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جامعة وهران للعلوم والتكنولوجيا محمد بوضياف
People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research
University of Sciences and Technology Oran Mohamed BOUDIAF
Faculty of Physics
Department of Energy de Physics

COURSE HANDOUT

Professions in Science and Technology 2

PST 2

Intended for first-year undergraduate students (LMD) L1-ST:

Option: **Science and Technology ST**

Elaborated by :

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Academic Year 2024-2025

INTRODUCTION

This syllabus, developed by the Ministry of Higher Education and Scientific Research, will serve as a table of contents for our course material intended for first-year Bachelor’s degree students specializing in Science and Technology (ST) for the second semester, titled: **Professions in Science and Technology (PST2)**.
The second semester includes a total of **22.5** hours, divided into a weekly duration of **1 hour and 30 minutes**, which includes only lectures.
The assigned coefficient is **01**, and the credit awarded is also **01.**

- This document is divided into seven main courses:

Course I : Industrial Hygiene and Safety (IHS), Mining Engineering
In this first course, we discuss the field of industrial hygiene and safety. We start by defining these two fields and their areas of application. These two professions in industrial hygiene and safety play a crucial role in the workplace, providing protection and safety for all workers. Professionals in this field, such as safety engineers, industrial hygienists, and safety managers, are responsible for identifying potential hazards, assessing risks, and implementing preventive measures. They are also tasked with promoting a culture of safety within the organization (company).

Course II. Fields of Climate Engineering and Transportation Engineering
In the second course, we explored the fields of Climate Engineering and Transportation Engineering, two essential areas for addressing contemporary environmental challenges.
Climate Engineering focuses on the design, optimization, and management of heating, ventilation, and air conditioning (HVAC) systems in buildings. Its goal is to ensure thermal comfort while reducing environmental impact. This field is fundamental for decreasing energy consumption and greenhouse gas emissions by integrating innovative technologies and eco-friendly practices.
On the other hand, Transportation Engineering deals with issues related to the mobility of people. It encompasses the planning, design, and management of transportation infrastructure, including roads, railways, ports, and airports.

These two fields offer varied and dynamic career prospects, responding to the growing demand for qualified professionals to tackle the challenges associated with the energy transition.

Course III. Fields of Civil Engineering, Hydraulics, and Public Works

The third course addresses the fields of Civil Engineering, Hydraulics, and Public Works, which are essential sectors in the design, construction, and management of infrastructures vital to our environment. These areas play a fundamental role in the sustainable development of contemporary societies by ensuring the safety, accessibility, and performance of public infrastructures.

Civil Engineering focuses on the design and implementation of various structures such as buildings, bridges, and roads. In contrast, the Hydraulics field specializes in the management of water resources, encompassing aspects such as hydrology, stormwater management, and the development of waterways. Lastly, Public Works cover all activities related to the construction and maintenance of public infrastructure, thereby ensuring the proper functioning of essential services such as transportation, sanitation, and water distribution, which contributes to the well-being of citizens.

Together, these fields offer varied and enriching professional opportunities, responding to the growing need for qualified specialists capable of addressing the challenges posed by urbanization, sustainability, and climate change.

Course IV. Field of Aeronautics, Mechanical Engineering, Maritime Engineering, and Metallurgy

In this fourth course, we examined three closely related fields: Aeronautics, Mechanical Engineering, Maritime Engineering, and Metallurgy. These fields play a crucial role in the industrial and technological development of our society. Each of these disciplines contributes significantly to the innovation and efficiency of the systems and infrastructures that shape our daily lives.

The Aeronautics field specializes in the design, manufacturing, and maintenance of aircraft. It requires in-depth engineering expertise to ensure the safety and performance of flying machines.

Mechanical Engineering, on the other hand, is fundamental to the design and analysis of machines and mechanical systems. This discipline covers a wide range of applications, from engines to robots, and plays a key role in optimizing production processes and equipment performance.

Maritime Engineering focuses on the design and management of ships and maritime infrastructure. It addresses the challenges of navigation, maritime transport safety, and the preservation of the marine environment, thus contributing to the sustainability of maritime activities.

Finally, Metallurgy focuses on the properties and behavior of metals, as well as their transformation and use. This discipline is essential for optimizing materials for various industrial applications, ensuring both durability and efficiency.

Course V. Approaches for Sustainable Production

This fifth course explores industrial ecology, remanufacturing, and ecodesign, three fundamental concepts that promote the transition to sustainable production systems. These strategies offer innovative solutions to minimize the ecological impact of industrial activities.

Industrial ecology draws inspiration from the principles of natural ecosystems to optimize industrial processes. Its goal is to create synergies between various industries, transforming one company's waste into reusable resources for another.

Remanufacturing, on the other hand, refers to the process by which used products are refurbished to give them a second life. This involves actions such as disassembly, repair, and part replacement, helping to extend product lifespans while reducing the consumption of new raw materials.

Finally, ecodesign focuses on creating products while considering their entire life cycle. This includes assessing environmental impacts from the earliest stages of design to integrate sustainable practices into product development.

These approaches are essential levers for encouraging environmentally friendly production and contributing to the emergence of a circular and resilient economy.

Course VI. Measuring the Sustainability of a Process/Product/Service

This course, which is the second to last, is dedicated to measuring the sustainability of a process, product, or service. This evaluation has become essential in a world where environmental and social issues are increasingly important. Sustainability is not limited to environmental impact alone; it also encompasses economic and social dimensions. Therefore, assessing sustainability involves analyzing how a process or product

contributes to the preservation of natural resources, the reduction of greenhouse gas emissions, and the improvement of community well-being.
To quantify this sustainability, various methodologies and indicators can be employed. Life Cycle Assessment (LCA) is one of the most recognized approaches, allowing for the evaluation of environmental impact at each stage of a product's life, from raw material extraction to final disposal. This holistic approach fosters a thorough understanding of the effects of a product or service and helps to guide decisions towards more sustainable practices.

Course VII. Sustainable Development and Business

In this final course, we explored the relationship between sustainable development and business, starting by defining each term. We also discussed the impact of economic activities on the environment and ways to engage in sustainable development practices, as well as the global ranking of companies most committed to this path.
Integrating sustainable development into a company's business model can offer numerous advantages. By adopting environmentally responsible practices, such as energy efficiency, waste management, and sustainable sourcing, companies can not only reduce their costs and carbon footprint but also improve their reputation and strengthen customer loyalty. This proactive approach also allows companies to differentiate themselves in the market, meet the growing expectations of consumers, and contribute to a more sustainable future for all.

We will provide a summary of this document along with training and additional questions and an extensive bibliography.

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PREFACE

This course booklet related to Professions in Science and Technology (PST2) is structured into seven chapters. Its primary objective is, first and foremost, to provide first-year students in science and technology with a comprehensive overview of the various fields available within this domain. Subsequently, it highlights the different careers accessible in this sector. In parallel, this course also addresses contemporary challenges associated with sustainable development as well as the emerging professions that result from it.

Many students in the common core of science and technology (ST) are not familiar with the meaning of this field or the careers related to it. Why pursue the study of this subject? The simplest answer lies in the fact that this module fulfills several fundamental objectives. Firstly, it provides students with the opportunity to explore the different specialties available in the science and technology sector, as well as the roles and responsibilities associated with each profession.

Furthermore, this course plays a crucial role in developing essential skills, both technical and non-technical, such as problem-solving, critical thinking, and teamwork. It also prepares students to enter the job market by informing them about employer expectations, industry trends, and job opportunities. In addition, students are encouraged to innovate and design projects that could have a positive impact on society. The course also addresses contemporary issues, including sustainable development, technological ethics, and the social responsibility of professionals working in the fields of science and technology.

Finally, this course serves as a professional orientation tool, helping students better understand their interests and make informed choices for their future. In summary, this module dedicated to careers in science and technology not only prepares students for specific professions but also provides them with a broader perspective on the impact of these jobs on our society and environment.

This teaching is part of the second semester (S2) at the **Faculty of Physics**, within the **Department of Basic Physics Education**, and is aimed at first-year students in the Bachelor's program in science and technology (ST). It allows for a deeper exploration of certain fundamental concepts already covered in previous courses. These texts have been developed with the aim of training students according to the LMD system.

Any comments, suggestions, or constructive criticism aimed at improving and enriching this course booklet will be received with enthusiasm.

Course I : Industrial Hygiene and Safety (IHS), Mining Engineering

Content:

- Definitions and areas of application (Safety of property and individuals, Environmental issues, Exploration and exploitation of mining resources, etc.)
- Role of the specialist in these fields.

I.1. Definition of the Industrial Hygiene and Safety (IHS) field

I.1.1. A bit of history…

a. Historical Context: Many scientists have conducted research on the working environment as well as on industrial hygiene and safety. Here are some notable contributions:

- Hippocrates (460-377 BC) described in his treatise "De Morbo vulgari" the effects of lead (or lead colic) on miners.
- Plautus (200 BC), a Greek physician, described occupational ailments (postural deformities) of tailors.
- Lucretius (98-55 BC) noted in his "De rerum natura" that the lives of those who work in mercury mines are very short and stated that toxic substances enter the body through the ears and nostrils.
- Pliny the Younger (1st century Roman) reported lead poisoning among slaves in the mines.
- Galen (2nd century Roman) observed that workers worked naked in an underground mine because the fumes destroyed their clothing (cause: copper sulfate).
- Arnaud de Villeneuve (French physician 1235-1313) systematically studied ailments caused by working conditions of craftsmen.
- Ulrich Ellenbog (Austrian physician in 1473) recognized the dangers of metallic fumes (mercury, lead, silver, etc.) and recommended that “workers should not hold their heads above this vapor but should wear masks because the vapors cause chest tightness, accumulate in the limbs, and often render them lame, especially in metal foundries…”.
- Jean Fernel, physician to Henry II in 1557, reported lead colic among painters and mercurial poisoning among gilders.
- Paracelsus (Swiss physician 1493-1541) wrote a thesis "De morbis metallici" on industrial pulmonary diseases in mines (e.g., mercury).

- Georgius Agricola (Anglo-Saxon physician 1494-1555) wrote "De Re Metallica," in which he described diseases associated with certain dusts in mines.
- Samuel Stockhausen (German physician) published in 1656 a book on his twelve years of experience with miners, addressing the toxicity of lead, mercury, arsenic, cobalt, etc.
- Bernardino Ramazzini (Italian physician 1633-1764) wrote "De Mortis Artificium Dia Triba" on the diseases of workers and is considered the father of occupational medicine.
- Sir Humphrey Davy (1778-1829) studied explosion issues in mines and developed lamps for work in mining.

I.1.2. Definition

The field of industrial hygiene and safety encompasses various professions that operate within businesses, industries, insurance companies, hospitals, consulting firms, and laboratories. These professions include: Industrial Hygienist, Occupational Hygiene and Safety Technician, Laboratory Technician, CHSCT Manager, and others.

Industrial hygiene, both a science and an art, is “dedicated to the recognition, evaluation, and control of the constraints related to the physical environment of the workplace, constraints that can cause occupational diseases, impair health and well-being, or create a state of discomfort or inefficiency for workers as well as citizens in general” (definition from the American Industrial Hygiene Association (AIHA)).

Hygiene: This refers to a set of principles and practices, both individual and collective, aimed at preserving health and ensuring the normal functioning of the body. For example, maintaining a healthy lifestyle, such as food hygiene, is important. It also encompasses the care provided to the body to maintain cleanliness, such as scalp hygiene.

Safety: Safety is a state in which hazards and conditions that could cause physical, psychological, or material harm are controlled to preserve the health and well-being of individuals and the community.

Safety:Short-term prevention involves addressing risks such as impacts, falls, cuts, burns, road accidents, and other incidents—terminology that is well-known in the business world. These risks have long been taken into account through work organization, improvement of techniques and tools, and training of personnel.

Industrial Hygiene: Medium- and long-term prevention involves addressing risks like asbestosis, cancers, genetic modification, stress, MSDs (Musculoskeletal Disorders), and infections. This terminology is also recognized (although some may be less familiar with it), but these risks are more challenging to assess.

I.1.3. What is an HSE Plan?

The preparation phase for work related to a construction site begins with the development of an analysis and assessment of the specific risks associated with the site. This helps to identify and direct training and awareness initiatives for workers on site.

I.1.4. What are the Safety Rules?

Safety rules are a set of guidelines to be followed in the workplace, established based on the present risks. These rules provide personnel with means to prevent accidents.

I.1.5. Why Have Safety Rules?

To establish a code of safe conduct that is respected by all personnel within the company.

I.1.6. What is the Purpose and Objective of Industrial Hygiene?

Industrial hygiene, or occupational hygiene, has the ultimate goal of protecting the health and well-being of workers.

It aims to achieve three objectives:

1. Identification and recognition of the constraints faced by workers in their work environments and the effects on their health and safety.
2. Qualitative and, more importantly, quantitative evaluation of these constraints using objective measurement and analysis techniques.
3. Implementation of technical means to prevent, control, reduce, or eliminate these constraints.

I.1.7. What is the Importance of Hygiene?

It is clear that maintaining good hygiene promotes health. Numerous studies have shown the impact of lifestyle on life expectancy. Hygiene, in general, helps to limit epidemics, the transmission of diseases, and the risk of infections in wounds.

I.1.8. Areas of Application

Employers of industrial hygienists may include:

- Industrial factories
- Government agencies (DSP, CLSC, CNESST, etc.)
- Occupational hygiene consultants
- Educational institutions
- Labor unions, etc.

