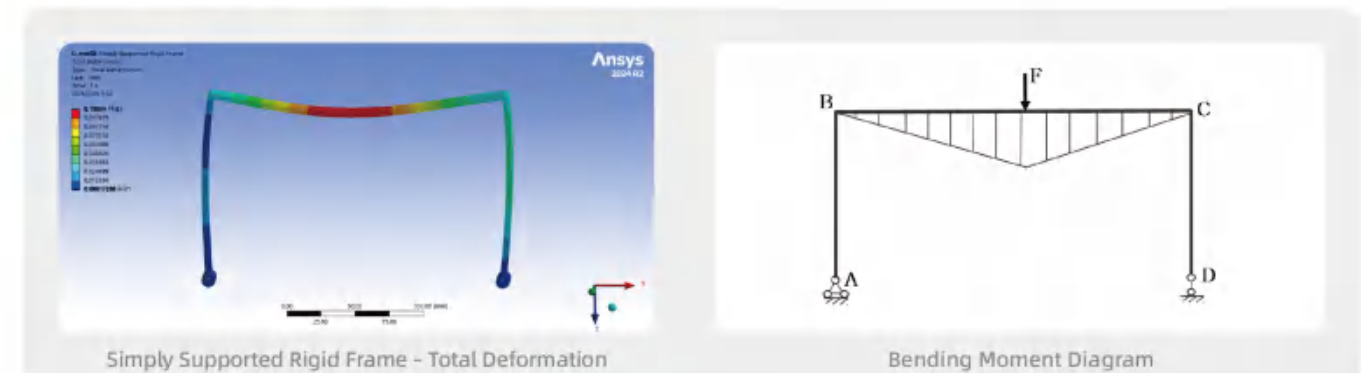


▶ MST02 Rigid Frame Apparatus

- An experimental module for structural mechanics teaching, integrating cantilever, simply supported, and three-hinged rigid frame configurations for civil and mechanical engineering applications.
- It precisely measures support reactions, member bending moments, and bending deformation under load, enabling intuitive comparison between theoretical calculations and measured data, helping students understand the load-bearing characteristics and deformation laws of rigid frame structures.



I FINITE ELEMENT SIMULATION ANALYSIS



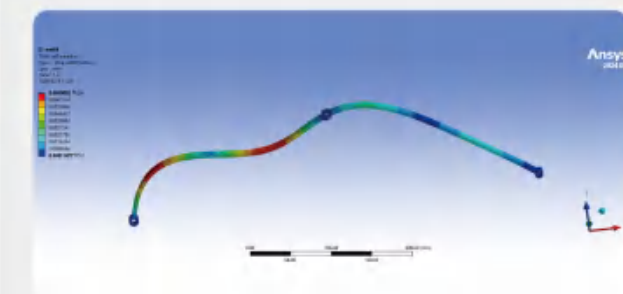


► MST03 Three-Hinged Arch Apparatus

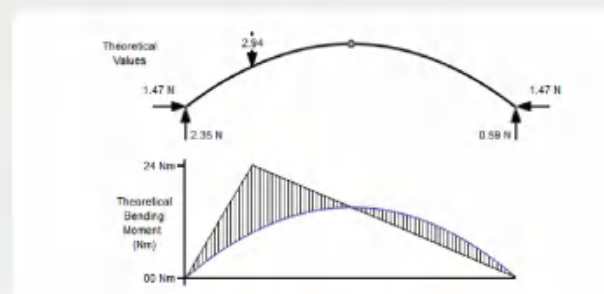
- An experimental module specifically designed for structural mechanics teaching. Optimized to meet the application needs of civil and mechanical engineering disciplines, the apparatus consists of two supports and a symmetrical arch structure connected by a pin joint.
- It accurately simulates three-hinged arch loading under vertical forces, measures horizontal thrust in real time, and intuitively verifies force distribution differences between arches and equivalent simply supported beams—an ideal tool for understanding thrust structure mechanics.

Specimen Material	Acquisition Channels	Error Range	Loading range
Aluminum alloy	5 channels	±5%	0-8N
Display	Product Dimensions(mm)	Product Weight	Input Power Supply
10.1-inch	950 × 300 × 950	Approx. 30 kg	Single-phase three-wire, 220 V

I FINITE ELEMENT SIMULATION ANALYSIS



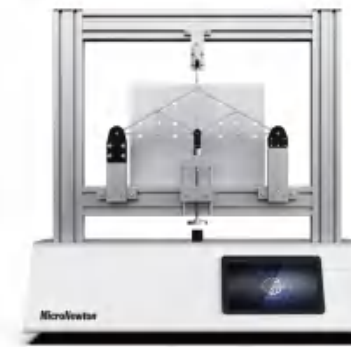
Total Deformation



Bending Moment Diagram

I EXPERIMENTAL FUNCTIONS

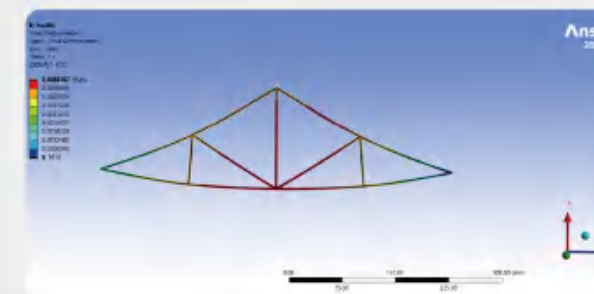
1. **Horizontal Thrust Test:** Measures horizontal reaction, verifying thrust is inversely proportional to arch rise.
2. **Moving Load Analysis:** Varies load position to plot horizontal reaction curves and analyze sectional internal force distribution.
3. **Uniform Load Simulation:** Long/short distributed load bars simulate real-world uniform loading (e.g., bridges), comparing measured and theoretical thrust values.
4. **Visualized Teaching:** Touchscreen displays real-time data and dynamic curves, enabling intuitive theoretical vs. measured comparison and understanding of concepts like the rational arch axis.



