

Course No. 1527

Advanced HVAC Systems Training Course

HVAC, REFRIGERATION & BUILDING SERVICES
INDUSTRIAL ENGINEERING, MAINTENANCE & OPERATIONS

DURATION

5 Days

DELIVERY

Classroom



Course Overview

The Advanced HVAC Systems Training Course is a comprehensive professional program designed to strengthen the technical, operational, and engineering capabilities required to manage modern heating, ventilation, and air conditioning systems. The course moves beyond basic HVAC principles to address advanced system design considerations, equipment performance, control strategies, energy efficiency, troubleshooting, maintenance, and system optimization. It provides participants with a structured understanding of how individual HVAC components interact as part of an integrated building or industrial system.

Modern HVAC installations are increasingly expected to deliver reliable environmental control while supporting energy efficiency, indoor air quality, operational continuity, and sustainable facility performance. This course addresses these requirements by examining advanced refrigeration systems, air-handling equipment, chilled-water systems, variable air volume systems, pumps, cooling towers, heat exchangers, ventilation systems, and associated control technologies. Participants will develop the ability to evaluate system performance and identify technical opportunities for improvement.

The Advanced HVAC Systems Training Course also emphasizes practical engineering analysis and operational decision-making. Participants will explore methods for diagnosing complex system problems, analyzing temperature and pressure conditions, evaluating airflow and water-flow performance, identifying energy losses, and improving equipment reliability. Attention is given to the interaction between mechanical equipment, electrical systems, control systems, building requirements, and operating conditions.

For organizations responsible for large buildings, industrial facilities, commercial properties, hospitals, hotels, infrastructure, manufacturing plants, and critical facilities, effective HVAC management is directly connected to operational reliability and facility performance. The course therefore integrates engineering principles with practical maintenance and performance-management approaches, enabling participants to develop more effective strategies for system optimization, preventive maintenance, energy management, and long-term asset performance.

Objectives

- Analyze advanced HVAC system configurations and explain the functional relationship between major mechanical, electrical, and control components during the course.
- Evaluate the performance of chillers, air-handling units, cooling towers, pumps, fans, heat exchangers, and associated equipment using relevant operating parameters.
- Apply advanced principles of refrigeration, heat transfer, psychometrics, airflow, and hydronic systems to practical HVAC engineering situations.
- Assess HVAC operating conditions and identify potential causes of abnormal temperature, pressure, airflow, water-flow, and equipment-performance conditions.
- Develop preventive and predictive maintenance strategies for critical HVAC equipment based on operating conditions, equipment characteristics, and reliability requirements.
- Improve system energy efficiency by evaluating equipment operation, control strategies, heat transfer performance, airflow management, and system loading.
- Design practical approaches for troubleshooting complex HVAC system problems and determining appropriate corrective actions.
- Evaluate the effectiveness of HVAC control and automation strategies in maintaining stable system performance under changing operating conditions.
- Strengthen decision-making related to HVAC equipment selection, replacement, maintenance, optimization, and lifecycle performance.
- Implement appropriate methods for monitoring HVAC performance through operating data, maintenance records, alarms, trends, and key performance indicators.
- Assess indoor environmental conditions and their relationship to ventilation, air distribution, filtration, humidity control, and occupant requirements.
- Develop an organization-specific HVAC improvement action plan incorporating reliability, energy efficiency, maintenance, safety, and operational priorities by the end of the course.

Who Should Attend

The Advanced HVAC Systems Training Course is designed for mechanical engineers, HVAC engineers, facilities engineers, maintenance engineers, building services engineers, energy engineers, commissioning engineers, and technical specialists responsible for the design, operation, maintenance, testing, and optimization of HVAC installations. It is also suitable for HVAC technicians, supervisors, maintenance planners, building-services professionals, and personnel involved in troubleshooting complex heating, ventilation, refrigeration, and air-conditioning systems.

The course is particularly relevant to facilities managers, maintenance managers, engineering managers, operations managers, energy managers, technical services managers, and project managers responsible for large-scale building and industrial infrastructure. Professionals working in government facilities, ministries, banks, financial institutions, hospitals, hotels, commercial buildings, manufacturing facilities, oil and gas organizations, utilities, and large corporations can apply the course concepts to improve the performance and reliability of their HVAC assets.

It is also appropriate for senior specialists and decision makers who participate in HVAC equipment procurement, technical evaluation, retrofit projects, facility upgrades, energy-efficiency initiatives, maintenance strategy development, or lifecycle asset management. Participants with existing HVAC knowledge will particularly benefit from the advanced analytical, troubleshooting, optimization, and performance-management aspects of the program.