The basic skills of an occupational hygiene practitioner include:

- Ability to work in a team
- Investigative and analytical skills
- Effective communication with both employers and workers
- Strong written and oral communication of abstract concepts and concrete data
- Problem-solving skills, particularly in addressing health issues
- Ability to persuade various stakeholders to implement preventive measures
- Effective prioritization of problems and solutions.

I.1.9. Field of Work:

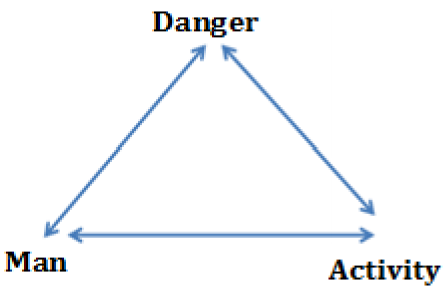
I.1.9.1. Occupational Physician:

The role is to prevent any deterioration in the health of workers.

I.1.9.2. Risk Assessment

a. Components in Industrial Hygiene

Industrial hygiene takes into account three components for risk assessment:



Activity:

The analysis of work activities forms the basis for assessing occupational risks through the observation of work situations. Through an ergonomic approach, it allows us to understand how work is actually performed in the field (real work) along with the adaptations made due to various constraints.

The Human Factor:

Considering the human aspect is essential in all its dimensions (medical, qualifications, status, skills, training, and information, etc.). The medical approach provides additional insights into the reality of exposures. It relies on the clinical and biological monitoring of employees (biomarkers of exposure and early effects).

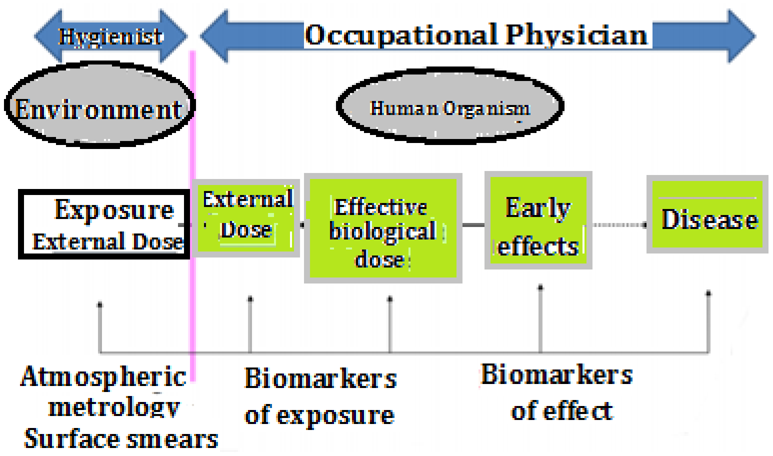
Several factors influencing the toxicity of a substance are related to the individual:

- Their physiological and pathological state
- Their lifestyle (diet, tobacco use, alcohol, hygiene, etc.)
- For certain risks, particularly chemical ones, their genetic susceptibility related to gene polymorphisms involved in the metabolism of xenobiotics or the repair of DNA lesions (Unfortunately, we are not all equal when it comes to disease).

b. Quantitative Assessment

The prevention of occupational diseases is partly based on risk analysis and partly on adhering to occupational exposure limit values. Quantitative assessment (metrology) is conducted through two sources:

- Atmospheric Measurements
- Individual Biological Measurements



Metrology

I.1.10. Safety of Property and Individuals

The safety and health of workers is a permanent priority for the employer, who must constantly:

- Establish and enforce regulations, guidelines, and requirements related to the prevention of occupational risks, hygiene, health, and safety.

- Integrate the safety of property and individuals into the choice of techniques and technologies as well as the organization of work.

Participating and consulting with workers, as well as their representatives or advisors, is essential for the success of risk assessment, mitigation, and monitoring.

I.1.11. Environmental Issues

One observable change is the degradation of the environment, which includes the pollution of water, air, and natural habitats, among others. This degradation is due to multiple causes, the most significant being population growth, increased industrial activities, and overconsumption. Some examples include:

- Marine debris.
- Overfishing and bycatch.
- Habitat destruction and decline of marine species.
- Invasive exotic species.
- Underwater noise.
- Ocean acidification.
- Eutrophication.
- Climate change.

I.1.12. Exploration and Exploitation of Mineral Resources

I.1.12.1. What is Mineral Exploration?

Mineral exploration is the first step in the cycle of mineral resource development. It involves searching for new mineral deposits with the objective of discovering new sources of metals or economically exploitable minerals, such as industrial minerals (e.g., silica used in glassmaking and clay used in ceramics), iron, base metals like lead, zinc, and copper, rare earth elements used in high technology, as well as precious metals and gemstones (e.g., gold, platinum, and diamonds). Exploration can occur in very different locations, either in areas where minerals have not yet been discovered (primary or preliminary exploration) or in regions adjacent to an operating or closed mine.

I.1.12.2. What is Mine Exploitation?

Mine exploitation, which represents the third stage of the mineral resource development cycle, involves extracting economically valuable minerals for the benefit of shareholders, various stakeholders, and society as a whole. A mine is considered operational when rock and soil are removed from the ground to extract a marketable product at the output of the processing plant. There are two main types of mining exploitation:

- Underground Mine: An underground mine is constructed when the mineral resource is located too deep to safely exploit through open-pit mining. Underground mines require artificial shafts and inclined ramps to access and extract the ore.
- Open-Pit Mine: An open-pit mine is used when the mineral resource is found at or near the surface of the ground.

I.1.13. Role of the Specialist in These Fields

I.1.13.1. Mining Professions

The term "galibot" referred to a young miner, while "porion" designated the foreman. The nickname "gueule noire" was used to describe all miners and those working with coal (such as coalmen and steam train drivers), in contrast to "gueules jaunes," which referred to iron mine workers.

I.1.13.2. What is the Role of a Mining Engineer?

Mining engineers perform numerous tasks related to the planning, design, organization, and supervision of mine development as well as mining facilities.

I.1.13.3. What are the Different Mining Professions?

The main mining professions were or are as follows:

- ✓ ***Underground:***

- Driller: A miner responsible for breaking down the ore, initially using a pickaxe and later with a jackhammer. This role is the most exposed to dangers such as methane explosions, dust inhalation, and collapses.

- Hewer: A miner who creates notches in the rock to facilitate the extraction of coal ("the blasting").

- Loader: Responsible for filling and pushing mine carts (wagons).

- Timberman: Responsible for woodwork (supporting structures) and its maintenance.

- Rock Worker: Tasked with drilling into the rock to reach the ore vein, initially using a pick and crowbar, later with dynamite. This position is highly exposed to silicosis.

- Shot Firer: Responsible for carrying out blasting operations using explosives.

- Winch Operator: Constructs the winches.

- Receiver: Positioned at the "receiving" area (lift door), responsible for vertical circulation.

- Groom: Responsible for caring for the horses.

- ✓ ***Surface (Open-pit):***

- Machinist: Operates machines (pumps, elevators).

- Sorter: Responsible for separating rock from ore. This job is also highly exposed to silicosis.

- Lampman: Responsible for maintaining and distributing lamps.

Today, work in mining is largely mechanized.

I.1.13.4. Risks:

In uranium mines, high concentrations of radon gas, which is highly radioactive, pose a risk leading to lung cancers, as evidenced by statistical studies and the Thomas/MacNeil report of 1982. According to French authorities, officially, French miners are not more exposed to lung cancer and laryngeal cancer than the average population, contrary to findings reported abroad.

In general, silicosis is a recognized occupational disease in mining. The dangers associated with uranium mines have led to the implementation of specific safety measures.

In coal mines, "gassy explosions" can occur, which are explosions that happen when this gas comes into contact with air. The deadliest explosion in France was the Courrières disaster in 1906, although it cannot officially be attributed to methane gas. This incident resulted in approximately 1,000 fatalities.

Another explosion occurred in France on December 27, 1974, in the Liévin mine, causing 42 deaths. This incident is known as the Liévin disaster.

I.1.13.5. Working Conditions:

In 1995, the Convention on Safety and Health in Mines (C176) was adopted by the ILO. The "Book III" of the Mining Code outlines "Social Provisions," particularly regarding "Working Conditions, Health, and Safety at Work."

In Canada, both Quebec and Ontario have regulations concerning health and safety in the mining sector. Most of their regulations are derived from lessons learned through accident analyses, often based on fatal incidents or those causing severe injuries or other serious consequences for workers.

Before 1925, the work of miners was very challenging and dangerous, particularly due to dust exposure, risks of falls in shafts, and collapses. Most accidents were fatal.

Additionally, it is important to note the risks associated with the explosion of dynamite sticks before their replacement with more powerful and easier-to-handle explosives, such as those from the plastic explosives family.

Course II. Fields of Climate Engineering and Transportation Engineering

Content: Definitions and Areas of Application (Air conditioning, Smart buildings, Transport safety, Traffic management and road, air, naval transport, etc.)
- Role of the Specialist in These Areas:

II.1.Definition of the Climate Engineering Field

Climate engineering is a specialty within physics that focuses on heating, air conditioning, ventilation, and control systems, along with their various applications. The theoretical study of this field is based on physical principles, while its implementation primarily takes place in the industrial sector and in **construction and public works** (CPW).

II.1.1. Presentation

Climate engineering involves the analysis, study, design, implementation, operation, and maintenance of systems that allow for the overall control of indoor environments. The treatment of air, as well as the regulation of its temperature and humidity, forms the foundation of this field. The analysis includes natural ventilation, indoor air circulation, the influence of wind, and external conditions on comfort, among other aspects. The areas of expertise encompass:

- **Hydraulics**
- **Heating**
- **Air Conditioning**
- **Cooling**
- **Airflow**
- **Regulation**

The term "***climate engineering***" was coined by Roger Cadiergues in 1962. This former student of the École Polytechnique served as the director of the **Scientific and Technical Committee of the Climate Industries** (STCCI), was a scientific advisor for the **Association of Engineers in Climate, Ventilation, and Cooling** (AECVC), and authored numerous books and columns. The website génieclimatique.fr, launched in 2016 and dedicated to the news of the heating, air conditioning, and ventilation markets, solidifies the term's relevance.

Here’s the translation of your text into English:

II.1.2. Different Air Conditioning Systems

In the summer, an air conditioning system should be able to maintain the ambient temperature of a room at 5 to 6 °C below the outside temperature and keep the humidity level at an acceptable level (65%), depending on the external conditions.

For aesthetic reasons and to minimize noise disturbances, it is important to carefully choose the location of the outdoor unit to avoid inconveniencing neighbors, who may complain and force you to relocate the heat pump. It should not be placed in a heavily sunlit area, as this would hinder the condenser's ability to dissipate heat.

There are several ways to classify air conditioning systems; generally, four main categories of products are distinguished:

- ✓ Direct expansion systems
- ✓ Air-to-air systems
- ✓ Water-to-water systems
- ✓ Heat pump systems with water loop

II.1.3. The Different Types of Air Conditioning

Equipped with multiple features, air conditioning can take many forms. It can cool a house and, for some models, even provide heating. Air conditioning units can be mobile or fixed, monobloc or split, or centralized. Several factors need to be considered when choosing the air conditioning system for your home. For a single room, a system with a single unit is sufficient. Beyond that, a version with multiple modules is necessary. This is especially true if you also want to provide heating in the winter. This type of device, known as a split system, comes in various models and generally offers a good quality/price ratio.

a. The Portable Air Conditioner

The portable air conditioner is movable on wheels and requires the passage of a duct through an opening. It is worth noting that it is louder than its counterparts.

b. Wall-Mounted Air Conditioners

The wall-mounted air conditioner is the most common system. It is fixed to the wall and installed at a height. Its footprint is minimal while still being aesthetically pleasing.

c. The Air Conditioning Console

Next, there is the air conditioning console. It can be positioned on a wall or on the floor.

d.The Cassette Air Conditioning

Finally, the cassette air conditioner (which is recessed into the ceiling) is reserved for rooms with a minimum height of 3 meters. Below this height, people may feel the airflow, which can lead to discomfort. Its units can cover an area of 60 to 70 square meters.

II.2. Definition of the Transportation Engineering Field:

Transportation engineering involves the application of technological and scientific principles to the planning, design, operation, and management of facilities used for transportation. Its primary goal is to ensure the safety, efficiency, speed, comfort, and convenience of transporting people and goods.

Among the sub-disciplines of transportation engineering, we can include railway engineering and marine engineering.

II.2.1. Railway Engineering: Railway engineering is a multifaceted branch of transportation engineering that focuses on the design, construction, and operation of all types of railway transport systems. It encompasses a wide range of engineering disciplines, including civil engineering, transportation engineering, computer engineering, electrical engineering, mechanical engineering, industrial engineering, and production engineering. Many other sub-disciplines of engineering are also involved.

This field requires a specialized engineering approach, where key roles include the designer responsible for design studies at various stages, the project manager overseeing execution, and the coordination of testing and commissioning operations along with certification.
All or part of this engineering work may be delegated by the project owner to external consultants.

II.2.2. Marine Engineering: Today, marine engineering refers to a specific branch of transportation engineering that encompasses a group of technical disciplines primarily focused on beaches, estuaries, and ports, as well as fixed structures constructed offshore, particularly for oil exploration (known as "offshore") or mobile and floating structures such as various types of vessels, which also fall under naval architecture. The field also includes oceanographic engineering.
Marine engineering utilizes and applies engineering sciences, including mechanical engineering, and has expanded in the 20th century to incorporate electrical engineering, electronic engineering, and computer sciences. This encompasses all phases from project design to the end-of-life management of structures, including operation and maintenance.