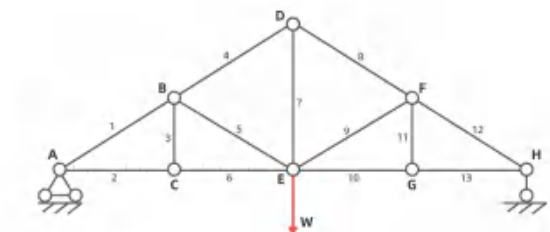
► MST04 Planar Truss Apparatus

- A precision experimental module for structural mechanics teaching, featuring a statically determinate plane truss with stainless steel members and pinned joints.
- Equipped with a screw loading mechanism, force sensors, displacement sensors, and half-bridge strain gauges, it precisely applies loads and simultaneously measures tensile/compressive strain in each member and structural deformation.
- Supporting intuitive theoretical vs. measured comparison, it is an ideal platform for truss internal force analysis and verification of the method of joints and method of sections.

I FINITE ELEMENT SIMULATION ANALYSIS



Total Deformation



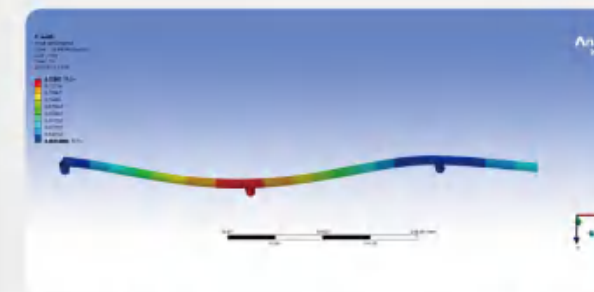
Plane Truss Diagram

► MST05 Beam Deflection Apparatus

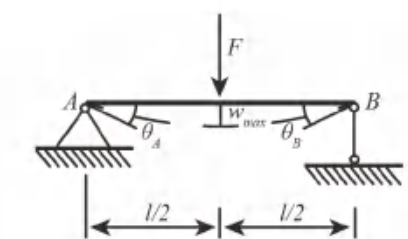
- An experimental module for structural mechanics teaching, consisting of a backboard, sliding displacement sensor, knife-edge supports, and base frame.
- It supports rapid setup of simply supported, cantilever, and overhanging beam configurations, with aluminum, copper, and steel beam specimens.
- Using a high-precision displacement sensor to measure deflection, it visually demonstrates the influence of load, span, and material on bending deformation—an ideal platform for verifying beam deflection theory and teaching the superposition method.



I FINITE ELEMENT SIMULATION ANALYSIS



Simply Supported Beam - Total Deformation



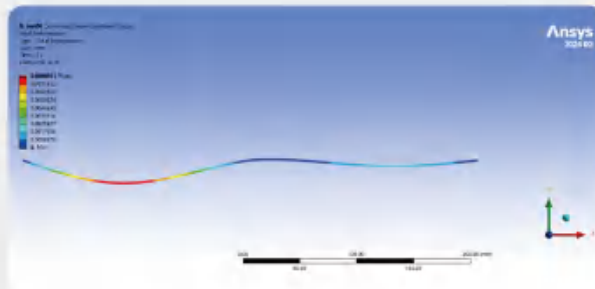
Simply Supported Beam Deflection Diagram



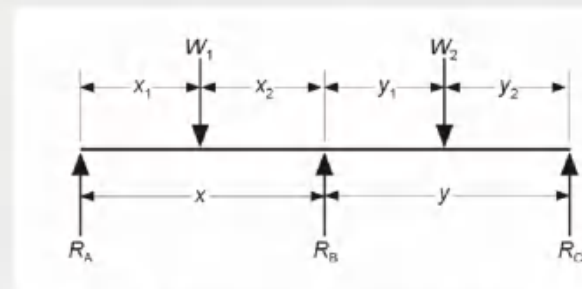
► MST06 Multi-Load Beam Apparatus

- Designed for comprehensive beam mechanical property testing, supporting statically determinate, indeterminate, and continuous beam experiments.
- Equipped with three vertical force-measuring supports and a fixed-end moment measurement structure for accurate reaction and internal force data, plus two high-precision displacement sensors for deflection monitoring and moving load influence line testing.
- Robust and easy to operate, it suits both university teaching and research, enabling comprehensive analysis of beam mechanical response.

I FINITE ELEMENT SIMULATION ANALYSIS



Indeterminate Beam Deformation



Indeterminate Beam Schematic

I EXPERIMENTAL FUNCTIONS

1. Constraint Force Testing of Statically Indeterminate & Continuous Beams:

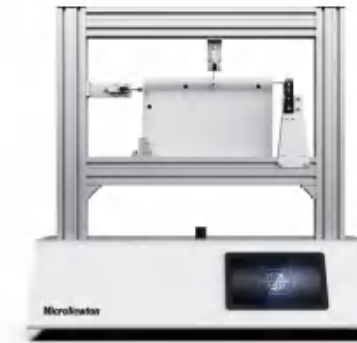
- Redundant force differences under same load with different materials/elastic moduli.
- Reaction and redundant force differences for same material with varying load positions.
- Mastering solution methods (additional constraint method, primary system selection).
- Understanding theoretical assumption limitations via error analysis (material nonlinearity, sensor accuracy).