Learning Outcomes

- Explain the operating principles and engineering relationships within advanced HVAC and refrigeration systems.
- Evaluate chiller, cooling tower, pump, fan, air-handling unit, and heat-exchanger performance using operational measurements.
- Analyze psychrometric conditions to assess temperature, humidity, air treatment, and ventilation requirements.
- Identify common and complex causes of HVAC performance deterioration, including heat-transfer limitations, airflow restrictions, water-flow problems, control faults, and equipment degradation.
- Apply structured troubleshooting techniques to investigate HVAC system abnormalities and determine suitable corrective actions.
- Assess chilled-water and condenser-water system performance and identify opportunities for hydraulic and thermal optimization.
- Evaluate variable air volume and variable flow systems and their influence on comfort, control, and energy consumption.
- Analyze HVAC energy performance and identify practical opportunities for reducing unnecessary energy consumption.
- Develop preventive and predictive maintenance programs for critical HVAC equipment based on equipment condition and operational requirements.

- Evaluate HVAC control strategies and identify opportunities to improve system stability, sequencing, set-point management, and equipment coordination.
- Use operating trends, alarms, maintenance records, and performance indicators to support evidence-based HVAC management decisions.
- Prepare a practical HVAC optimization and improvement plan addressing reliability, maintenance, energy efficiency, operational performance, and long-term asset value.

Course Outline

DAY 01

Advanced HVAC Engineering Principles and System Architecture

- Advanced principles of heating, ventilation, air conditioning, and refrigeration.
- Heat transfer mechanisms and their application to HVAC system performance.
- Advanced refrigeration cycles and refrigerant-system considerations.
- Psychrometrics and analysis of air-conditioning processes.
- HVAC system configurations for commercial, institutional, industrial, and critical facilities.
- Chilled-water and air-cooled HVAC systems.
- Central plant architecture and interaction between major HVAC components.

PRACTICAL APPLICATION

Analyze a complete HVAC system and identify the relationship between its major components.

DAY 02

Chillers, Cooling Towers, Hydronic Systems, and Air-Handling Equipment

- Advanced chiller operation and performance characteristics.
- Air-cooled and water-cooled chiller systems.
- Chiller loading, efficiency, sequencing, and operating limitations.
- Cooling tower operation, heat rejection, water circulation, and performance assessment.
- Chilled-water and condenser-water systems.

DAY 02 — CONTINUED

- Pumps, pump curves, pressure relationships, and flow control.
- Air-handling units, coils, filters, dampers, fans, and ventilation systems.
- Variable air volume and variable flow systems.

PRACTICAL APPLICATION

Evaluate operating data from a chilled-water HVAC plant and identify performance-improvement opportunities.

DAY 03

Advanced HVAC Troubleshooting, Diagnostics, and Maintenance

- Systematic approaches to HVAC troubleshooting and fault diagnosis.
- Diagnosing abnormal refrigeration pressures and temperatures.
- Compressor performance and common compressor-related problems.
- Airflow measurement, balancing, restrictions, and distribution problems.
- Hydronic system troubleshooting and water-flow abnormalities.
- Heat-exchanger and coil performance assessment.
- Identification of control, sensor, actuator, and sequencing problems.
- Preventive, predictive, and condition-based HVAC maintenance.
- Root-cause analysis for recurring HVAC failures.
- Maintenance planning for critical HVAC assets.

PRACTICAL APPLICATION

Conduct a structured troubleshooting exercise involving multiple HVAC faults and develop corrective recommendations.

DAY 04

HVAC Controls, Automation, Energy Efficiency, and Performance Optimization

- Fundamentals of HVAC control architecture and automation.
- Sensors, actuators, controllers, valves, dampers, and control loops.
- Temperature, pressure, humidity, and airflow control.
- Building automation and HVAC monitoring systems.
- Equipment sequencing and load-based control strategies.
- Variable-speed drives and their application in pumps and fans.
- Set-point optimization and system scheduling.
- Energy efficiency in chillers, air-handling units, pumps, fans, and cooling towers.
- Identifying excessive energy consumption and operational losses.
- HVAC performance indicators and energy monitoring.

PRACTICAL APPLICATION

Review an HVAC control and energy-performance scenario and develop a system optimization strategy.

DAY 05

Integrated HVAC Performance Management and Advanced Optimization

- HVAC system reliability and lifecycle performance management.
- Advanced approaches to improving equipment availability and operational continuity.
- HVAC commissioning, testing, performance verification, and functional assessment.
- Developing performance-based maintenance strategies.
- Asset criticality assessment and prioritization of HVAC maintenance activities.
- HVAC energy-management opportunities and continuous improvement.
- Indoor air quality, ventilation effectiveness, filtration, and environmental control.
- Risk management and safe operation of advanced HVAC equipment.
- Developing HVAC performance dashboards and practical key performance indicators.

DAY 05 — CONTINUED

- Evaluating repair, replacement, retrofit, and modernization options.

FINAL WORKSHOP

Develop an integrated HVAC systems improvement plan covering system performance, troubleshooting, maintenance, energy efficiency, controls, reliability, and implementation priorities.

Register or Request More Information

Course page: <https://quest-training.com/courses/advanced-hvac-systems-training-course>

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