Module guide for the certificate programme BioMex

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Table of contents

Overview 1

Biotechnology and Biomedicine (BT) 2

- Module BT1: Molecular Biology and Molecular Biotechnology 2
- Module BT2: Biostatistics and Data Literacy 3
- Module BT3: Physiology and Anatomy 4
- Module BT5: Molecular Cell Biology 5
- Module BT6: Immunobiology 6
- Module BT7: Medical Microbiology 7
- Module BT8: Genetic Engineering 8
- Module BT9: Immunotherapy 9
- Module BT10: Bioelectrical Signals and Sensors 10

Pharmaceutical Chemistry and Pharmaceutical Technology (PT) 11

- Module PT1: Pharmaceutical Chemistry and Pharmacology 11
- Module PT2: Basic Concepts in Pharmaceutical Industry 12
- Module PT3: Good Manufacturing Practice (GMP) and Quality Controls 13
- Module PT4: Fundamentals in Epidemiology and Clinical Trials 14

Innovation Management and Intercultural Cooperation (IM) 15

- Module IM1: Innovation Management 15
- Module IM2: Entrepreneurship 16
- Module IM3: Intercultural Communication and Mediation 17
- Module IM4: Scientific Communication 18

Facility, Energy and Environmental Management (EM) 19

- Module EM1: Facility Management 19
- Module EM2: Environmental Management 20
- Module EM3: Energy Management 21

Overview

In this module guide you will find explanatory short descriptions of our modules in the BioMex Advanced Biomedical Expertise certificate programme in Rwanda. We offer you a flexible training programme in a blended learning format.

As the programme is still under construction, the module guide is not yet complete. We apologise for this and are constantly updating our offers.

Four different competence clusters are available to you. Each of the competence clusters includes various modules, as listed below.

Competence cluster	Module	ECTS
Biotechnology and Biomedicine (BT)	Module BT1: Molecular Biology and Molecular Biotechnology	3
	Module BT2: Biostatistics and Data Literacy	3
	Module BT3: Physiology and Anatomy	3
	Module BT5: Molecular Cell Biology	3
	Module BT6: Immunobiology	3
	Module BT7: Medical Microbiology	3
	Module BT8: Genetic Engineering	3
	Module BT9: Immunotherapy	3
	Module BT10: Bioelectrical Signals and Sensors	3
Pharmaceutical Chemistry and Pharmaceutical Technology (PT)	Module PT1: Pharmaceutical Chemistry and Pharmacology	3
	Module PT2: Basic Concepts in Pharmaceutical Industry	3
	Module PT3: Good Manufacturing Practice (GMP) and Quality Controls	3
	Module PT4: Fundamentals in Epidemiology and Clinical Trials	3
Innovation Management and Intercultural Cooperation (IM)	Module IM1: Innovation Management	3
	Module IM2: Entrepreneurship	3
	Module IM3: Intercultural Communication and Mediation	3
	Module IM4: Scientific Communication	3
Facility, Energy and Environmental Management (EM)	Module EM1: Facility Management	3
	Module EM2: Environmental Management	3
	Module EM3: Energy Management	3

Module BT1: Molecular Biology and Molecular Biotechnology

This module reviews and examines the major components of molecular biology. The aim of this module is to provide extensive knowledge of biology at a molecular level. It will cover a range of topics including genome structure, replication and repair; the transcription, RNA processing and translation; regulation of gene expression as well as discuss the methods and laboratory techniques of molecular biology and molecular biotechnology.

Having successfully completed the module, students should be able to:

- Demonstrate knowledge and understanding of genome organization and packaging in prokaryotes and eukaryotes
- Demonstrate knowledge and understanding of the process of DNA replication and repair mechanisms, RNA transcription and translation of proteins.
- Explain he processes involved in gene expression in prokaryotes and eukaryotes
- Explain the basic genetic mechanisms
- Accurately perform the basic and advanced molecular biology techniques
- Correlate results of molecular biology techniques in research and in diagnosis of specific diseases.

The module will be delivered online. Learning materials are provided on E-learning platform and students can interact among them as well as the lecturer through the platform. Practical skills are acquired and practiced in the state-of-the-art laboratories. Student are expected to participate proactively during the course delivery through learning activities.

In this course an introduction into biostatistics and data literacy is given. Statistics is the discipline that covers how to gather, display, review, and analyse data and how to draw conclusions from data. Statistics is therefore important in all areas of empirical research which is based on observed data. Biomedical research is an empirical science. The analysis of data is essential for valid conclusions and any recommendation in evidence-based medicine. Therefore, data literacy, that is the ability to read, write and communicate data, and the ability to carry out statistical analyses are important. Biostatistics is the area of statistics where data from life sciences including medicine are analysed.