The work of engineers in this field involves improving propulsion systems and onboard systems, as well as advancing oceanographic technologies. This includes, but is not limited to, propulsion mechanisms and energy sources, along with machinery, piping, and automation and control systems for marine vehicles of all types, ranging from surface vessels to submarines, and including gliders and marine drones.

II.3. Areas of Application

II.3.1. Air Conditioning

The aim of the bachelor's program in climate engineering is to train individuals who can master the energy design of buildings and their systems in collaboration with architects.

a. Careers in Climate Engineering: These encompass all activities related to heating, air conditioning, ventilation, as well as sanitary plumbing and fire protection, all within buildings. Outside, we refer to RVN (Roads and Various Networks), traditionally executed by general contractors.

Today, careers in climate engineering extend beyond the traditional HVAC (Heating, Ventilation, **Air Conditioning**) and PB (Plumbing) scope, shifting towards energy performance professions. Knowledge of electricity, particularly concerning all energy-consuming devices like lighting, is now part of the skill set required for engineers and technicians in climate engineering.

All levels of expertise are represented in **climate and energy engineering** professions, ranging from heating installers, plumbers/heating specialists (experts in the installation and repair of central heating systems), energy technicians, refrigeration technicians (who fabricate, install, or maintain air conditioning and refrigeration systems such as air conditioners, cold rooms, and refrigerators), thermal engineers (specialists in thermal energy), to heat pump **commissioning technicians.**

b. Responsibilities of a Refrigeration and Air Conditioning Technician

The role encompasses diverse functions. The technician is responsible for the installation of refrigeration and air conditioning systems, including heat pumps.

A refrigeration and air conditioning technician performs adjustments, troubleshooting, and both preventive and corrective maintenance on refrigeration and air conditioning installations. During interventions, they may either install a refrigeration system or repair it in case of a malfunction, selecting appropriate equipment based on the technical issues encountered.

Organization is key in this profession. Installing equipment and ensuring its operation in a timely manner requires careful planning, monitoring, and verification of equipment orders. Given the rapid evolution of technologies, the refrigeration technician must develop skills in automation, electronics, and knowledge of new materials. Occasionally, the technician consults specialized experts in these areas. Furthermore, in the case of large-scale installations, they coordinate and supervise a team.

Here's a refined version of your text:

c. Skills/Qualities Required to Become a Refrigeration Technician

- Insight, quick decision-making, and execution
- Rigor
- Organizational skills
- Interest in cutting-edge technologies

d. Career Opportunities for Refrigeration and Air Conditioning Technicians

Refrigeration technicians can be found working for manufacturers and service providers of refrigeration and air conditioning equipment, as well as in refrigerated warehouses, the food industry, or collective catering. Experienced technicians are in high demand.

e. Career Advancement for Refrigeration and Air Conditioning Technicians

With experience or additional training, technicians can aspire to take on responsibilities such as **team leader, workshop supervisor, intervention manager**, or even hold a technical sales position with a manufacturer of equipment.

II.3.2. Smart Buildings

II.3.2.1. Definition

A smart **building** is defined as a high-energy-efficiency structure that integrates the management of energy-consuming equipment, energy-generating systems, and potential storage facilities into a coordinated intelligent system. The goal is to apply "intelligence" to the private electrical network of buildings (such as homes, residential complexes, or office buildings) to facilitate and enhance energy management and the operation of electrical devices within the network.

Technologies that have already been gradually implemented in public distribution networks will similarly serve as essential tools for improved management within private electricity networks. Additionally, three significant developments in electrical networks will greatly impact energy management within buildings:

- Decentralized electricity production from renewable energy sources (such as wind and solar power);
- The rise of electric vehicles, which can serve as storage installations;
- Smart meters, which act as interfaces between public electricity networks and the building's private network, leading to major innovations downstream of the meter.

II.3.2.2. Smart Buildings: Perspectives from Distribution Network Managers and Electricity Producers

Given that smart buildings can generate their own renewable energy, managing loads on the grid becomes easier. This capability also helps prevent costly energy consumption peaks for electricity producers. Communicating buildings assist electricity producers in adjusting their output more efficiently.

II.3.2.3. Operation of Smart Buildings

Smart buildings leverage new information and communication technologies (NICT) to transmit and store data regarding the building's usage and condition, allowing for optimized energy consumption. This principle, which has already been gradually introduced into public distribution networks as part of smart grids, is now expanding to private buildings.

II.3.2.4. Smart Buildings – Emerging Job Trends in Construction

This analysis is based on job postings in the fields of industry, construction, engineering R&D, and information technology published on apec.fr in 2016 and 2017, featuring keywords such as "smart building," "connected home," "smart building," and "GTB/GTC." In addition to this analysis, companies that posted job offers in 2017 and industry experts were consulted.

Currently, the smart building market continues to evolve:

- Between 2016 and 2017, the number of job postings in this field published by Apec increased by 23%, rising from 700 to 888 offers.
- Engineering firms and IT companies are the primary recruiters in this sector.
- Île-de-France accounts for 37% of job offers in the industry.

Regarding recruitment, companies increasingly seek cross-disciplinary skills:

- In 64% of cases, recruiters are looking for experienced profiles with diverse expertise (electrical and electronic engineering, embedded software development, automation) applied to the building sector.
- Due to a lack of interdisciplinary training programs that integrate these various technological skills, the search for specific profiles can prove challenging.

For example, "The Edge" is recognized as the smartest and one of the most eco-friendly buildings in the world. Designed by architect Ron Bakker, it received the highest sustainability score ever awarded by the BREEAM certification agency: 98.4%. Located in Amsterdam, Netherlands, the project was completed in 2014. Several features that characterize this smart building include:

- The design of The Edge features an atrium that serves as the gravitational center of the building's system, enabling natural ventilation.
- An application provides access to each employee's daily agenda and delivers useful real-time information.
- Approaching vehicles are recognized and automatically redirected to available parking spaces.
- The adaptable and intelligent workspaces are allocated automatically based on the schedule and needs of employees, including options for sitting desks, standing desks, cubicles, and meeting rooms.
- Lighting and temperature settings for various areas are adjusted according to user preferences, among other features.

II.3.3. Security in Transportation

II.3.3.1. Definition:

Security in transportation is a significant concern due to the risks of fraudulent manipulation of shipments for terrorist purposes or other illicit activities, as well as potential criminal attacks targeting the supply chain. Transportation means and equipment, such as full or empty containers, can be diverted from their intended use, posing a threat to the security of the cargo.

Such acts can occur at various stages, including within the transportation means, during loading and unloading, or throughout the storage process. Documents may be falsified to mislead private transport operators and relevant authorities.

II.3.3.2. Types of Risks

The risks associated with transportation security can be categorized as follows:

- Risks to People:
- Risks to Property:
- Risks to the Natural Environment:

II.3.3.3. Risk Factors

- Human Factors: Driving, monitoring, surveillance, maintenance, etc.
- Material Factors: Relating to the suitability and condition of the equipment used (infrastructure, signage, vehicles, etc.).
- Nature of Transported Goods:Hazardous materials such as explosives, flammable products, or toxic substances.
  - For instance, the presence of highly flammable fuels is an aggravating risk factor.
  - It is essential to establish scales of hazard or toxicity, as some insidious risks may not be immediately apparent.

II.3.3.4. Preventing Occupational Risks

Activities involved in road freight transport expose employees to various occupational risks, including joint pain, back pain, trips, slips, and falls. The following resources can help in understanding these risks better, preventing them, and preparing your unique assessment document.

II.3.3.5. Key Transportation Sectors in Security

By sector:

- Air Safety
- Road Safety
- Maritime Safety

II.3.4. Traffic Management and Road Transportation

Intelligent transport systems play a crucial role in managing road traffic through dynamic means and equipment utilized by traffic control centers on roadways and highways. They also serve as a significant asset for informing users and for the overall operation of the road network.

a. Demand Management: On highways and urban expressways, as traffic intensifies, traffic managers implement a range of measures to balance the supply (the infrastructure's capacity to handle traffic) with the demand. To achieve this, traffic control centers employ strategies and tools largely based on Intelligent Transport Systems (ITS).

b. Transport Incidents:On road and highway networks, transport incidents can quickly disrupt the proper functioning of infrastructure due to the congestion they create upstream and the dangers they pose (risk of secondary accidents). Consequently, managing transport incidents is a key activity within a traffic control center; it must be executed swiftly and effectively.

c. Traffic Management and Control: Intelligent transport systems are particularly involved when dynamic traffic management measures are implemented. This includes dynamic speed regulation, which optimizes traffic flow on the infrastructure, and dynamic restrictions on overtaking for heavy vehicles on highways based on traffic conditions.

d. Traffic Knowledge: Real-time knowledge of traffic conditions is essential for the effective operation of the road network (particularly to support traffic management systems) as well as for informing public policies and providing statistics on the sector in a deferred manner.

For example, traffic data can be utilized to:

- ✦ Develop policies for the management, operation, and maintenance of the national road network
- ✦ Monitor transportation policies, particularly the evolution of road traffic and its environmental impact
- ✦ Optimize the use of existing infrastructures to meet the objectives outlined in the Grenelle de l'Environnement and the National Transport Infrastructure Scheme
- ✦ Formulate and assess the effects of public policy aimed at reducing road safety risks
- ✦ And more...

II.3.5. Air Transportation

Air transportation refers to the activity of moving passengers or freight via air, as well as the economic sector encompassing the primary and ancillary activities related to this mode of transport. Responsibilities include controlling air traffic within a designated airspace, transmitting landing and takeoff information and instructions to airborne aircraft, maintaining communication between control centers, and coordinating flight movements in closely situated regions.

II.3.6. Naval Transportation

Naval vessels and structures for military, commercial, fishing, recreational, offshore, or riverine purposes are often complex systems. Their design, construction, and maintenance—traditionally known in France as maritime engineering for over 250 years—are the responsibility of naval engineers.

Regardless of their specific applications, naval engineers share a broad knowledge of the marine environment and possess comprehensive skills across various disciplines: stability of floating bodies, hydrodynamics, material behavior, structural calculations, mechanics, energy production, control systems, ergonomics, construction methods, and various assessments. Some naval engineers may specialize in particular areas, such as hydrodynamics (calculating and testing model hulls and propellers) or structural integrity (material resistance and calculations), potentially becoming renowned experts in their fields.

Course III: Fields of Civil Engineering, Hydraulics, and Public Works

Content:- Definitions and Areas of Application: (Construction Materials, Major Road and Rail Infrastructure, Bridges, Airports, Dams, Drinking Water Supply and Sanitation, Hydraulic Flows, Water Resource Management, Public Works and Urban Planning, Smart Cities….)
- Role of Specialists in These Fields:

III.1. Definition of the Civil Engineering Field

Civil engineering encompasses all the techniques related to civil construction. ***Civil engineers***, or engineers in civil engineering, are responsible for the design, implementation, operation, and rehabilitation of construction works and infrastructures. They manage these projects to meet the needs of society while ensuring public safety and environmental protection. Their achievements are quite diverse and are primarily divided into five major areas of intervention: structures, geotechnics, hydraulics, transportation, and environment.

III.1.1. The Main Options in the Civil Engineering Field

The civil engineering field encompasses two main options:

– Buildings

– Public Works & Developments

III.1.1.1 Buildings

The term "buildings" refers to the construction of structures, their interior layout, maintenance, restoration, or demolition. These projects are carried out by companies of all sizes, from small artisans to large multinational corporations.

These structures include collective housing, individual homes, as well as commercial and industrial spaces (shopping centers, factories, agricultural buildings), recreational centers (swimming pools, sports halls, concert venues, theaters, cinemas, museums), public places (schools, town halls, hospitals), and historic buildings (castles, ancient monuments).

In the construction of a building, there are two key phases: the structural work, which ensures the solidity and stability of the structure (foundations, load-bearing walls, frameworks, floors), and the finishing work, which includes everything else: from the roofing and windows to electrical systems, plumbing, painting, and tiling.

III.1.1.2. Public Works

Public works refer to construction or maintenance projects of general utility carried out on behalf of the state or local authorities.

The term "***Public Works***" encompasses infrastructures such as roads, tunnels, pipelines, and civil engineering structures, including bridges, dams, airport runways, and more.

III.1.2. Various Professions in Civil Engineering and Construction

- Design Engineer in the Planning Office

The technician in the planning office is responsible for creating the execution plans intended for the construction site.

- Construction Economist

The construction economist's role is to estimate project costs. They assist the designer in determining the most suitable technical options in terms of cost-effectiveness.

- Head of Planning Office

The head of the planning office manages multiple projects; they allocate various studies among designers and assist them in finding the most appropriate technical solutions.

- Method Technician

The method technician's task is to define, in collaboration with the site manager and the works supervisor, the most suitable construction methods in terms of timelines.

- Site Manager

The site manager is responsible for overseeing the construction site assigned to them by their company or technical service.

- Works Supervisor

The works supervisor is responsible for multiple construction sites. They ensure that the preparation phases are completed beforehand, define the various work operations, determine the necessary resources, and establish the work execution schedule.

- Project Director

The project director oversees several works supervisors; they study bids, negotiate, and manage projects across an entire geographical area.