2. Beam Influence Line Testing:

- Plotting bending moment, shear force, and reaction influence lines at specified sections.
- Precisely measuring target quantities under unit load at specific positions.
- Verifying theoretical values at key points.
- Demonstrating multi-load arrangement for maximum effect using influence lines.
- Verifying the Müller-Breslau principle (kinematic method).

3. Continuous Beam Internal Force Influence Line Testing:

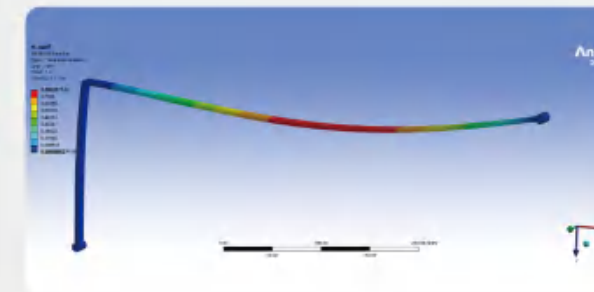
- Plotting influence line curves for statically indeterminate structures.
- Demonstrating positive and negative effect zones.
- Verifying Müller-Breslau principle application in indeterminate structures.
- Determining most unfavorable load positions.
- Studying span ratio effects on influence lines.



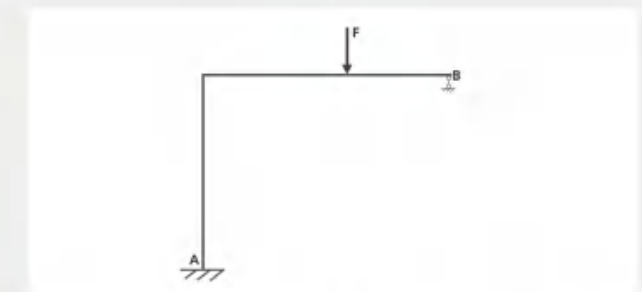
► MST07 Indeterminate Frame Apparatus

- An experimental module for structural mechanics teaching, consisting of a mounting plate, cantilever rigid frame internal force measurement module, and force sensors.
- It simulates loading of a once statically indeterminate cantilever rigid frame, measuring horizontal/vertical displacements, support reactions, and member internal forces in real time via high-precision displacement sensors and strain gauges.
- Supporting intuitive comparison between measured data and force method theoretical values, it is ideal for studying indeterminate structure characteristics and verifying force method principles.

I FINITE ELEMENT SIMULATION ANALYSIS



Total Deformation



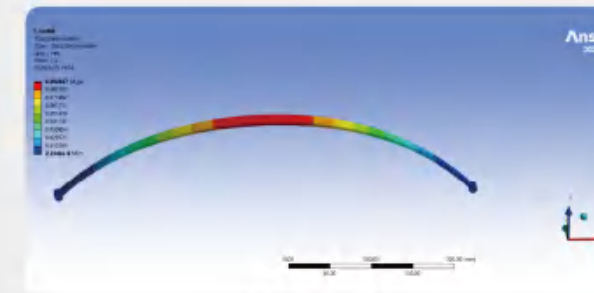
Statically Indeterminate Cantilever Rigid Frame

► MST08 Two-Hinged Arch Apparatus

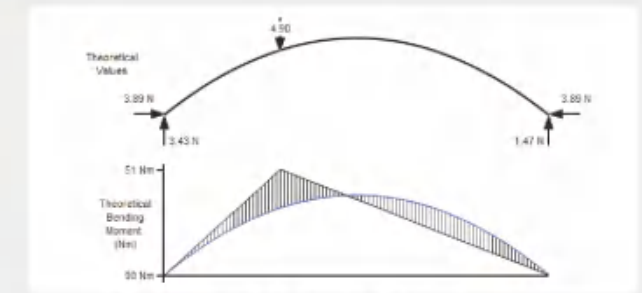
- An experimental module for structural mechanics teaching, consisting of two supports and a symmetrical rigid-connected arch structure.
- It accurately simulates two-hinged arch loading under vertical forces, measures horizontal thrust and support reactions in real time, and intuitively verifies force distribution differences between arches and equivalent simply supported beams—an ideal tool for understanding statically indeterminate thrust structure mechanics.