We start with a brief introduction into the free and open-source software package R. Knowledge of software such as R is crucial to carry out statistical analyses and therefore for professional practice.

In chapter 2, descriptive statistics and methods for exploratory data analysis are presented. Descriptive statistics provides tools to describe properties of observed data, whereas inferential statistics is used to infer properties of a population, mainly using estimation and by testing hypotheses. The main part of this course deals with inferential (also called inductive) statistics. We describe random sampling and randomization. Then, estimation, confidence intervals and hypothesis tests are introduced, before these methods are presented for different types of data such as categorical, continuous and time-to-event data.

Since biostatisticians often have to work with small sample sizes, a special focus is on exact permutation tests and the bootstrap. Correlation, regression models and the analysis of variance are also covered. We briefly introduce some basic methods to deal with multiple testing problems. In addition, we give an overview on clinical trials including interim analyses, and discuss a case study.

In all chapters, example data are used together with R code to illustrate the methods. In the last chapter the topic data literacy is discussed and illustrated. For example, it is shown how graphs are – regrettably – used to distort reality. Bayesian methods are not covered because this is an introductory course. Recommendations for further reading are given.

The main learning objective is the knowledge of commonly used statistical methods, both in descriptive and inferential statistics. Students should understand the different methods, should be competent to choose an appropriate method for a given problem, and should have the ability to carry out these analyses with the software R.

Our body is truly an incredible miracle! It's made up of many amazing organs, systems, and structures that work together like a well-oiled machine! They're built to last, and they're built to be better than any machine we've ever made! It can adapt to different environments and situations, which is one of the reasons why we're such a successful species on Earth. But your body is much more than a perfectly built, adaptable, multi-functional machine. It's also a miracle worker that can repair itself when things are broken. And after repair, they are often even better than before! And there are so many more amazing things about our incredible human body: for example, it can replace whole parts! And it does so every minute, day by day, year by year! Isn't that amazing? Did you know it only takes six weeks for your liver to regenerate completely? And every seven years, your skeleton is wholly rebuilt from the ground up, every single bone!

This module is here to help you understand your body's different organs and functions better. It is divided into fifteen chapters, each covering a different topic. You'll learn about cells and tissues, the skin, the skeletal system, the muscular system, the nervous system, the endocrine system, the blood, the cardiovascular system, the immune system, the respiratory system, the digestive system, the urinary system, and the reproductive system. Each chapter contains information on histology, gross anatomy, and key physiological concepts. It also dives into some essential pathophysiological concepts, such as inflammation, cancer, and some of the most common diseases, like heart attacks, strokes, diabetes, and infectious diseases like malaria and others.

This module is about building that bridge between what you will learn in the textbook, virtual experiments and online meetings and how it applies to our everyday lives. We'll explore how the human body works and how to use that knowledge to live healthier, happier lives.

In the depths of a seemingly hidden world lies a small universe that holds the key to understanding life. Welcome to the "Molecular Cell Biology" module, where science and wonder meet and cells become the true heroes of life.

Step by step, we delve into the complexity of cells, the tiny factories of life. But beware! Behind an unassuming membrane lies a labyrinth of molecular machinery and chemical reactions that control the essence of life itself. In this module we will see how DNA, the blueprint of life, reveals its secrets. We will follow the dynamic dance of proteins, how they are modified and receive information for their functions in a network of membranes. We will understand how the intracellular transport of nutrients is organised via tiny molecular motors and how cells can move as if by magic. On our journey, we will learn about cutting-edge technologies, from genome editing to live cell imaging, to unlock the secrets of the cell. In molecular cell biology, we find not only the understanding of life, but also hope for cure and medical progress.

Are you ready to explore the frontiers of life? Then open the gates to the world of molecular cell biology with us and make the invisible visible. The greatest magic lies in the smallest units of life - in the cells.

Studying the immune system is of major importance because it protects our bodies from diseases and infections. By understanding how the immune system works, we can develop better treatments and vaccines for various diseases. Additionally, studying the immune system can teach us why certain diseases affect particular people differently and how we can personalize modern medicine based on individual immune responses.