- Control Professions

Numerous professions accessible after a DUT in Civil Engineering—whether or not followed by further studies—exist in the field of control:

- Materials testing laboratories

- Surveyors
- Control organizations

Here is the translation of your text into academic English:

III.1.3. Scope of Civil Engineering

The scope of civil engineering is particularly broad, encompassing both public works and building construction. It notably includes:

- Structural work in general, irrespective of the type of construction or building, such as skyscrapers. This domain is divided into two distinct categories:
  - The design of a new structure,
  - The rehabilitation of an existing structure, also referred to as the conservation of existing works, which involves expertise and/or intervention project planning.
- Industrial constructions, including factories, warehouses, reservoirs, and so forth.
- Transportation infrastructure, comprising roads, railways, civil engineering structures, canals, ports, tunnels, etc.
- Hydraulic constructions, such as dams, levees, and jetties.
- Urban infrastructure, including aqueducts and sewers.

III.2. Definition of the Hydraulic Sector

Historically, the term "hydraulics" referred to the science dedicated to measuring, directing, and elevating water. Hydraulic machines primarily denoted the pumps employed for these purposes. At that time, hydraulics fell under the domain of fountain makers and their specialized workers, such as firefighters, who were experts in the manufacturing and maintenance of pumps, and plumbers, who specialized in working with lead.

Louis Vicat further expanded this term by introducing an additional meaning: hydraulicity, which refers to the property of mortars, plasters, lime, and cements that can set under water.

The term "**hydraulics**" currently refers to two distinct domains:

- The sciences and technologies concerning natural water and its applications, including hydrology, urban hydraulics, hydrogeology, among others.
- The sciences and technologies related to the industrial use of pressurized liquids, encompassing hydrostatics and hydromechanics, as well as applications such as oil

hydraulics, hydraulic motors, hydraulic pumps, hydraulic presses, and hydraulic machines.

III.2.1. What is Hydraulic Energy?

Hydraulic energy is the energy generated by the movement of water in all its forms, including waterfalls, rivers, ocean currents, tides, and waves. This movement can be harnessed directly, as in the case of a watermill, or more commonly converted into other forms of energy, such as electrical energy in a hydroelectric power plant. Hydraulic energy essentially represents kinetic energy associated with the displacement of water, as seen in ocean currents, rivers, tides, and waves, or it can involve the potential energy utilized in cases such as waterfalls and dams.

III.2.2. The Operation of Hydraulic Systems

In other words, hydraulic systems utilize pressurized fluids and the principles of liquid behavior to facilitate mechanical work. These systems employ incompressible fluids, primarily liquids such as oil.

III.2.3. Areas of Study

The fields of study encompassed by hydraulics include several domains, such as:

- Hydraulic machines (refer to hydromechanics and oil hydraulics);
- The flow of incompressible fluids in conduits or open surfaces;
- Hydraulic energy;
- Urban hydraulics;
- River hydraulics;
- Pressurized hydraulics;
- Canals.

III.2.4. Hydraulic Engineer: Career Opportunities

While technical consulting firms and engineering companies represent the primary career pathways for recent graduates, experienced professionals can quickly diversify their areas of activity, which include:

- Eco-industries (water management, soil decontamination, etc.);
- Water agencies;

- Companies specializing in the design or operation of infrastructure;
- Local or regional authorities;
- Autonomous ports.

III.3. Definition of Public Works Sector

The term "public works" refers to infrastructure projects that are publicly funded, in contrast to private works. Various types of public works include:

- VRD (standing for "voiries et réseaux divers," which encompasses roads and highways): activities such as paving, curb installation, sanitation, and the laying of telephone cables and electrical lines;
- Civil engineering structures, referred to as works of art: the construction of bridges and tunnels, dams, locks, and wastewater treatment plants;
- Railway works: the creation and maintenance of rail tracks;
- Earthworks;
- Infrastructure for the transportation of energy (electricity, gas pipelines, oil pipelines) or fluids (aqueducts, steam systems).

Additionally, certain large-scale buildings are classified as public works, including airports, seaports, power generation facilities (solar, hydro, wind, thermal, nuclear), military structures, and stadiums.

III.3.1. Overview of the Public Works Sector

Public Works technicians are proficient in utilizing computer technology for various purposes, including communication, technical solution design (CAD/CAM), development of construction processes (process simulation), and operation of specialized software (project management, cost estimation, etc.). The organization of construction sites is evolving, as project managers, given their workload, often delegate a portion of their tasks—along with the associated responsibilities—to site managers (foremen and team leaders). Consequently, project managers are increasingly becoming "upstream business managers," which elevates the role of site managers to that of the primary technical overseers of the project. They rely on team leaders, who are encouraged to take more initiative in their responsibilities.

III.3.2. The Technician in the Public Works Sector

A technician in the public works field operates at various levels:

- In production, they are responsible for the overall organization of a construction site or a portion thereof, depending on its scale. In this capacity, they monitor and coordinate the work of teams, keeping the project schedule up to date. They also ensure compliance with directives, standards, and regulations, particularly concerning safety. Their work is organized around three main activities: site preparation, organization and monitoring of the site, and project completion. As a direct assistant to the project manager, they may occasionally substitute for them in certain tasks.
- In a company's design office, the technician participates in cost estimation studies, prepares method statements and execution documents under the guidance of a design engineer.
- In project management, they engage in the design of structures and the preparation of preliminary project documents, consultation files for contractors, and project monitoring. They participate in site meetings, manage service orders and progress reports, and maintain updated execution schedules.

III.3.3. What is the Difference Between Construction and Public Works Companies?

The construction sector encompasses over 30 different trades. The term "**public works**" refers to infrastructure projects such as roads, tunnels, pipelines, and civil engineering structures, including bridges, dams, and airport runways. Some companies operate in both fields.

III.4. Construction Materials

III.4.1. Definition:

Construction materials are those utilized in the construction sector, which includes both building and public works (commonly referred to as BTP). The range of materials employed in construction is quite extensive. It primarily consists of wood, glass, steel, plastics (mainly for insulation), and materials derived from the processing of quarry products, which can vary in complexity. For instance, clay is transformed into bricks, tiles, flooring, and sanitary fixtures.

Construction involves the assembly of various components of a structure using appropriate materials and techniques. The economic sector known as "**building and public works**" (**BPW**) encompasses all activities related to the design and construction of both public and private buildings, whether industrial or otherwise, as well as infrastructure such as roads and pipelines. It is one of the leading sectors in the economy.

III.4.2. Classification of Construction Materials

There are three commonly recognized types of classification for construction materials:

a) **Scientific Classification**: In materials science, materials are categorized based on composition and structure as follows:

- Metals and alloys
- Polymers
- Ceramics

b) **Raw Materials and Products**:

- Raw materials (such as clays, stones, wood, limestone, and metals).
- Manufactured and composite materials (such as cement, which is made from limestone and clay, alloys, concrete, etc.).

c) **Practical Classification**: In construction, materials are classified according to their area of application and their main properties (e.g., strength, compactness):

- Load-Bearing Materials: These materials possess the ability to withstand various stresses (such as self-weight, overload, seismic activity, etc.). Commonly used load-bearing materials include stone, ceramics, wood, concrete, and metals.
- Protective Materials: These materials serve to envelop and protect primary construction materials from external actions. Examples include coatings, paints, and bitumen.

III.5. Major Road and Rail Infrastructure

III.5.1. Definition:

Transport infrastructure encompasses all fixed or dynamic installations required to facilitate the smooth circulation of various modes of transportation within terrestrial, aerial, or maritime transport systems. These infrastructures are essential elements (necessary but not sufficient) for ensuring the freedom of movement for people and goods, as well as for supporting the functioning and development of the economy.

Human involvement is central to the railway systems commonly encountered, whether in train operation, directing trains to their destinations, or ensuring the safety of passengers and transported goods. Human work is governed by established procedures.

Railway systems require a specific infrastructure known as the railway track. Vehicles are guided by one or more lines of rails fixed to sleepers.

III.5.2. Major Transport and Rail Infrastructures

- ★ Road network
- ★ Railway network
- ★ Navigable waterways (rivers, canals)
- ★ Port infrastructures (including inland ports)
- ★ Airports
- ★ Bicycle paths
- ★ Energy transport networks (heat, natural gas, electricity, hydrogen, etc.)
- ★ Information transport networks (cable, fiber optics, telecommunications, information highways, etc.)

III.6. Bridges

III.6.1. Definition:

A bridge is a civil engineering structure that allows for the crossing of a natural or artificial obstacle (such as a depression, watercourse, transportation route, valley, ravine, or canyon) by spanning over it. This crossing facilitates the passage of individuals and vehicles in the case of a road bridge, or water in the case of an aqueduct.

- **Metal Bridges:** Iron is a material that offers greater strength than stone. While its tensile strength is relatively low, it is significantly higher than that of any other material available prior to the mass production of steel.
- **Reinforced Concrete Bridges:** Natural cements were only rediscovered at the end of the 17th century, and it wasn't until the early 19th century that artificial cements emerged, thanks to the work of French engineer Louis Vicat and Englishman Joseph Aspdin.
- **Suspension Bridges:** Early 19th-century suspension bridges were often fragile, and numerous accidents occurred due to the excessive flexibility of wooden decks and the corrosion of inadequately protected cables.

Course IV. Field of Aeronautics, Mechanical Engineering, Maritime Engineering, and Metallurgy

Content: - Definitions and areas of application (Aeronautics, Avionics, Automotive Industry, Ports, Dikes, Industrial Equipment Production, Steel Industry, Metal Processing, etc.)
- The role of specialists within these fields.

IV.1. Definition of Aeronautics:

Aeronautics encompasses the sciences and technologies aimed at the design and operation of aircraft within the Earth's atmosphere. The term "aeronautics" refers to matters related to navigation in the air.

IV.1.1. Aeronautical Sector

According to **GIFAS**, the aeronautics, space, defense, and security workforce in France comprises approximately 180,000 individuals. Explore the main professions within the sector, along with their associated missions, required skills, and qualities, through the aeronautical job descriptions:

IV.1.2. Aeronautical Professions

- Aircraft Assembly Technician: The aircraft assembly technician is responsible for receiving and assembling the components that make up a part of an aircraft, such as engines, turbines, fuselage, wings, and nacelles. Following the technical specifications and instructions, he first analyzes the composition of the elements (gears, bearings, actuators, etc.) and their mode of attachment (screws, rivets, or welding).
- Aerospace Sheet Metal Worker: A key player in the manufacturing of an aircraft, the aerospace sheet metal worker shapes the metal components that form the structure of the aircraft using hand tools and suitable machinery. Before starting work, he reviews the technical documentation (plans, diagrams, instruction sheets), defines the layout of the parts, and organizes the sequence of tasks to be performed.
- Draftsman/Designer: The draftsman/designer is responsible for creating two- or three-dimensional schematics of the components to be produced, drawing up plans according to the precise specifications contained within the technical data sheet. He

considers the materials to be used and the overall assembly in which the parts will be integrated.

- Aerospace Electronics Technician: The aerospace electronics technician is a specialist responsible for the design, installation, and replacement of various electronic components necessary for the operation of aerospace equipment (aircraft, radars, missiles, etc.). When a fault is detected, he locates the issue, replaces the affected component (whether it be a component or electronic board), modifies the software programmed into a chip, and restores the equipment to service.
- Research and Development Engineer: The R&D engineer designs and conducts program studies, which may involve new products, industrial processes, or the improvement of existing products or processes. He is responsible for program studies during the pre-project and/or project phases and may be involved at all stages of design and implementation: process studies, analyses, testing, and from implementation to market launch.
- Calculation Engineer in Aeronautics: The calculation engineer is responsible for the design studies of industrial parts or assemblies. He operates downstream of the R&D teams and upstream of the industrial production (whether for prototypes or series manufacturing). Through numerical modeling, he simulates material behaviors.
- Structural Engineer in Aeronautics: The structural engineer is a technical expert specializing in materials such as metal frameworks, concrete, wood, and steel. He is involved in the pre-construction project phase, working from technical plans. In collaboration with R&D, he performs calculations related to the dimensions of a part, assembly, or structure of a building.
- Aeronautical Mechanic: Whether in a workshop, hangar, or on the runway, working for a manufacturer, maintenance company, flying club, or airline, the tasks of an aeronautical mechanic vary and cover a range of activities. His primary role is to prevent any malfunctions or anomalies before or after a flight.
- Aircraft Wiring Technician: The aircraft wiring technician is responsible for the assembly and attachment of electrical and electronic components onto a support structure (such as electrical panels or chassis) necessary for the operation of aerospace devices (aircraft, radars, engines, etc.).

- ✦ CNC Operator in Aeronautics: The CNC operator (Computer Numerical Control operator) manufactures mechanical parts using machine tools equipped with 3, 4, 5 axes, or more. He employs machining or turning techniques utilizing digital machines. The CNC operator first prepares the manufacturing process by studying the parts, drafting designs, and establishing the production sequence.
- ✦ Aerospace Painter: The aerospace painter is tasked with preparing and painting parts or structures of aircraft. Based on a detailed specification sheet, he initially sets up the equipment, prepares the surfaces (sanding, stripping, cleaning, masking), and then applies the paint, typically using a spray gun (either conventional or electrostatic).

IV.1.3. What is the difference between aviation and aeronautics?

The terms "**aviation**" and "**aeronautics**" are often used interchangeably, but their meanings are not exactly the same. The word "**aviation**" primarily refers to the field of airplanes, while "**aeronautics**" has a broader scope, encompassing all types of aircraft. Therefore, it is more appropriate to use the term "aeronautics" when discussing topics related to all aircraft.

