



SCIENCE AND TECHNOLOGY CAREER PATHWAYS II

SEMESTER II

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Course Outline

Chapter 2

Climate (HVAC) engineering and Transportation engineering

Climate (HVAC) Engineering & Applications

Refrigerants Cycle

Career prospects & HVAC Specialist Role

Transport engineering

Safety and Security in Transportation

Career prospects & Transportation Specialist Role

Introduction

- Imagine walking into a building on a hot summer day. Outside, it's very hot, but once you enter, the air is cool and fresh, keeping you comfortable and productive. This comfort doesn't happen by accident—it's the result of the work of **HVAC engineers**, who design and maintain the systems that control heating, ventilation, and air conditioning to create a perfect indoor climate.
- Now, think about a busy city at rush hour. Cars, buses, and trains are all moving people and goods to their destinations. The roads are well-maintained, and public transport is running smoothly. This seamless flow is the product of **transportation engineers**, who design, build, and optimize transportation networks to ensure safety and efficiency.
- In this chapter, we'll explore two fields—**HVAC and transportation engineering**—that are integral to modern life.



Climate (HVAC) Engineering

- HVAC stands for Heating, Ventilation, and Air Conditioning. It involves the design, installation, maintenance, and regulation of heating, ventilation, and air conditioning systems in buildings and other enclosed spaces to ensure comfort, air quality, and thermal control.



Applications

- Some of the common applications of HVAC engineering include:

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- ✓ **Residential Buildings:** HVAC systems are used in homes and apartments to regulate indoor temperature, humidity, and air quality.
 - ✓ **Commercial Buildings:** Office buildings, stores, restaurants, hotels, and other commercial spaces utilize HVAC systems to create comfortable environments for employees, customers, and guests. These systems also help maintain optimal conditions for equipment and materials.
 - ✓ **Industrial Facilities:** Manufacturing plants, warehouses, and industrial facilities require HVAC systems to regulate temperature and humidity levels for processes, equipment, and product storage.
 - ✓ **Data Centers:** Data centers require precise temperature and humidity control to ensure the efficient operation of servers and other electronic equipment.

Refrigerants

- Refrigerants are substances used in refrigeration and air conditioning systems to transfer heat and enable the cooling process. These substances have the ability to change between liquid and gas states and vice versa. During evaporation, they absorb heat, and during condensation, they release it within the refrigeration cycle.
- Refrigerants classification refers to the categorization of these substances based on their physical, chemical properties, and applications. The classification of refrigerants generally depends on several criteria, including:
 - Chemical composition
 - Cooling capacity
 - Environmental and safety considerations
 - Industrial applications

Refrigerants

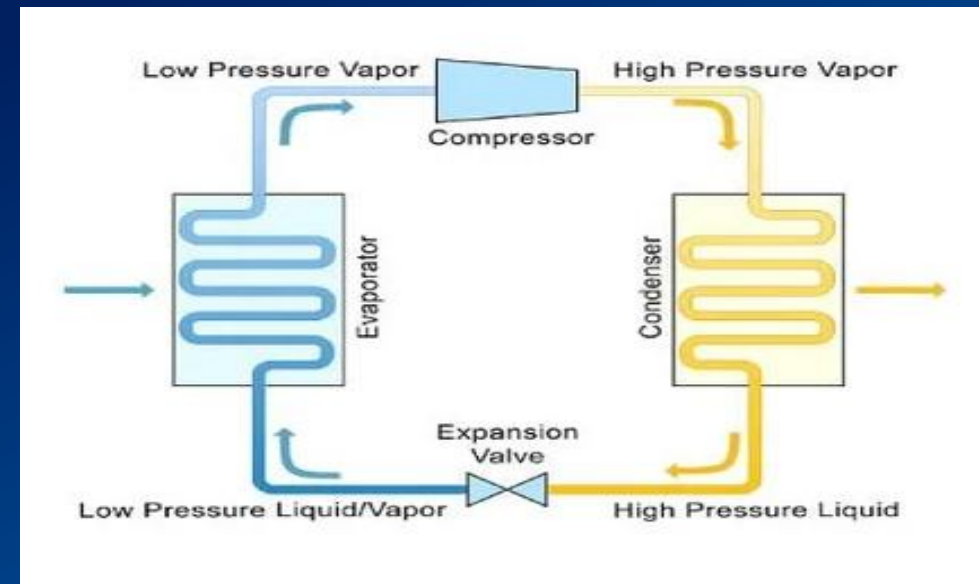
- Examples of refrigerants include:

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- ✓ Chlorofluorocarbons (CFCs): Examples include R-12, which was commonly used in older refrigeration systems but has been phased out due to its ozone-depleting properties.
 - ✓ hydrochlorofluorocarbons (HCFCs): Examples include R-22, which has been widely used as a refrigerant in air conditioning systems but is being phased out due to its ozone-depleting potential.
 - ✓ Hydrocarbons (HCs): Examples include propane (R-290) and isobutane (R-600a), which are natural refrigerants with low environmental impact and are being increasingly used in refrigeration and air conditioning systems.
 - ✓ Ammonia (NH₃): Ammonia is an efficient refrigerant with zero ozone-depleting potential and low global warming potential. It is commonly used in industrial refrigeration systems but requires careful handling due to its toxicity.
 - ✓ Carbon Dioxide (CO₂): Carbon dioxide is an environmentally friendly refrigerant with zero ozone-depleting potential and low global warming potential. It is used in CO₂ refrigeration systems for commercial and industrial applications.

Refrigerants Cycle

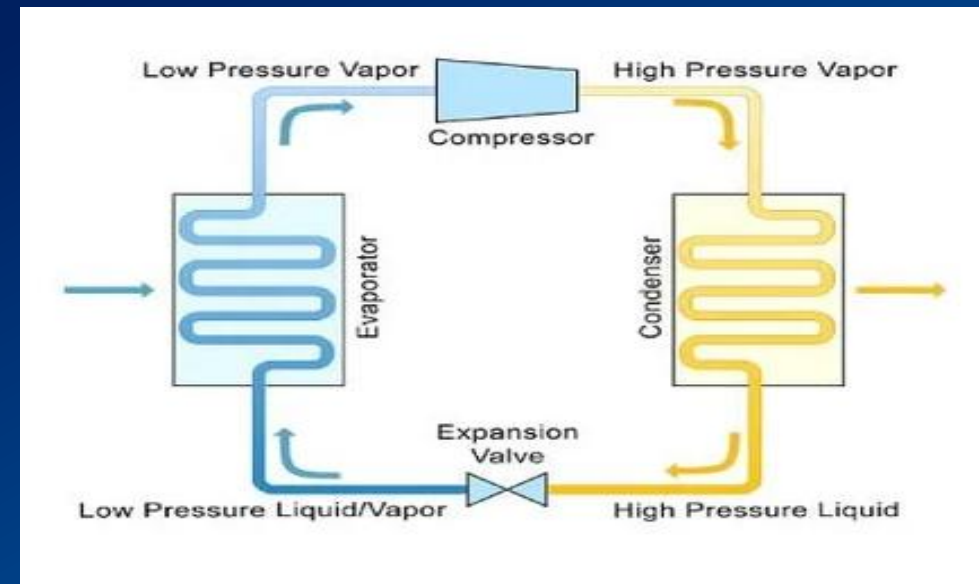
- The refrigeration cycle is a thermodynamic process that involves the transfer of heat from a low-temperature region to a high-temperature region, resulting in the cooling of a space or substance.
- This cycle involves several stages, each serving a specific purpose in the cooling process:

✓ **Compression:** The cycle begins with the compression of a low-pressure refrigerant gas by a compressor. As the gas is compressed, its temperature and pressure increase significantly. The compressor provides the energy required for this process.