I FINITE ELEMENT SIMULATION ANALYSIS



Total Deformation



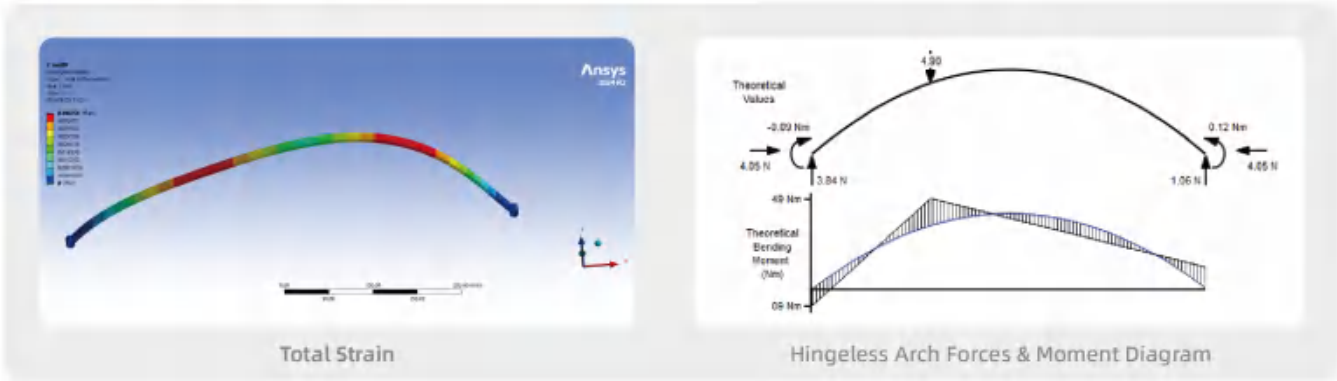
Two-hinged Arch Forces & Moment Diagram



► MST09 Hingeless Arch Apparatus

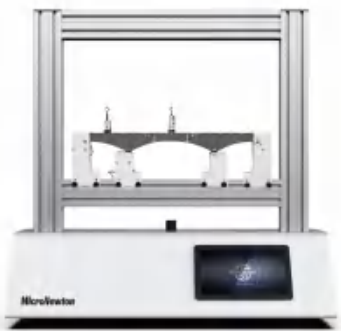
- An experimental module for structural mechanics teaching, consisting of two fixed-end supports and a symmetrical rigid-connected arch structure.
- It accurately simulates fixed arch loading under vertical forces, measures horizontal thrust, vertical reactions, and support moments in real time, and intuitively verifies force distribution differences between arches and equivalent simply supported beams—an ideal tool for understanding highly statically indeterminate thrust structure mechanics.

FINITE ELEMENT SIMULATION ANALYSIS

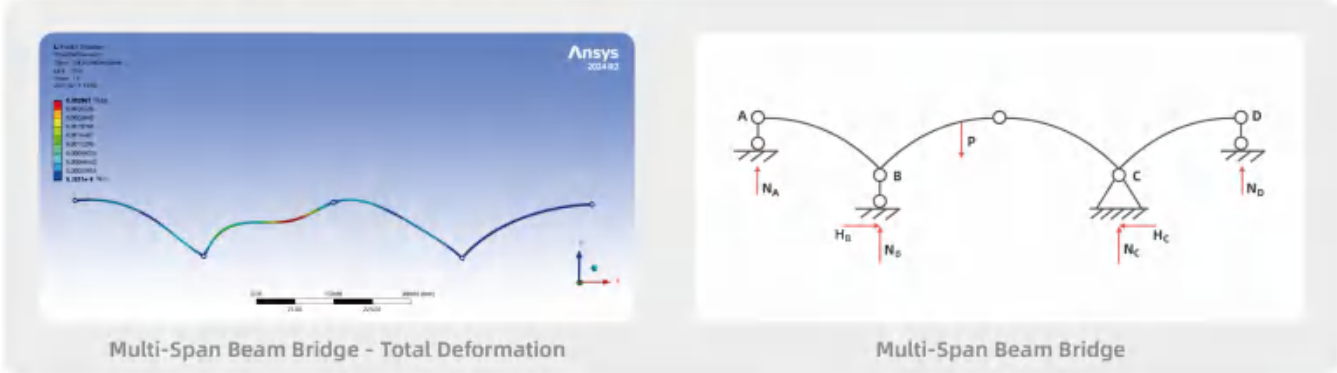


► MST10 Multi-Span Bridge Beam Apparatus

- Designed for structural mechanics teaching, this apparatus analyzes the force mechanism of statically determinate multi-span beams (Gerber beams).
- Using a precision articulated beam structure and high-sensitivity force-measuring supports, it captures real-time support reaction variations under moving loads.
- Students can plot reaction influence lines by hand, intuitively understand the force transfer between "primary" and "secondary" parts, and master most unfavorable load position determination—bridging mechanics theory and bridge engineering practice.



FINITE ELEMENT SIMULATION ANALYSIS

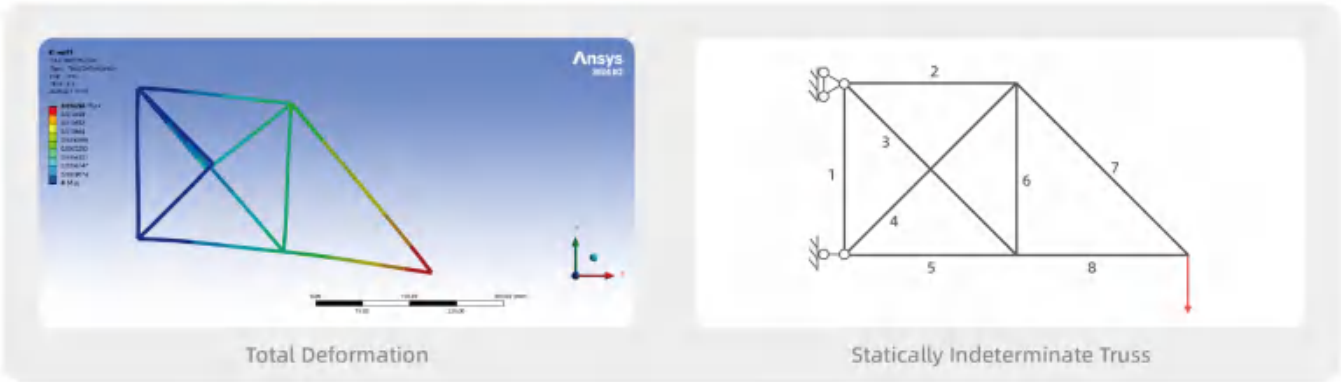


► MST11 Indeterminate Truss Apparatus

- An experimental apparatus for structural mechanics teaching, measuring key mechanical responses of statically indeterminate plane trusses under vertical loads, including member internal force distribution and overall truss displacement.
- Students systematically compare measured internal force data against force method theoretical values, gaining intuitive understanding of the principles and calculation process for solving indeterminate structures.
- It provides solid experimental evidence for abstract theory while enhancing students' ability to analyze complex structures and solve practical engineering problems.