IV.2. Mechanical Engineering

IV.2.1. Definition

Mechanical engineering, also known as applied mechanics, encompasses the entire body of knowledge related to mechanics, both in the physical sense (the science of motion) and in the technical sense (the study of mechanisms). This field of knowledge covers the full process, from the design of a mechanical product to its recycling, including the stages of manufacturing and maintenance.

IV.2.2. Importance of Mechanical Engineering

The mechanical engineer plays a critical role in the development of all technical products within the industry. In a design and development office, he is responsible for creating the overall plans for a product, machine, or tool while selecting the most suitable materials for their manufacture.

The advanced technologies we know today exist and evolve thanks to the contributions of mechanical engineering. Nowadays, a mechanical engineer must be capable of leading an innovative industrial project in collaboration with a multidisciplinary team. This professional is also referred to as an industrial engineer.

IV.2.3. Branches of Mechanical Engineering

Major complex industries are the primary employers of mechanical engineers. Among these are:

- The automotive industry
- The aerospace and aeronautics industry
- The biomechanical industry
- Robotics
- Defense
- Metallurgy
- The railway sector

IV.2.4. Role of the Mechanical Engineer

The mechanical engineer supervises the manufacturing of a mechanical assembly. He or she has oversight over all stages of the process, from the design plans to the production line. His or her responsibilities include:

- **Feasibility** study, in collaboration with the design office
- Design of the **overall plan** and budget estimation
- Construction of a **prototype** and implementation of any necessary adaptations
- Selection of appropriate **materials**
- Initiating **construction**, whether carried out in-house or through subcontracting

IV.2.5. Required Skills

The mechanical engineer is a highly qualified professional, possessing in-depth knowledge across various technological fields. Whether dealing with machines or software such as Computer-Aided Manufacturing (CAM), this expert is distinguished by his commitment to innovation. Intellectual curiosity, responsiveness, and adaptability are therefore essential qualities. Additionally, he may be required to demonstrate creativity and ingenuity to overcome certain technical challenges.

IV.3. Maritime Engineering

IV.3.1. Definition

Maritime engineering is the **field** of study concerned with the design, development, production, and maintenance of equipment used at sea, such as ships, submarines, oil platforms, and ports.

Course IV. Field of Aeronautics, Mechanical Engineering, Maritime Engineering, and Metallurgy

The term "**maritime engineering**" (or **marine engineering**) is currently used to refer to a type of transportation engineering that encompasses a group of technical disciplines primarily related to beaches, estuaries, and ports, as well as fixed structures built at sea, including offshore oil operations, or mobile or floating structures such as various types of ships, which also fall under naval architecture. The field also includes oceanographic engineering.

IV.3.2. Role of the Maritime Engineering Field

The role of the maritime engineering field is to train engineers with the skills needed to participate in the design, development, and operation of complex systems in marine, underwater, and coastal environments:

- ✦ Mastery of knowledge in the scientific and technical field of maritime engineering,
- ✦ Proficiency in modeling, simulation, measurement, and testing tools for fluids and structures,
- ✦ Basic knowledge in mechanics, energy, materials, and automation.
- ✦ Maritime engineering can be divided into military maritime engineering and civil maritime engineering.

In Algeria, the maritime engineering program is subdivided into two specialties, namely:

a. Naval Architecture and Navigation:

The profession of a naval architect operates within the realms of recreational boating and commercial navigation. The naval architect divides their time between the design office, the workshop where the vessel is constructed, and their clients.

The naval architect is responsible for the design and construction of boats and other marine structures. **Their role includes**:

- Establishing the technical and regulatory plans for the vessel.
- Determining the equipment and materials needed for the construction of the boat.
- Performing calculations related to strength, consumption, weight, etc.
- Overseeing the design of the boat until it is launched.

b. Naval Equipment Engineer:

The naval equipment engineer is responsible for designing, developing, producing, and testing maritime systems, including:

- Hull systems,
- Propulsion systems (diesel engines, gas turbines),
- Fire protection systems,
- Ship machinery,
- Electrical systems, air distribution systems, electromechanical systems, and other related equipment on a vessel.

IV.3.3. Field of Application

This unique training offers numerous career opportunities at both national and international levels in various fields such as:

- ✦ Offshore oil and gas,
- ✦ Marine construction and port engineering,
- ✦ Renewable marine energy,
- ✦ Coastal protection and land-based structures,
- ✦ Underwater robotics and oceanography.

IV.4. Metallurgy

IV.4.1. Definition

Metallurgy encompasses the production of objects that can float, fly, or roll. This sector designs and manufactures a wide array of machines and equipment, such as engines, circuit boards, and cables, for various fields including food processing, construction (BTP), chemistry, and wind energy. Companies in this sector, often referred to as technological industries, offer a broad range of professions in diverse environments.

Metallurgy is defined as the collection of industries and techniques dedicated to the production of metals, which are materials that conduct electricity. Professionals working in this field are known as metallurgists. This sector also includes several subfields, such as steelmaking, which specializes in the processing of iron and its alloys.

IV.4.2. Professions related to metallurgy

- ➢ Forge helper
- ➢ Welder helper
- ➢ Boilermaker
- ➢ Boilermaker-assembler-repairer

Course IV. Field of Aeronautics, Mechanical Engineering, Maritime Engineering, and Metallurgy

- Fusion furnace operator
- Pressure casting machine operator
- Sheet metal machining operator
- Forging press operator
- Foundry color worker
- Mold finisher
- Blast furnace founder
- Blacksmith
- Physical metallurgy engineer
- Precision machinist
- Pattern maker
- Metallic articles assembler
- Sand molder
- Molder
- High-power press setter-operator
- Welder
- Arc welder in a controlled atmosphere
- Welder for pressure vessels
- Welder-assembler
- Metallurgy technician (quality control)
- Metallurgical process technologist
- Metallurgist technologist
- Welding technologist
- Steel structure tracer

IV.4.3. Field of Application

Six main areas can be identified:

1. **The automotive industry**, the largest market, through the following components:

- ✓ Upper engine parts: injector flanges, cams, valve seats and guides, counting wheels, etc.
- ✓ Lower engine parts: bearing caps, connecting rods, sleeves, etc.
- ✓ Timing components: pulleys, sprockets, chain sprockets, tensioner rollers.

- ✓ Transmissions: ABS ring.
- ✓ Gearboxes: hubs and synchronization rings, engagement fingers, dog clutches, shifters, torque converter hubs, etc.
- ✓ Shock absorbers: guides, bearings, pistons, caps.
- ✓ Various accessories: pump bodies and drives, starter components (sprockets, reducers), alternator and starter elements.

2. **Power tools**: various gears, levers, dog clutches, percussion mechanisms;
3. **Home appliances**: compressors (pistons, connecting rods, etc.), various transmission gears;
4. **Agricultural sector** and heavy-duty vehicles;
5. **Public works**: similar applications to those in the automotive industry, with limitations on dimensions and minimum volume;
6. **Brake pads**, ranging from bicycles to aviation, including railways.

IV.5. Production of Industrial Equipment

IV.5.1. Definition:

Industrial equipment encompasses all the machines and tools required for the production process within a company. They are utilized to **produce industrial goods in large quantities across various sectors**, including petrochemicals, food processing, aerospace, metallurgy, and boiler-making, among others.

IV.5.2. Examples of Industrial Equipment

Each sector of activity, as well as every production phase, has its specific needs. For **packaging**, continuous handling conveyors, pneumatic transport systems, and low-profile or tipping bins facilitate the movement of goods and packaging. For the transfer of loads within factories or storage warehouses, equipment such as handling carts, stacker pallet trucks, and lifting devices are essential. In the area of machining, there is a wide range of machine tool sets for sheet metal forming and welding, including milling machines, punch shears, and drills. Additionally, every industry requires a surface treatment and thermal processing system for **cleaning, degreasing, and purifying machine effluents.**

IV.5.3. Access to Employment in the Field

This job/occupation is accessible with a diploma ranging from CAP/BEP to a professional Bac in mechanics, production, electrotechnics, or industrial maintenance. It is also attainable with professional experience in production and operation of production equipment. One or more Certificates of Aptitude for Safe Driving - CACES - may be required, conditioned by a periodic medical assessment.

IV.6. Steelmaking

IV.6.1. Definition:

The term "**steelmaking**," derived from the ancient Greek "sidérourguéïon" (meaning "**smith's workshop**"), which is formed from "**sideros**" (meaning "**iron**") and "ergon" (meaning "**work**"), refers to both the technologies used for producing pig iron, iron, and steel from iron ore, as well as the industry that implements these processes.

IV.6.2. What is the difference between steelmaking and metallurgy?

Steelmaking encompasses all the techniques and industries involved in the production of iron and its alloys (known as ferrous alloys). It is an essential subfield of metallurgy, which studies the manufacture of metals in a more general sense.

IV.6.3. What is the role of a Metallurgy and Steelmaking Technician?

A Metallurgy and Steelmaking Technician is a specialist in the field of **metallurgy** and **steelmaking** who works daily to carry out compliance analyses on certain products within their area of expertise.

IV.6.4. What does a Metallurgy and Steelmaking Technician do?

The **Metallurgy** and **Steelmaking** Technician:

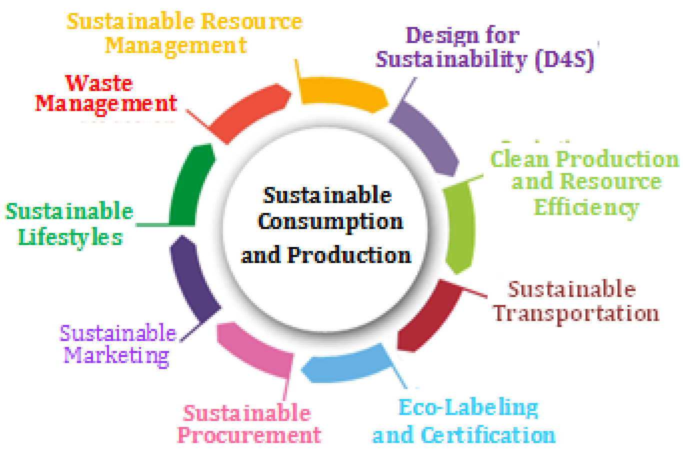
- Primarily conducts tests, analyses, and controls on raw materials.
- Must adhere to very strict protocols and procedures regarding hygiene, safety, and the environment.
- Utilizes laboratory equipment, ensuring it is well-maintained.
- Writes activity reports and records results.
- Performs technological and competitive monitoring.

Course V. Approaches for Sustainable Production

Content: Industrial Ecology, Remanufacturing, Ecodesign.

V.1. Definition of Sustainable Production

Sustainable consumption and production aim to "do more and better with less." They also involve decoupling economic growth from environmental degradation by increasing efficiency in resource use and promoting sustainable lifestyles. Sustainable consumption and production can also help reduce poverty and ensure the transition to green, low-carbon economies.



Clarifying concepts related to sustainable consumption and production UNEP (United Nations Environment Programme), 2010

For four decades, food and financial crises have followed one another in a latent combination with climate change. The most recent food crisis of interest occurred in 2006-2007, characterized by soaring agricultural commodity prices followed by riots in several African countries.

Sustainable consumption and production aim to minimize the negative environmental impacts of consumption and production systems, taking into account all stages of the product and service life cycle, while contributing to improving the quality of life for all. This is a general framework encompassing many operational solutions that are essential for designing and implementing policies and measures to ensure economic, social, and environmental sustainability. These solutions include, but are not limited to: supply chain management, waste management and reuse, efficient resource use throughout the value chain, cleaner production techniques, life cycle thinking, eco-innovation, and eco-labeling. Some are illustrated in the diagram below.

V.2. Principles of Sustainable Consumption and Production

UN Environment proposes four key principles for sustainable consumption and production as a framework for analysis and policy action:

1. Improve quality of life without increasing environmental degradation and without compromising the resource needs of future generations
2. Decouple economic growth from environmental degradation in the following ways:
   - ✓ Reduce the material/energy intensity of current economic activities and decrease emissions and waste resulting from extraction, production, consumption, and disposal;
   - ✓ Promote the transition of consumption patterns towards groups of products and services that have lower energy and material intensity without compromising quality of life;
3. Adopt a life cycle approach that considers the impacts of all stages of the production and consumption life cycle;
4. Prevent the rebound effect, where efficiency gains are negated by the resulting increase in consumption.

V.3. What Do We Mean by "Efficient Resource Use"?

Efficient resource use refers to the reduced use of resources to achieve the same or even better outcomes. It can be achieved by increasing resource productivity or by reducing resource use intensity (resource use/value added). Sustainable resource use must be considered at all stages of the value chain, from sourcing and design, manufacturing, transport, to end-of-life usage/reuse.

V.4. Why Resort to Efficient Resource Use?

Price volatility and increasing demand for resources amid growing scarcity are leading to supply insecurity for a number of strategically important resources in modern production and consumption systems. By 2030, global demand for water is expected to exceed supply by 40%.

V.5. Contributing to the Fight Against Poverty

Unsustainable consumption and production patterns have accelerated the rate of greenhouse gas (GHG) emissions in the atmosphere. This has led to an acceleration of climate change caused by extreme weather events, directly undermining efforts aimed at eradicating poverty and hunger. Furthermore, the effects of "dangerous, inefficient, and unnecessary" consumption and production processes can intensify poverty, harm the health of populations, and delay development.