Therefore, this module teaches the key players in immunology and aims to transmit a fundamental understanding on how the immune system works. The module will be built-up in three major learning blocks. At first, an introduction to the immune system will be provided. Starting with scientific milestones, the major immunological components (innate and adaptive) and their functions will be presented. In the second part the central cellular elements (T and B cells) and essential basics of adaptive immunity will be introduced. Finally, in the third part the role of the immune system in health and disease will be outlined and an outlook with basic ideas of how to use the acquired immunological knowledge in order to develop treatment options will be delivered. This outlook will give a preparative connection to the upcoming module of immunotherapies.

Discover the intriguing world of Medical Microbiology, where the smallest organisms have the most profound impact on human health. This module provides an in-depth look at key pathogens (viruses, bacteria, fungi, parasites and prions) offering essential knowledge on how they function, cause disease and can be detected in clinical settings.

Through this course, you'll explore the mechanics behind infectious diseases and learn to recognize the signs and symptoms associated with various pathogens. You'll dive into state-of-the-art diagnostic techniques, from traditional culture methods to advanced molecular and serological tests. Imagine diagnosing infections accurately in a lab setting - an invaluable skill in today's medical and biotechnological fields.

We'll also tackle one of the biggest challenges in healthcare today: antimicrobial resistance. You'll learn why certain pathogens are harder to treat and the role of microbiologists in combating this global issue. And finally, the module introduces foundational principles in epidemiology and infection control, giving you the tools to understand disease spread and contribute to health safety in clinical environments.

Engage with a curriculum designed to not only teach but also inspire. By the end, you'll be equipped with the expertise to identify pathogens, understand disease processes and utilize diagnostic tools in theory - knowledge that's crucial in healthcare, research, and beyond. Take the leap into this essential module and start building the foundation for a rewarding career in the biomedical sciences.

In the heart of molecular science lies a transformative or revolutionary field that pushes the boundaries of biology and unlocks the molecular secrets of life. Welcome to the Genetic Engineering module, where we delve into the intricate language of DNA to explore how we can read, edit, and reimagine genetic blueprints. Genetic engineering forms the core of modern biotechnology, involving the modification and manipulation of an organism's genes through a set of technologies, including recombinant DNA technology, gene cloning, and editing. These techniques enable us to alter the genetic makeup of cells and transfer genes within and across species boundaries to create improved or novel organisms. The world has come to realize the miracles of genetic engineering in almost every walk of life, including its applications in medicine, agriculture, industry, and environmental protection. In addition to countless desired benefits, novel organisms may bring novel risks as well. Thus, these risks must be carefully assessed to ensure that all effects—both desired and unintended—are benign.

This module is intended to provide students with an introduction to DNA, RNA, protein synthesis, gene structure, function, and recombinant DNA technology. Students will delve into techniques for gene isolation, cloning, vector design, and transformation methods for various organisms. Furthermore, genetic modification in bacteria, plants, and animals for industrial, agricultural, and research purposes will be covered. The exploration of CRISPR-Cas9 and other genome editing technologies, along with their mechanisms, precision, and ethical considerations, will be comprehensively examined. An overview of genetic engineering's impact in healthcare, agriculture, and industry, including trends in gene therapy and personalized medicine, will be taught. Lastly, a discussion on the ethical implications and necessary biosafety protocols in genetic modification will be presented.

The learning materials will be uploaded to the e-learning platform, allowing students to interact with each other and the lecturer. The module will feature various engaging and interactive components, including PowerPoint slides with illustrations and a concise digital textbook. Links to instructional videos will enhance understanding through visual and auditory learning. Self-assessment questions will enable students to check their comprehension, promoting independent learning. Finally, online interactive sessions on Zoom will be conducted in a seminar-style format, focusing on Q&A instead of traditional lectures.

Immunotherapy is a rapidly evolving field that has revolutionized the treatment of cancer and other diseases. It involves using the body's own immune system to fight disease by stimulating or suppressing the immune response. Immunotherapy has shown great promise in the treatment of cancer, with several types of immunotherapies now approved for use in clinical practice. These include immune checkpoint inhibitors, cytokine therapies, antibody therapies, and adoptive cell transfer.

Immune checkpoint inhibitors are drugs that block certain proteins on immune cells that prevent them from attacking cancer cells. They have been shown to be effective in treating several types of cancer, including melanoma, lung cancer, and bladder cancer. Cytokine therapies stimulate the immune system to fight disease. Interferon-alpha and interleukin-2 are examples of cytokines that have been used to treat some types of cancer. Antibody therapies use antibodies to target specific cells or proteins in the body. Monoclonal antibodies like rituximab and trastuzumab have been used to treat some types of cancer.

Adoptive cell transfer is a type of immunotherapy that involves removing immune cells from a patient, modifying them in a lab to target cancer cells, and then re-infusing them into the patient to attack the cancer. This approach has shown great promise in treating some types of cancer, including melanoma and leukemia.