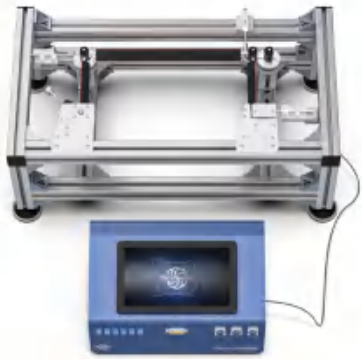
Specimen Material	Acquisition Channels	Error Range	Loading range
Stainless steel	10 channels	±5%	0-600N
Display	Product Dimensions(mm)	Product Weight	Input Power Supply
10.1-inch	950 × 300 × 950	Approx. 30 kg	Single-phase three-wire, 220 V

FINITE ELEMENT SIMULATION ANALYSIS



EXPERIMENTAL FUNCTIONS

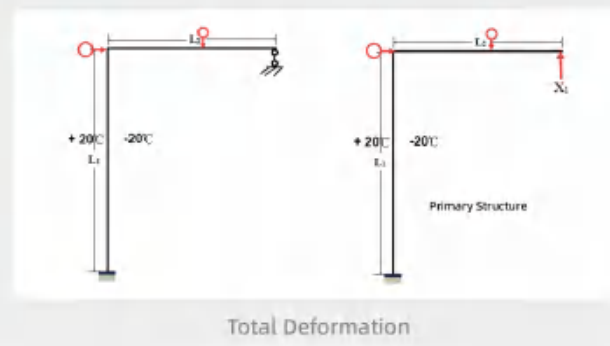
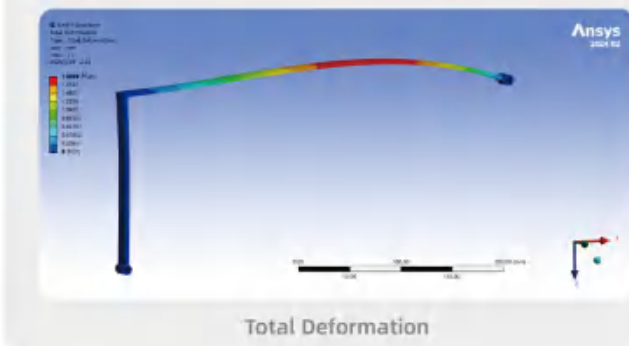
1. Apply varying loads/positions to identical geometry trusses; record member internal forces and overall displacement.
2. Perform force method calculations using experimental data (axial forces, reactions, joint displacements); verify agreement with theoretical values.
3. Review method of joints and method of sections for determinate trusses; strengthen ability to select advantageous redundant constraints for simplifying indeterminate truss calculations via the force method.
4. Understand ideal truss assumption limitations through error analysis (joint friction, material nonlinearity), supporting subsequent learning of approximate methods (force method, displacement method) for indeterminate structures like continuous beams and arches.



► MST12 Thermal Structural Loading Apparatus

- A specialized apparatus for studying temperature effects on statically indeterminate structures.
- Temperature changes cause only deformation in determinate structures, but generate significant self-stress and additional internal forces in indeterminate structures due to redundant constraints restricting free expansion/contraction.
- By simulating a temperature field, it measures internal forces and displacements of both determinate and indeterminate structures via sensors, involving strain and displacement testing of bar systems under varying temperature differences.

I FINITE ELEMENT SIMULATION ANALYSIS

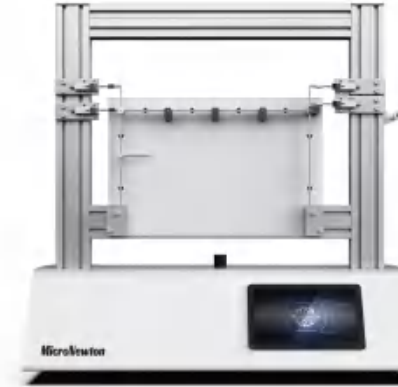
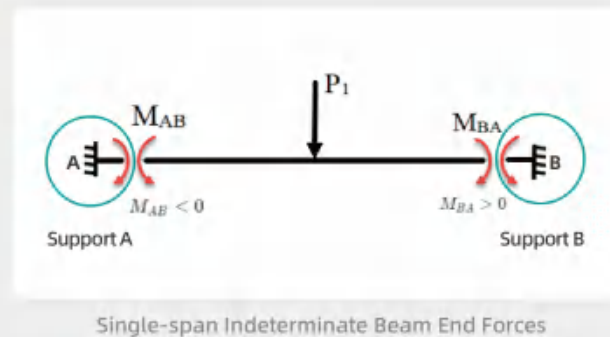
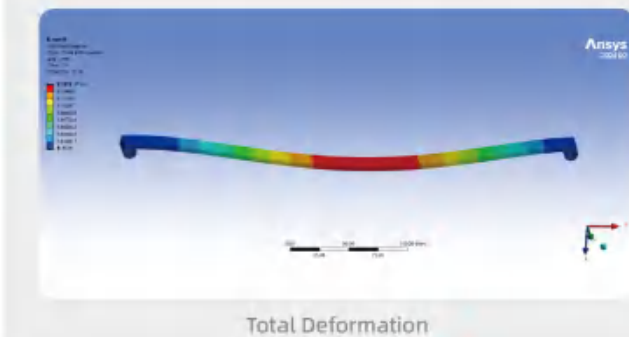


► MST13 Indeterminate Beam Apparatus

- A core apparatus for studying load-bearing characteristics of continuous beams or fixed-end beams with multiple degrees of static indeterminacy.
- Its main feature is direct measurement of bending moments and shear forces at supports under load, verifying force method, displacement method, and moment distribution calculations.
- A key teaching aid for understanding internal force redistribution in indeterminate structures and the effects of support settlement/rotation.