Refrigerants Cycle

- ✓ **Condensation:** The high-pressure, high-temperature refrigerant gas then enters the condenser, where it undergoes a phase change from a gas to a liquid. This process occurs as the refrigerant releases heat to the surroundings and cools down. The condenser is typically a coil or heat exchanger located outside the cooled space.
- ✓ **Expansion:** The high-pressure liquid refrigerant exits the condenser and passes through an expansion valve or device. This valve reduces the pressure of the refrigerant, causing it to expand rapidly. As a result, the temperature and pressure of the refrigerant decrease significantly.



Refrigerants Cycle

- ✓ **Evaporation:** The low-pressure, low-temperature liquid refrigerant enters the evaporator, which is located inside the space or substance to be cooled. As the liquid refrigerant absorbs heat from its surroundings, it evaporates into a gas. This process causes the surrounding area to cool down.
- ✓ **Return to Compression:** The low-pressure refrigerant gas exits the evaporator and returns to the compressor to begin the cycle again. This continuous process allows the refrigeration system to maintain a consistent cooling effect.

Career prospects & HVAC Specialist Role

- Here are some potential career paths and opportunities for HVAC engineers:

 - ❑ Design Engineer
 - ❑ Installation Engineer
 - ❑ Service and Maintenance Engineer
 - ❑ Energy Efficiency Consultant
 - ❑ Research and Development Engineer
 - ❑ Project Management
 - ❑ Teaching and Training
- The career prospects for HVAC engineers are diverse and rewarding, offering opportunities for specialization, career advancement, and making a positive impact on building comfort, energy efficiency, and environmental sustainability.

Transport engineering

- Transport engineering, also known as transportation engineering, is a branch of engineering that focuses on the planning, design, construction, operation, and maintenance of transportation systems and infrastructure.
- This field encompasses various modes of transportation, including roadways, railways, waterways, and airways.
- Transport engineers work to improve the efficiency, safety, and sustainability of transportation networks to meet the growing demand for mobility and facilitate the movement of people, goods, and services.
- They employ principles of engineering, economics, and urban planning to address challenges related to traffic congestion, air pollution, infrastructure deterioration, and sustainable transportation solutions.

Safety and Security in Transportation

- Safety and Security in Transportation refer to two critical concepts aimed at ensuring the protection of passengers, goods, and infrastructure against potential risks and threats.

✓ Safety in Transportation:

- Safety in transportation involves the protection of people, vehicles, and infrastructure against accidents, and hazards related to transportation operations.
- This includes preventing road accidents, train derailments, air incidents, maritime disasters, and other events that could cause harm to passengers, transportation workers, and the environment.
- Safety measures in transportation may include safety policies and regulations, secure operational procedures, personnel training, vehicle and infrastructure maintenance, as well as public awareness.

Safety and Security in Transportation

✓ Security in Transportation:

- Security in transportation aims to prevent intentional acts of sabotage, terrorism, crime, and any other malicious activity that could endanger the safety of passengers, goods, and transportation infrastructure.
- This includes protection against terrorist attacks, aircraft hijackings, infrastructure sabotage, cargo theft, maritime piracy, and other similar threats.
- Security measures in transportation involve the implementation of security devices, strict control procedures, surveillance and detection systems, as well as international cooperation to share information and coordinate security efforts.

Career prospects & Transportation Specialist Role

- Here are some common career paths and roles for transportation specialists:
 - Transportation Planner
 - Traffic Engineer
 - Transit Planner/Manager
 - Logistics and Supply Chain Manager
 - Freight Transportation Specialist
 - Aviation/Airport Planner
 - Sustainable Transportation Specialist
- Overall, career prospects for transportation specialists are promising, with opportunities available in government agencies, consulting firms, transportation companies, logistics providers, and nonprofit organizations.