V.6. Industrial Ecology

V.6.1. History

In Algeria, the post-independence industrialization program, rapid population growth, coastward migration in the North, and unemployment exacerbated by the structural adjustment program have negatively impacted environmental quality in both urban areas and villages. After three decades of development and a stagnation in ecological culture, Algeria has realized, particularly with the emergence of the environment-development debate, that it faces environmental issues, just like other countries, that cannot be ignored (pollution, erosion, fragility of vegetation cover and its depletion, over-urbanization, etc.).

The emergence of the concept of industrial ecology at the end of the 1980s coincided with the publication of the Brundtland Report on sustainable development and with new concerns regarding Corporate Social Responsibility (CSR). The practice of industrial ecology thus appears as an approach aimed at addressing the challenges of economic performance, social well-being, and environmental protection at the territorial level. Industrial ecology is defined as a comprehensive approach to the industrial system interpreted as a biological ecosystem (Frosch and Gallopoulos, 1989). Based on the analysis of material and energy flows, this approach to environmental management aims to limit environmental impacts by seeking organizational synergies among economic actors.

V.6.2. Definition

Industrial ecology, defined by Robert Frosch (1995) as "the set of practices aimed at reducing industrial pollution," leads us to think that the industrial ecosystem can be a true vector for sustainable development.

The concept of "industrial ecology" was defined in 1989 in a special issue of *Scientific American* (Pour la Science in French) dedicated to "managing planet Earth." In an article titled "Viable Industrial Strategies," Robert Frosch and Nicolas Gallopoulos, both research leaders at General Motors, develop the idea that it is becoming necessary to recycle used goods, conserve resources, and seek alternative raw materials.

V.6.3. Industrial Ecology and Maghreb Ports: The Cases of Jorf Lasfar (Morocco) and Bejaïa (Algeria)

African port territories face significant challenges in managing local pollution, both on land (illegal dumping) and at sea (floating solid waste and effluents). The ports of the Maghreb are no exception to this observation. In addition to these important environmental issues, new social and economic challenges have emerged, revealed during the events of 2011 (the "Arab Spring"), which highlighted the demands for self-determination from local populations (democratic and representative dimensions), well-being (quality of the environment and living conditions), and the need for local employment, through a greater contribution from large state-owned enterprises to local economic development (Ben Abdelkader and Labaronne, 2013).

The Port Establishment of Bejaïa (EPB) in Algeria has initiated an internal policy for sustainable development, articulated around a dynamic of certification (environmental management system and CSR policy), aimed at strengthening its cooperation with partners at a Euro-Mediterranean scale (the MEDA MoS project involving the Port of Béjaïa and the port cities of Marseille and Barcelona) and at a local scale (local authorities, industrial actors).

V.6.4. The Ecological Assessment

Between direct and indirect consequences, both positive and negative, the strategy pursued in Algeria has resulted in a negative ecological balance. Today, the country faces issues of industrial pollution. The industrialization process, which ignored ecological imperatives for several decades, has left Algeria with an aging industrial base that is often inefficient and polluting. Pollution caused by the discharge of untreated industrial wastewater, harmful atmospheric emissions, and the production of special waste improperly managed threaten the quality of ecosystems (MATE, 2001).

This section of the contribution aims to highlight the environmental consequences of the pursuit of an independent and prosperous economy by Algerian authorities since the country's independence. To this end, we can start from Algeria's Environmental Performance Index (EPI).

V.7. Remanufacturing

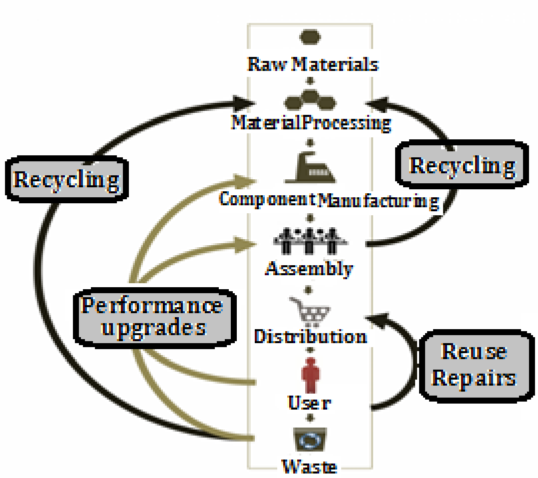
V.7.1. Definition:

Remanufacturing, and Circular Economy, allows for the recovery of a significant portion of the value, composed of materials, energy, and knowledge stored in the product during its elaboration and manufacturing process.

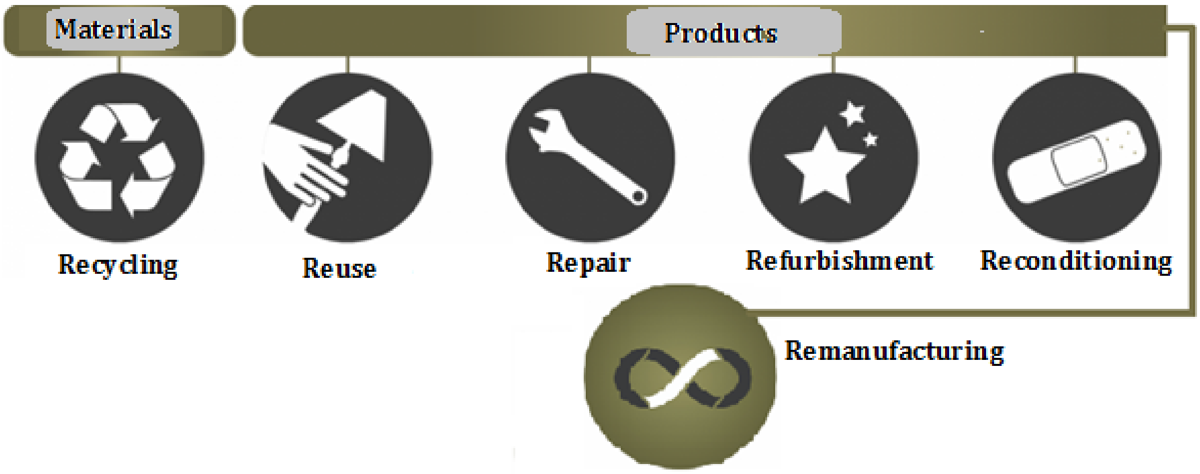
In the technical loops of value regeneration within the Circular Economy, products can be repaired, renovated, refurbished, or remanufactured, and materials can be recycled.

The Circular Economy model applied to these various technical loops is based on the reuse of products and components that have reached the end of their life as incoming resources for more or less structured and rigorous activities aimed at restoring their performance.

Remanufacturing is implemented through a well-defined ***industrial process***, the most rigorous and structured of all other value regeneration processes. The industrial remanufacturing process involves restoring a used product or component (broken, at the end of its life, obsolete, or in a waste state) to *a performance and quality level that is equal to—or even exceeds—its original state.*



V.7.2. The Technical Loops of the Circular Economy for Extending Product Lifespan



Recycling: The fine extraction of raw materials from a product and their transformation in order to reuse them for manufacturing new products or as a source of energy. It is a good option for recovering value from materials in products with simple structures and few components.

Reuse: The simple reuse of a product without modification. For example, passing it on to a new user.

Repair: Fixing a defect, but without guaranteeing the performance of the entire product.

Renovation: Operations primarily focused on the aesthetic improvement of a product to give it a "like-new" appearance, potentially with some functional restorations.

Refurbishment: Operations conducted on a product to restore it to working order and give it a "like-new" appearance, but without necessarily regaining its initial performance.

Remanufacturing: A rigorous industrial process that involves regenerating the intrinsic value of components (transformed materials, energy, knowledge) from products at the end of their lifecycle. These components are then reused to be reassembled into products that exhibit performance equal to—or even superior to—their original state.

V.8. Ecodesign

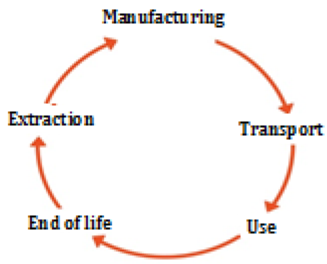
V.8.1. Definition

Ecodesign is a term that denotes the intention to design products that adhere to the principles of ***sustainable development*** and ***environmental protection***.

The official definition recognized by ADEME (The French ***Agency for Environmental and Energy Management***, ADEME, is a public industrial and commercial establishment created in 1991. It is also known as the "Agency for Ecological Transition") is as follows: "It is a preventive and innovative approach that aims to reduce the negative impacts of a product, service, or building on the environment throughout its entire lifecycle (LCA), while maintaining its usability qualities."

From this definition, other formulations or variations can indeed be derived. Ecodesign is an approach that considers environmental impacts in the design and development of a product and integrates environmental aspects throughout its lifecycle (from raw materials to end-of-life, including manufacturing, logistics, distribution, and use).

Life Cycle



V.8.2. Why Engage in Ecodesign?

A competitive advantage. Undertaking an ecodesign approach also allows for a comprehensive cost analysis. Ecodesign enables better control of the manufacturing costs of a product by examining its entire lifecycle: from raw material extraction to its recovery or recycling.

V.8.3. Analysis Method

Ecodesign is an approach of continuous improvement aimed at better respecting the environment at various stages of a product's lifecycle. Among the methodologies that can be integrated into this approach, we can distinguish:

- The life cycle analysis of the object and its components (analysis of its design, production, distribution, consumption, and disposal, as well as the study of pollution and waste generated at different stages);
- A more in-depth study of user behavior as well as their values;
- A more thoughtful consideration of the choice of materials and technologies used to create the object, including disassemblability, traceability, recyclability, and the use of **"clean",** renewable, or biodegradable materials and technologies, as well as the integration of recycled materials, etc.;

- Reflections on upgrading, modularity, durability, and viewing the product as a service rather than just an object, which allow for a shift in perspective and the development of new product concepts.

V.8.4. Impacts That Ecodesign Seeks to Prioritize for Reduction

- The consumption of renewable or non-renewable materials (e.g., can recycled materials be used instead of materials extracted from nature?).
- Resource waste (by facilitating disassembly and recycling or reuse, for example, of waste from electrical and electronic equipment, which was still very poorly recycled in 2015, even for very precious metals. According to a UN-Interpol report published in 2015, in 2012, three hundred tons of gold were reportedly lost with electronic waste because they were not recycled, while in Europe alone, six million tons of "e-waste" are incompletely or not at all recycled annually).
- Energy consumption (e.g., standby mode consumption for electrical products).
- Greenhouse gas emissions.
- Acidification of air, water, and soil (especially from acid mine drainage).
- Photochemical pollution (including through the formation of photochemical oxidants).
- Water pollution.
- Soil pollution.
- Air pollution.
- Transportation (of customers, raw materials, objects, and waste, and their harmful effects on the environment).
- Waste.
- Occupational strain and work-related diseases.
- The use of products and production chains ecocertified by credible, transparent, and recognized environmental or socio-environmental labels.
- Unaccounted nuisances.

Course VI. Measuring the Sustainability of a Process/Product/Service

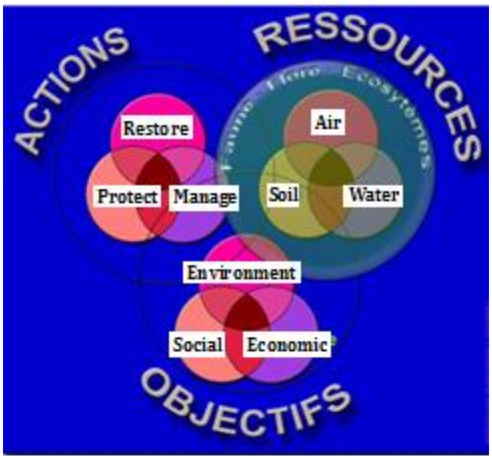
Content: Environmental analysis, Life Cycle Analysis (LCA), Carbon footprint, case studies/applications.

VI.1. Sustainability of a Process:

What is sustainability? The ecological definition of sustainability comes from the Brundtland Report, written in 1987, which describes sustainable development as a mode of development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Innovation for sustainability, including technological and social innovation, is a key element of sustainable consumption and production. Sustainable consumption and production enable the private sector to innovate by offering alternative solutions and products that can help achieve a competitive advantage in an increasingly alert and dynamic market.

Specific examples of national sustainable public procurement programs have demonstrated that increasing sustainability in public markets can lead to job creation, innovation, and improved efficiency.



A representation of sustainable development concepts: managing, restoring, and protecting more or less renewable resources.

VI.2. The Following Statements Have Been Made:

The report emphasizes the interdependence of economic, social, and ecological phenomena and provided the basis for the three-dimensional design at the Earth Summit in **Rio de Janeiro** in 1992. The concept is based on the three interdependent dimensions: environment, society, and economy:

- ✓ Economic, social, and ecological processes are interconnected. Both private and public actors must never act in isolation or unilaterally but should always consider the interactions among the three dimensions of the environment, society, and economy.
- ✓ Sustainable development has a broader scope than environmental protection. To meet our material and immaterial needs, we require a prosperous economy and a supportive society.
- ✓ The long-term effects of today's interventions must be taken into account (intergenerational dimension) so that future generations can also meet their needs.
- ✓ Sustainable development requires a long-term structural change in our economic system and society to reduce our resource and environmental consumption to a sustainable level while preserving a high-performing economy and a supportive society.

VI.3. Origin of the Problem

VI.3.1. *Environmental Balance*: Environmental issues and access to natural resources have been a growing concern for Western societies since the 1970s, particularly due to oil shocks and pollution.