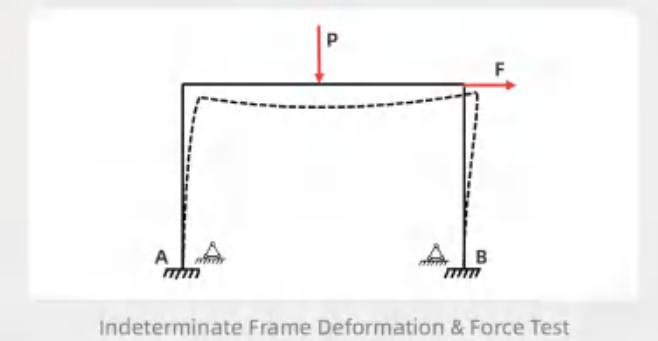
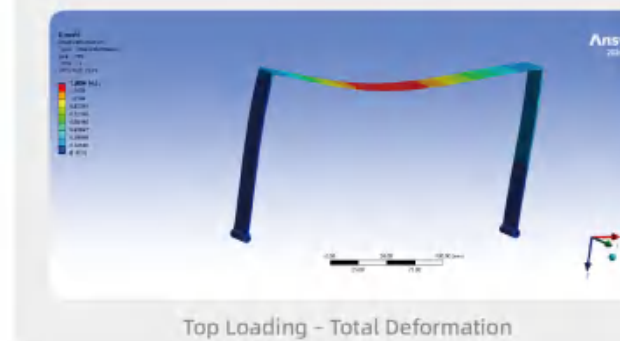
I FINITE ELEMENT SIMULATION ANALYSIS



► MST14 Indeterminate Frame Apparatus

- A specialized apparatus for studying deformation and internal force distribution of plane rigid frames under load.
- It features an aluminum portal frame on a backboard, with eight strain measurement points (four on the beam, four on columns) and four displacement sensors measuring joint lateral displacement and rotation.
- Equipped with a static strain acquisition unit, its core lies in accurately measuring rigid joint rotation and horizontal sidesway, verifying displacement method and moment distribution method calculations.

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. Determination of Rigid Joint Displacements:

- ① Horizontal Sidesway : Measure sidesway under horizontal loads, asymmetric vertical loads, or couples; the key feature differentiating rigid frames from continuous beams.
- ② Joint Rotation : Measure rotation at beam-column intersections; at rigid joints, beam-end and column-end rotations are equal—a fundamental displacement method assumption.

2. Member End Force Determination:

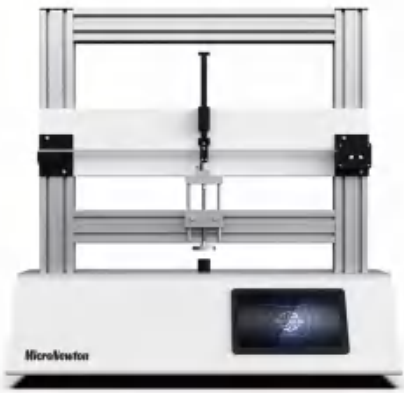
- ① Measure bending moments, shear forces, and axial forces at column bases, tops, and beam ends via strain gauges or force transducers
- ② plot moment, shear, and axial force diagrams

3. Verification of Displacement Method Canonical Equations :

- ① Verify relationships between basic unknowns (joint rotations, linear displacements) and external loads
- ② verify physical meaning of stiffness coefficient k_{ij} (reaction from unit displacement)

4. Sidesway Effect on Internal Forces:

Compare internal force distribution with and without sidesway (e.g., bracing added), demonstrating that sidesway generates significant additional bending moments (basis of second-order effects)

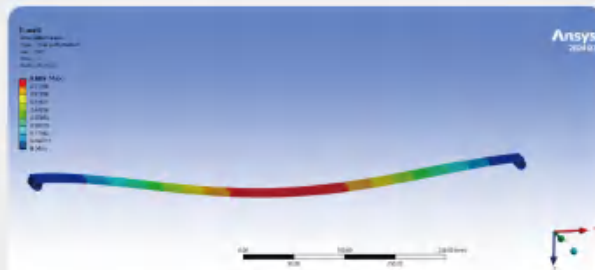


► MST15 Beam Ultimate Load Machine

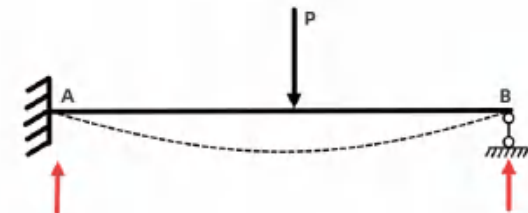
- A core apparatus for studying material nonlinear behavior, plastic hinge formation and development, and beam load-carrying capacity at the ultimate limit state.
- Through precise loading, it visually demonstrates plastic hinge location and rotational characteristics after yielding, and verifies theoretically derived ultimate load values.
- Students master ultimate load determination via the static equilibrium method, gain in-depth understanding of plastic hinge unidirectional rotation and residual deformation after unloading—providing a practical foundation for plastic design of steel structures.

Specimen Material	Acquisition Channels	Error Range	Loading range
Aluminum alloy	5 channels	±5%	0-600N
Display	Product Dimensions(mm)	Product Weight	Input Power Supply
10.1-inch	950 × 300 × 950	Approx. 30 kg	Single-phase three-wire, 220 V

I FINITE ELEMENT SIMULATION ANALYSIS



Total Deformation



Beam Plastic Limit Load

I EXPERIMENTAL FUNCTIONS

1. Plastic Limit Load Determination:

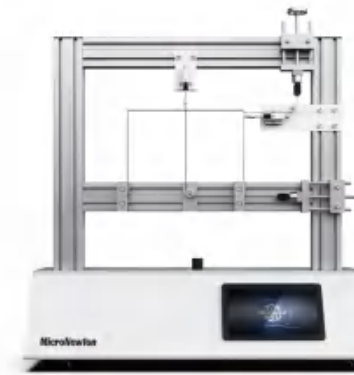
- ① Measure the complete load-displacement curve from elastic through elastic-plastic to fully plastic failure
- ② determine ultimate load at loss of capacity and compare with theoretical value from plastic section modulus

2. Plastic Hinge Formation & Development:

- ① Visually demonstrate how the maximum moment section progresses from edge yielding to full-section yielding, forming a freely rotating "plastic hinge"
- ② verify its difference from a mechanical hinge (sustains ultimate moment, directional rotation)

3. P-Δ Full-Range Curve Plotting:

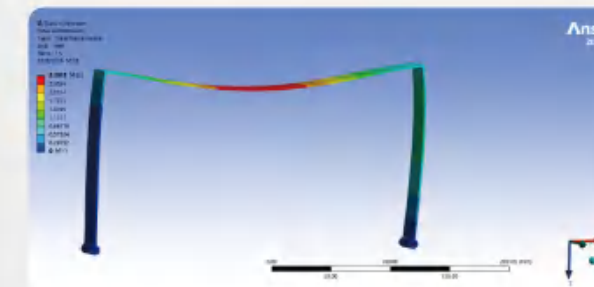
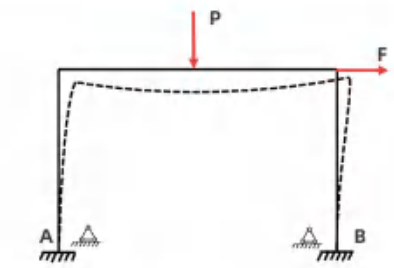
Record load vs. mid-span deflection, clearly distinguishing elastic, elastic-plastic transition, and plastic flow (plateau) segments



► MST16 Frame Ultimate Load Machine

- An apparatus for testing nonlinear behavior, failure mechanism formation, and ultimate load-carrying capacity of plane rigid frames under extreme loads.
- Rigid frame failure modes are complex, involving competition among sidesway, beam, and combined mechanisms.
- It demonstrates the entire process from elastic to plastic state, internal force redistribution through sequential plastic hinge formation, and ultimate collapse upon becoming a geometrically unstable system.

I FINITE ELEMENT SIMULATION ANALYSIS

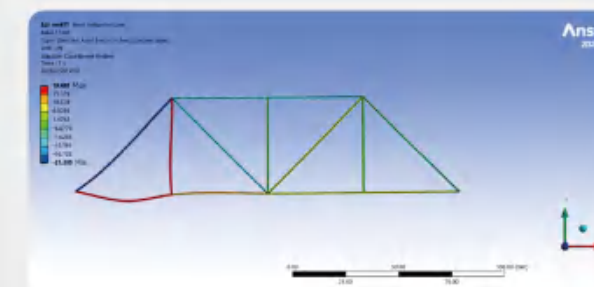
Statically Indeterminate Simply Supported
Total DeformationStatically Indeterminate Rigid Frame
Deformation and Internal Force Testing

► MST17 Truss Influence Line Apparatus

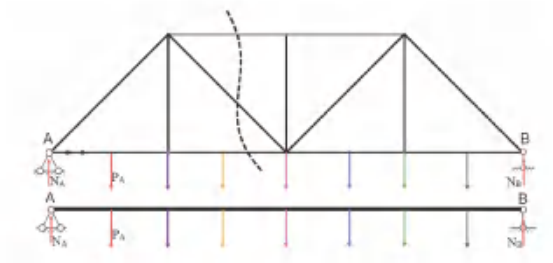
- A testing apparatus for studying axial force variation in plane truss members under moving loads.
- A moving load system simulates a unit load traveling along the truss span, supporting concentrated, uniformly distributed, and multi-point loading adaptable to different truss topologies. Electrical measurement captures real-time stress data at each joint, generating influence line curves for comparison with theoretical values.



I FINITE ELEMENT SIMULATION ANALYSIS



Truss Axial Force



Truss Influence Line



► MST18 Free Vibration Apparatus

- A comprehensive experimental platform for structural mechanics and mechanical vibration teaching.
- Its modular design integrates simple pendulum, compound pendulum, string pendulum, center of percussion, mass-spring system, torsional vibration, and cantilever beam modules.
- Serving civil and mechanical engineering teaching, practical training, and research, it helps students master simple harmonic motion, moment of inertia, and natural frequency through intuitive physical experiments.