Indeed, studies by ecological experts show that humanity's ecological footprint has exceeded the Earth's capacity to regenerate new natural resources and to absorb the waste generated by all types of economic activity since the mid-1970s. Climate change is just one aspect of this problem, which partly stems from a trend towards greater concentrations of greenhouse gases in the atmosphere.

VI.3.2. *Social Equity*:In developed countries, the need to ensure respect for employee interests within companies became evident in the second half of the 19th century during the Industrial Revolution, leading to the emergence of labor unions, the right to strike, and other related expressions such as "economic and social" and "capital/labor," which have significantly influenced minds and institutions.

However, there are still income inequalities in the world regarding social aspects:

- An imbalance between developed countries and developing countries, particularly the least developed countries, with severe inequalities in access to knowledge (education), food, and health (nutrition, medicine); this has given rise to alternative globalization movements, calls for food sovereignty, and NGOs focused on human rights.

- Within developed countries, there are also significant inequalities.

VI.4. New Sustainable Economic Models

VI.4.1. ***Weak Sustainability*****:** In this hypothesis, compatible with neoclassical economists and advocated by Hartwick (1977), there is a substitution between artificial capital (created wealth) and natural capital (natural resources). This is also referred to as substitutability.

This conception of sustainability prevails in many international organizations (United Nations, World Bank, WBCSD) and, according to researchers such as S. Baker, J. Barry, and C. Rootes, within the European Union as well.

The indicator proposed by the Stiglitz Commission, adjusted net savings, renders the three forms of capital interchangeable: "economic" (derived from production), "human" (approached solely through education expenditures), and "natural" (limiting ecological damage to climate aspects only). Thus, this indicator fits into a model of weak sustainability.

VI.4.2. ***Strong Sustainability*****:** This hypothesis is advocated by Herman Daly (1990). According to him, only material flows in the economy that fulfill the following three conditions can be considered sustainable in material and energy terms:

- The rate of consumption of renewable resources must not exceed the rate of regeneration of those same resources;
- The rate of consumption of non-renewable resources must not exceed the rate at which renewable and sustainable substitutes can be developed;
- The rate of pollution emissions must not exceed the environment's capacity to absorb and assimilate this pollution.

In this hypothesis, the stock of natural capital must not decrease. Daly argues that natural capital and artificial capital are complementary and not substitutable.

VI.5. Environmental Analysis

VI.5.1. *Definition*: Environmental analysis is a comprehensive study of human activities such as industrial operations or the use of natural resources (solar energy, water, etc.) and their direct and indirect effects on environmental parameters.

Environmental analysis is a major component of the ISO 14001 standard and is essential for implementing an Environmental Management System (EMS). This system is defined by an environmental policy and deploys resources to establish and maintain it over time. It is based on the principle of continuous improvement (Deming's wheel), allowing for an increase in overall performance in line with the environmental policy. At the same time, environmental analysis is accompanied by regulatory analysis.

<u>The ISO 14001 Standard</u>: *This is an **international** standard, like all ISO standards. They are created by a worldwide federation of national standardization organizations comprising approximately 140 countries. ISO is thus an acronym for "**International Organization for Standardization**." These strategies promote environmental respect within the company. It is based on the principle of **environmental management** and ensures that a consistent approach is present to achieve the company's objectives while preserving environmental balance.*

VI.5.2. Why Conduct an Environmental Analysis?

Questioning the environmental impacts of an organization has several **advantages**. First, it allows for setting sustainable development objectives through better environmental management by optimizing resource use (which can lead to cost reductions, particularly those related to energy consumption, water, materials, and waste treatment). These objectives are based on the organization’s activities and will help identify **dysfunctions** that can be corrected by developing an Environmental Management System (EMS) within the framework of continuous improvement. Additionally, this analysis aims to reduce accidental risks, and the accompanying regulatory monitoring ensures compliance with **environmental regulations**. More generally, it enables the adoption of more environmentally friendly and efficient practices without compromising the organization’s activities.

VI.5.3. How to Conduct an Environmental Analysis?

First, create a site plan that includes the main facilities, activities, and equipment. Then, perform a mapping of the organization's activities. This step allows you to list all activities in order to subsequently analyze their main sources of environmental impact.

Conducting an environmental assessment requires **time** and **good organization**. Therefore, it is important to **collect the right information** to obtain a complete environmental analysis upon which you can rely when drafting your action plan.

The environmental analysis examines **several parameters**:

- Air
- Noise
- Waste (solid, liquid (fluids), or gaseous)
- Water
- Energy
- Landscape
- Soil and subsoil
- Technological and natural risks
- Etc.

VI.5.4. How to Conduct an Environmental Analysis of Your Business?

Today, **awareness is growing** regarding environmental issues. Consumers are becoming increasingly demanding about the products they purchase and seek to identify with the values promoted by the company. Therefore, **businesses** must pay attention to their **environmental** impact, their commitments, and the missions they set for themselves.

But how can one become aware of their impact and measure it? This is where **environmental analysis** comes into play. As part of the ***ISO 14001 standard***, it allows for the possibility of certification and promotes the establishment of an Environmental Management System (EMS).

The environmental analysis of a company becomes the cornerstone of a long-term approach that fits within a policy of sustainable development. The company is on a quest for continuous improvement, following Deming's wheel (Plan, Do, Check, Act), to enhance its environmental performance.

VI.5.5. Why Conduct an Environmental Analysis of Your Business?

It primarily allows for an assessment of its activities and the consequences they have on the environment. An environmental analysis becomes proof of the company's desire to commit to sustainable practices. It embodies the idea of continuous improvement, responding to an environmental policy. These environmental issues go hand in hand with an effective and proactive strategy.

VI.6. Life Cycle Analysis (LCA)

VI.6.1. Definition: LCA is the most advanced tool for the comprehensive and multi-criteria evaluation of environmental impacts. The principle is to identify and quantify the flows associated with the design of a product. All flows are analyzed, whether they are material or energy-related.

VI.6.2. What Are the Different Life Phases in an LCA?

Steps in the Life Cycle of a Product:

Traditionally, the following five stages of a product's life cycle are considered:

- The extraction of raw materials;
- Distribution (a stage that encompasses all the transport needed throughout the product's life cycle);
- The manufacturing of the product;
- The use of the product;
- End of life (landfilling, incineration, recycling, etc.)

These five stages are detailed in the **ISO 14040-44 standards**.

VI.7. The Carbon Footprint

VI.7.1. Definition: The carbon footprint is a diagnostic tool invented by the Agency for the Environment and Energy Management (**ADEME**) to understand and analyze the activities of individuals, businesses, communities, and administrations in terms of direct and indirect greenhouse gas emissions. It accounts for six gases according to a method whose rules are publicly available and officially recognized by international agreements:

- Carbon dioxide (CO2)

- Methane

- Nitrous oxide

- Hydrofluorocarbons

- Perfluorocarbons

- Sulfur hexafluoride

Since CO2 is the most prevalent gas, it has become a reference point when discussing ***carbon footprint data***. Indeed, the other five gases are converted into carbon equivalents, and the final result of the ***carbon footprint*** is expressed in tonnes of CO2 equivalent.

VI.7.2. How to Calculate a Carbon Footprint?

How do you calculate your personal **carbon footprint**? The calculation of CO2 emissions is as follows: ***CO2 emissions = quantity consumed x emission factor***. Therefore, you collect data that you associate with an emission factor to calculate your **carbon** equivalent.

VI.7.3. Why Conduct a Carbon Footprint?

The **Carbon Footprint** allows for the calculation of all greenhouse gas emissions of a company. Carbon dioxide, methane, nitrous oxide, and other types of gas emissions are reviewed. The objective of this approach for a company is to gain a precise understanding of its carbon footprint.

VI.7.4. Who Conducts the Carbon Footprint?

The carbon footprint is a diagnostic tool developed by ADEME, the Agency for Ecological Transition, formerly known as the Agency for the Environment and Energy Management.

VI.7.5. What is the Carbon Footprint of a Product?

The ***Carbon Footprint*** is a regulated methodology for calculating greenhouse gas emissions of a company. It allows for the calculation of emissions related to your company's activities and identifies pathways for reducing these emissions.

VI.7.6. How to Calculate a Carbon Footprint for Transportation?

The most common carbon calculation approach (the ***Carbon Footprint*** Method) involves estimating the energy consumed by the manufacturing and use of the mode of transportation throughout its entire lifespan, and then relating it to a coefficient per kilometer.

Course VII. Sustainable Development and Business

Content: Definition of the company as an economic entity (concepts of profit, costs, performance) and social entity (concept of corporate social responsibility), Impact of economic activities on the environment (examples), Challenges/benefits of sustainable development for the company, Means of commitment to a sustainable development approach (e.g., ISO 14001 certification, labeling (e.g., energy labeling, Ecolabel, Organic Label/AB, FSC Label, etc.), strategic sustainable development plan, Global Reporting Initiative (GRI), etc.), Global rankings of the most sustainable companies (Dow Jones Sustainable Index, Global 100, etc.), Case studies of high-performing/eco-responsible companies in the technology sectors (e.g., SIEMENS, Cisco, Henkel AG & Co, TOTAL, Peugeot, Eni SPA, etc.).

VII.1. Definition of the Company as an Economic Entity

A company can be simply defined as an organized economic entity, comprising one or more individuals who work to produce goods or services to be sold on a market to satisfy needs.

- **Goods:** Tangible products of economic activity (e.g., car)
- **Services:** Intangible products of economic activity (e.g., hairdresser)

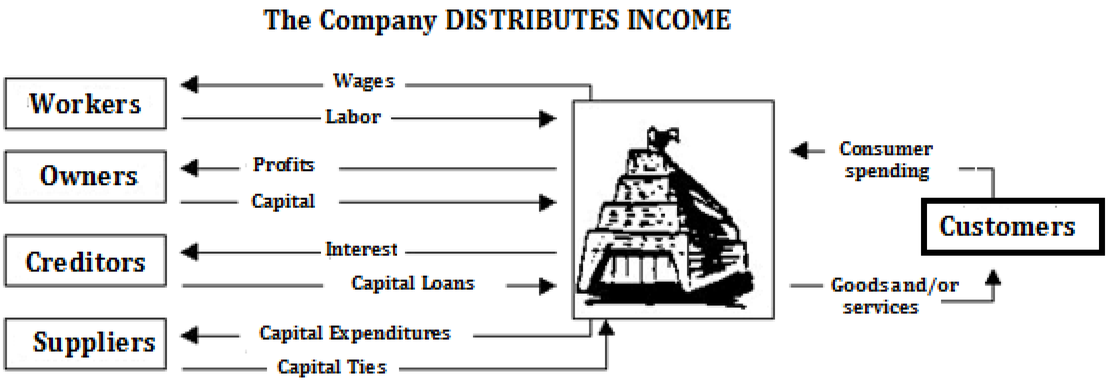
The company combines capital and labor to produce wealth. It purchases raw materials, intermediate goods, labor on the labor market, and capital (machines, etc.), so we say that the company combines the factors that enable production: labor and capital.

- **Labor factor:** Workforce.
- **Capital factor:** Buildings, machines, equipment, etc.

By combining these two factors of production (labor and capital) as efficiently as possible, the company seeks productive efficiency to achieve the best result at the lowest cost.

VII.2. The Company Distributes Income:

The company distributes income to the various participants in its activities in exchange for their services.



Example: The company pays wages to workers in exchange for their labor.

VII.3. Concepts of Profit

VII.3.1. What is Profit?

Profit is a positive accounting result generated by a company over a 12-month period. When the difference between a company's revenues and expenses is positive, its net result shows a profit. When this difference is negative, it is referred to as a deficit or loss. In most countries, companies that generate a profit are subject to corporate tax. The portion remaining after expenses, depreciation of assets, provisions for impairments, and taxation is known as net profit. This net profit is distributed, in publicly traded companies, among shareholders in the form of dividends and retained by the company itself to increase its self-financing capacity. The net profit divided by the number of shares allows for the assessment of a company's performance.

VII.3.2. How to Calculate Profit?

We do not calculate profit but rather net income, which, if positive, is considered a profit. Here is the formula for calculating net income:

Net Income (profit or loss) = Revenue - Expenses

VII.4. Costs

VII.4.1. Definition

Costs refer to all expenses and charges incurred by a company during the production process of a product or service intended for sale. The activities of the company require a certain number of resources, such as financial or human resources, which are considered costs.

First, it is important to clarify that cost is a combination of expenses.

- Its analysis begins with the examination of the charges in accounting. There are "incorporable" expenses and "non-incorporable" expenses.
- Non-incorporable expenses are those that are set aside because they fall outside the normal scope of operations.

VII.4.2. What is the Purpose of Cost Calculation?

In general, its calculation, commonly referred to as "analytical accounting," serves to inform decision-making and measure the performance of the company.

VII.4.3. Different Types of Costs

- Variable Costs

A variable cost is one whose amount varies with the level of activity of the company.

- Fixed Costs

In contrast to variable costs, fixed costs do not change based on the volume of activity. For example, the rent of a warehouse is a fixed cost. However, costs remain fixed only within certain limits. For instance, a production machine is a fixed cost for a production of 1,000 units. If the company decides to increase its production capacity, it will need to purchase a new machine.

- Direct Costs

A direct cost can be directly and unequivocally attributed to a cost object without intermediate calculation. For example, the cost of raw materials used exclusively for the manufacture of certain identical parts is a direct cost.

- Indirect Costs

An indirect cost, on the other hand, requires prior allocation treatment (referred to as "allocation"). For example, the human resources department affects the cost of all products in the company. The same is true for the accounting department...