Specimen Material	Acquisition Channels	Error Range	Input Power Supply
Carbon steel, Stainless steel, Spring steel	5 channels	±5%	Single-phase three-wire, 220 V
Display	Product Dimensions(mm)	Product Weight	Frequency Range
10.1-inch	950 × 300 × 950	Approx. 30 kg	0-200 Hz

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. **Simple & Compound Pendulum:** Determine gravitational acceleration *g*; verify period relationships with length, mass, and amplitude; explore Kater's pendulum principle
2. **Moment of Inertia & String Pendulum:** Study mass distribution effects on period using bifilar/trifilar pendulums; verify the parallel axis theorem
3. **Center of Percussion:** Identify this special rigid-body point; analyze impact force vs. pivot reaction force relationship
4. **Vibration System Analysis:** Cover free vibration of mass-spring systems, free torsional vibration, and cantilever beam vibration; determine natural frequency, stiffness, and damping characteristics

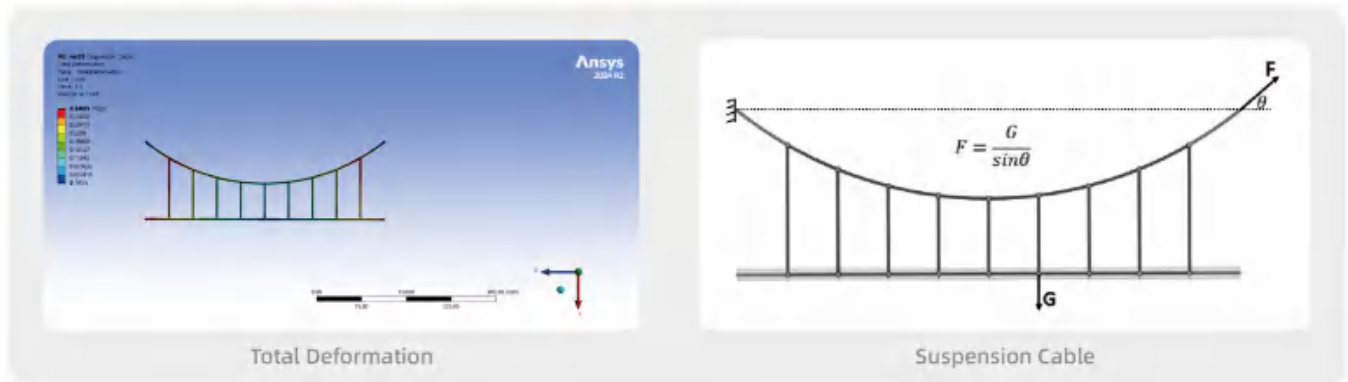


► MST19 Cable Tension Apparatus

- A specialized platform for teaching and research on flexible cable structure force mechanisms and cable force measurement techniques.
- Simulating a real suspension system, it accurately measures cable force variation under vertical loads, visually demonstrating flexible structure deformation compatibility.
- It investigates how load magnitude, position, and type influence cable forces, verifying the nonlinear relationship between cable force and load application points—providing theoretical and practical support for cable force monitoring in bridges and large-span spatial structures.

Specimen Material	Acquisition Channels	Error Range	Input Power Supply
Aluminum alloy, Stainless steel	5 channels	±5%	Single-phase three-wire, 220 V
Display	Product Dimensions(mm)	Product Weight	Loading Range
10.1-inch	950 × 300 × 950	Approx. 30 kg	0-20N

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. Apply varying load magnitudes and positions to identical geometry suspension cables; observe and record cable force variation
2. Apply different load types (concentrated, uniformly distributed) to identical geometry cables; observe and record cable force variation
3. conduct comparative analysis between concentrated load-cable force and distributed load-cable force relationships
4. Systematically study geometric parameter effects on cable force by adjusting support spacing, initial sag, or cable cross-sectional properties; establish a quantitative "geometric parameters-cable force response" model and verify correction coefficients in the theoretical cable force formula

CUSTOMIZED DEVELOPMENT WORKFLOW



► Enthalpy Difference Comprehensive Testing Laboratory

A specialized facility for testing performance of air conditioning, refrigeration, and heat pump products. Its core function is to precisely control environmental conditions and measure cooling capacity, heating capacity, and COP under various operating conditions.



► Phase Change Thermal Storage Performance Experimental Device

Used to study and develop efficient thermal energy storage technologies, suitable for temperature ranges from 0 to 650°C.



► Microchannel Heat Exchange Experimental System

Equipment utilizing micron-scale microchannel structures for efficient heat exchange.



► LNG Cold Energy Recovery Experimental System

This system maximizes utilization of LNG vaporization cold energy through precise heat exchange and cooling mechanisms. The system includes CO2 dry ice production loop, ORC loop, and liquid nitrogen loop. The entire process optimizes cold energy use, improves energy recovery efficiency, and effectively integrates refrigeration, power generation, and freezing functions.



Customized Research Series

Customized experimental equipment designed as innovative platforms for higher education, cutting-edge research, and interdisciplinary needs.

This series focuses on modularity, intelligence, and scalability, deeply integrating teaching practice and scientific research.

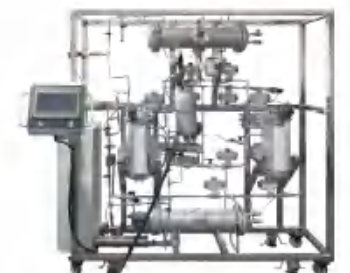
Supports multiple disciplines including thermal engineering, aerodynamics, fluid mechanics and hydraulics, artificial environments and testing rooms, multi-energy complementary distributed energy systems, energy storage applications, energy saving optimization, and carbon emission studies.

These customized research devices assist universities in advancing from verification experiments to original research breakthroughs.



► CO2 Adsorption Experimental System

Device used to study materials' CO2 adsorption capacity, efficiency, and thermodynamic properties.



► Ammonia-Water Power Cycle Experimental System

Provides heat exchange functions to reduce pump energy consumption, thereby lowering overall energy use and improving system efficiency.