VII.5. Performance

VII.5.1. Definition:

The performance of a company revolves around everything that contributes to improving the value-cost ratio, thereby aiming for the maximization of net value creation. A high-performing company can thus be described as: A sustainable company that makes money and is consistently profitable.

VII.5.2. Performance Indicators of the Company*

Performance indicators provide information about the health of the company, that is to say, about the quality of its operations.

These indicators are presented in the form of quantitative information. They allow one to determine whether the company:

- Achieves its objectives (effectiveness);
- Obtains the best possible results given the resources employed (efficiency).

They constitute a true dashboard and are therefore also decision-making tools in terms of management and strategic steering of the company.

VII.5.3. The Main Performance Indicators

a. Financial Indicators: Revenue is the primary performance indicator, as it measures the volume of activity. It corresponds to the total sales of the company.

b. Commercial Activity Indicators: These indicators provide detailed information about the origin of revenue by measuring the income generated by each category of products, the customer conversion rate (the number of potential customers contacted who became customers of the company), customer satisfaction rates, customer loyalty levels, the impact of promotional campaigns (advertising), product or brand recognition on social media, and changes in market share compared to competitors.

c. Human Resources Management Indicators: These include, among others, the absenteeism rate, workplace accident rate, production costs, and production capacity. They are essential for measuring the potential for improvement in the various departments of the company.

d. Social Responsibility Indicators: These provide information about the quality of production methods in terms of environmental impact (water or energy consumption, pollution, etc.) and the working conditions of employees.

VII.6. Concept of Social Responsibility

VII.6.1. Definition of CSR

CSR (***Corporate Social Responsibility***) encompasses all practices implemented by companies to adhere to the principles of sustainable development, meaning being economically viable, having a positive impact on society, and better respecting the environment.

VII.6.2. History and Origin of Corporate Social Responsibility (CSR)

The idea that companies should engage in **CSR** has its roots in the work of certain American managers in the **1950s**. Their idea? If companies focus not only on their profits but also on the impact they have on society, they will benefit from it. For example, if a company pays its employees better, it contributes to their purchasing power, with which they may buy the company's products. If a company manages its environmental impact better, it will save money in the long term by avoiding the need to address natural disasters. ***Howard Bowen*** published a book in **1953** titled "***The Social Responsibility of the Businessman***," in which he explains why companies have an interest in being more responsible and provides the first "recognized" definition of Corporate Social Responsibility. With the development of environmental, social, and economic concerns in the second half of the 20th century, along with globalization, corporate responsibility becomes an increasingly important issue.

VII.6.3. What are the 3 Pillars of CSR?

The Corporate Social Responsibility approach translates into a commitment from economic actors in favor of sustainable development. CSR is based on three fundamental pillars:

- Economic Responsibility: Through service quality, support for local producers and suppliers, transparency, and timely payment of invoices.

- Social Responsibility: By advocating for diversity and equal opportunities, ensuring hygiene and safety for employees, upholding workers' rights, and collaborating fairly with global producers.

- Environmental Responsibility: By reducing the carbon footprint of its activities, using resources responsibly, reducing corporate waste, and raising employee awareness of environmental issues.

The development of a company engaged in a CSR approach must be balanced across these three areas to be both responsible and sustainable.

- Training Questions -

1. Answer True or False

Galen in the 2nd century observes that workers work naked in an underground mine because the fumes destroy their clothing due to copper sulfate.

2. Complete the paragraph with the following words

[[1]] is a state where hazards and conditions that can cause damage of a [[2]], psychological or [[3]] nature are controlled in order to preserve [[4]] and the well-being of individuals and [[5]].

Words: **Safety, physical, material, health, community**.

3. Check the correct answers

Safety: it is a short-term prevention such as

- ◯ Burns
- ◯ Traffic accidents
- ◯ Infection
- ◯ Cancers

4. What does the abbreviation CSR stand for? Short answer:

C:
S:
R:

5. Check the correct answer

Safety rules are a set of rules to follow in the

- ☐ Workplace
- ☐ Personal
- ☐ Academic

6. Industrial hygiene therefore aims for three objectives: Match the correct answers (a, b, c)

- Identification and recognition of the constraints endured →
- Qualitative and quantitative evaluation of these constraints →
- Implementation of technical means →

a. by workers in their work environments

b. to prevent, control, reduce, or eliminate these constraints

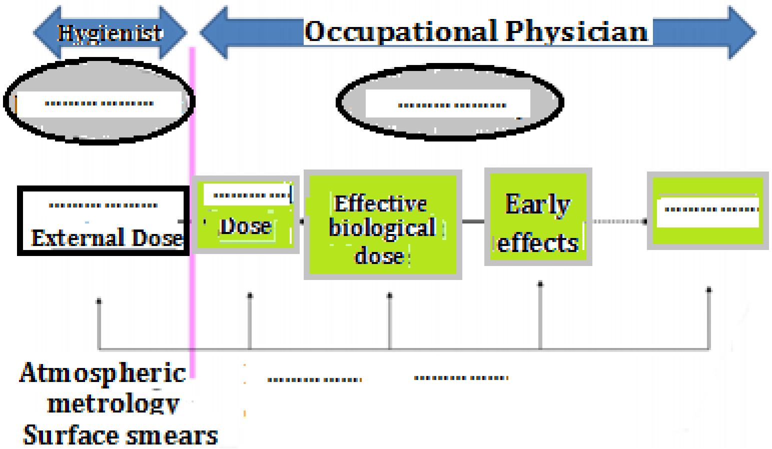
c. by objective measurement analysis techniques

7. Short answer

Industrial Hygiene takes into account three components for risk assessment. What are these three components?

Training Questions

8. Complete the following diagram



- Human organism
- Environment
- Exposure
- Internal
- Disease
- Exposure biomarkers
- Effect biomarkers

9. Complete the following sentence

Engineering [[1]] is a branch of [[2]] that deals with the field of heating, air conditioning, [[3]], [[4]], and its applications.

Words: **regulation; climatic; physical; ventilation.**

10. Answer True or False

The analysis of natural ventilation, indoor air irrigation, the influence of wind, and external conditions on comfort.

11. List the main options in the civil engineering sector?

- ☐ Buildings
- ☐ Public works & facilities
- ☐ Projectors
- ☐ Air conditioning

– Correction –

1. Answer True or False

Galen in the 2nd century observes that workers work naked in an underground mine because the fumes destroy their clothing due to copper sulfate.

Answer: True

2. Complete the following sentence**

Safety is a state where hazards and conditions that can cause damage of **physical**, psychological or **material** nature are controlled in order to preserve **health** and the well-being of individuals and **community** .

3. Check the correct answers: Safety: it is a short-term prevention such as

- ● **Burns**
- ● **Traffic accidents**
- ○ **Infection**
- ○ **Cancers**

4. What does the abbreviation CSR stand for?

C: Corporate
S: Social
R: Responsibility

5. Check the correct answer

- ■ Workplace
- ☐ Personal
- ☐ Academic

6. Industrial hygiene therefore aims for three objectives: Match the correct answers

- Identification and recognition of the constraints endured → (a)by workers in their work environments
- Qualitative and quantitative evaluation of these constraints→(c) by objective measurement analysis techniques
- Implementation of technical means →(b) to prevent, control, reduce, or eliminate these constraints

7. Short answer

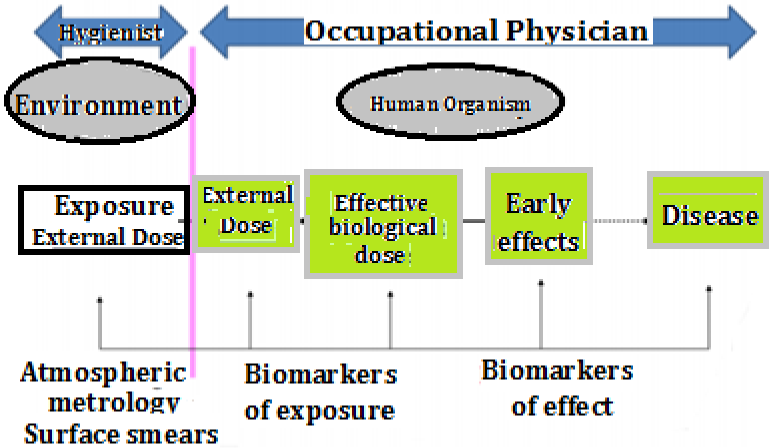
Industrial Hygiene takes into account three components for risk assessment. What are these three components?

Answer: Danger; person; activity

8. Complete the following diagram

(Please provide the diagram or indications to complete it.)

Correction



[1] Complete the following sentence

Engineering **climatic** is a branch of **physical** that deals with the field of heating, air conditioning, **ventilation**, **regulation**, and its applications.

[2] Answer True or False

The analysis of natural ventilation, indoor air irrigation, the influence of wind, and external conditions on comfort.

Answer: True

[3] List the main options in the civil engineering sector?

- ■ Buildings
- ■ Public works & facilities
- ☐ Projectors
- ☐ Air conditioning

- Additional Questions -

1. Check the correct answers : Main transport and railway infrastructures

- ☐ Road network
- ☐ Airports
- ☐ Bicycle paths
- ☐ Steam cracking
- ☐ Design and drawing of mechanical products.

2. Short answer

What does the word "aeronautics" mean?

3. Answer True or False

Aeronautics involves the sciences and techniques aimed at constructing and operating an aircraft on Earth.

4. Choose the correct answer

- ☐ The laminator-draper is a
- ☐ production worker Yes
- ☐ essential actor in aviation safety
- ☐ technical expert

5. Fill in the correct answers

What is the difference between aviation and aeronautics?

The term [[1]] specifically covers the domain of [[2]], while the term [[3]] is therefore more general and should be used when the subject encompasses all [[4]].

Words: **Aviation, aircraft, aeronautics, aerial vehicles.**

6. Check the professions related to metallurgy

- ☐ Welder
- ☐ Moulder
- ☐ Biochemist
- ☐ Home automation technician

7. Answer True or False

Industrial ecology, defined by Robert Frosch (1890) as "the set of practices aimed at reducing industrial pollution."

8. Check the correct answer to fill in the blank in this sentence

Remanufacturing allows us to recover ………………..of value, composed of material

- ✦ A large part
- ✦ A small part

Additional Questions

9. Connect the sentences?

Domains	Explanations
Recycling **Reuse** **Repair** **Renovation** **Reconditioning** **Remanufacturing**	1.Restoring to working order but without necessarily achieving the initial performance. 2. A product without modification, passed on. 3.Without a guarantee of performance over the entire product. 4.The fine extraction of raw materials from a product and their transformation. 5.An aesthetic enhancement of a product while restoring its functional condition. 6. Consists of regenerating the intrinsic value of components.

10. Complete the paragraph with the appropriate words:

[1] and Sustainable production aim to "do [2] and better with [3]." They also involve [4] economic growth from environmental degradation by increasing efficiency in resource use and [5] sustainable lifestyles.

Words : **favoring; consumption; decoupling; more; less**

11. In what year was the Environment and Energy Management Agency created?

12. Which circular model is applied? Fill in the blank by choosing the correct answer:

The ………………… circular model applied to these different technical loops relies on the reuse of products and components reaching the end of their life as incoming resources for more or less structured and rigorous activities to upgrade their performance.

Words: **Commercial ; Economic ; Agriculture**

13. Answer True or False:

The ecological definition of sustainability comes from the Brundtland Report written in 1987 and describes sustainable development as a way of life.

14. Fill in the following text:

The realization of an environmental report requires [1] and good [2]. It is therefore important to [3] the right information to [4] a complete environmental analysis on which you can rely when [5] your action plan.

Words: **Time; organization; collect; obtain; writing**

15. Check the correct answer to fill the blank in this sentence:

The calculation of emissions of .... is as follows: = quantity consumed x emission factor

☐ **CO2** ☐ **LCA** ☐ **Sustainability**

16. Check the correct answer:

The carbon balance is a diagnostic tool developed by

☐ AET, Agency for Ecological Transition,

☐ AEE, Agency for Energy Economics

☐ NAID, National Agency for Investment Development

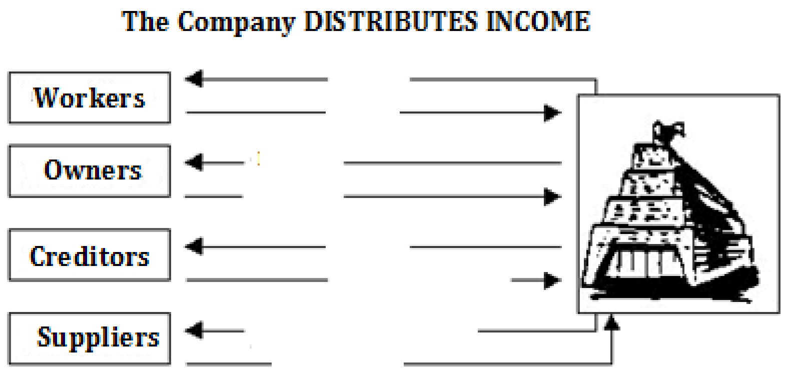
Additional Questions

17. Fill in the blank in this paragraph with the following words:

The company [1] capital and labor to [2] riches. It [3] raw materials, intermediate goods, [4] on the labor market, capital (machines, etc.), so it is said that the company combines the factors that [5] production.

Words: **Combines; to produce; buys; work; allow;**

18.Complete the following diagram



- salary
- work
- profits
- capital
- interests
- capital loans
- capital expenditures
- equipment links

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