Immunotherapy is not without challenges, however. One of the biggest challenges is identifying which patients will respond to immunotherapy and which will not. Researchers are working to develop biomarkers that can predict response to immunotherapy. Another challenge is managing the side effects of immunotherapy, which can range from mild to severe and can affect different parts of the body.

Despite these challenges, immunotherapy is a rapidly growing field that has the potential to transform the treatment of cancer and other diseases. Ongoing research is focused on developing new and more effective immunotherapies, as well as improving our understanding of how the immune system interacts with disease. As our knowledge of immunotherapy continues to grow, we can expect to see even more exciting developments in the years to come.

By the end of the course, participants will have a thorough understanding of the principles and practice of immunotherapy, as well as the latest developments in this rapidly evolving field. They will be equipped with the basic knowledge and skills needed to contribute to the ongoing research and development of new and more effective immunotherapies.

Have you ever wondered how an electrocardiogram, or ECG, works? How can we visualize cardiac activity?

This course will provide you with comprehensive insight into the technology used to measure the body's bioelectrical signals, including the physiology, electrochemistry, electronics, and signal processing behind it. And don't worry if you are not yet familiar with these topics. All the necessary basic knowledge will be presented in this course.

In addition to theory, we make the course as practical as possible. We construct our own ECG with simple electronic components and develop the entire software ourselves. You will even be able to get your hands on your own electronic components. (optional)

After the course, you will have a versatile technical toolkit that can also be transferred to other biomedical engineering topics.

The course is structured in the following chapters:

- Fundamental concepts of information, sensors, and signals.
- Basics of electronics and microcontrollers.
- Introduction to programming: data and signal processing.
- Bioelectrical signals in the body – sources and transmission.
- Electrodes - the interface between bioelectricity and electronics.
- From weak to strong - amplification of signals.
- Shifting potentials - making it electrically suitable.
- From voltage to numbers - analog to digital converter in practice.
- Serial communication - transmission of digital signals.
- Temporal data storage - buffer and ring buffer.
- Digital filtering of signals - getting rid of the noise.
- Visualizing signals and plotting graphs.
- Data processing - retrieving information from signals.
- Bonus topic: wireless devices.

Module PT1: Pharmaceutical Chemistry and Pharmacology

This module is intended to provide students with the conceptual and methodological basis needed to understand the mechanism of action of drugs, their therapeutic value and their potential toxicity. The student will be introduced to the current definitions of 'drug' and 'medicine' and how these definitions have evolved over the centuries. The student will be introduced to the notion that the biological effect of a drug is due to its chemical structure and its capacity to interact with 'receptor' macromolecules expressed by cells. Pharmaceutical chemistry is the discipline which studies the structural basis of the action of drugs and the way in which drug can be modified to produce new, better, and safer medicines. Pharmacology is the discipline that studies the mechanism of action of drugs in terms of their ability to perturb basilar cellular processes. Pharmaceutical chemistry and pharmacology are both fundamental to understand the processes of absorption, distribution, metabolism and excretion, and to foresee the potential toxicity issues.

Knowledge of these concepts is required not only to discuss the therapeutic use of drugs, but also to understand the whole process of the pharmaceutical industry from discovery to post-marketing vigilance.

1) *Knowledge and understanding*: Knowledge of molecular basis of drug's action
2) *Ability to apply knowledge and understanding*: Ability to independently apply acquired knowledge to identify the most suitable class(es) of drugs to treat a given therapeutic need.
3) *Communication skills*: Ability to use the specific language of this specialist discipline.
4) *Autonomy of judgement*: Being able to evaluate the potential therapeutic application and the possible toxicity/side effect of individual classes of drugs.

The module will be taught by using study letters flanked by video insights provided by the lecturer. Examination will be done in written form.

While it may seem apparent that discovery of new drugs is the real advancement provided by pharmaceutical industry, it must be clear that development, production and quality control are equally important in providing high quality and effective medicines at a population level. This module will introduce students to the basic concepts which drive modern pharmaceutical and biotechnological industries. Students will be exposed to the most common routes through which medicines are administrated and how the pharmaceutical form (i.e. tablets, injections, cream, …) impacts the efficacy. Basic technology processes will be discussed in detail and analyzed for their importance in defining the quality of the finished medicinal products. We will wander around the importance of the pre-formulation steps, and their scale up to the industrial formulation process. We will start introducing the concept of the Good Manufacturing Practices (GMP) and their industrial and regulatory relevance. At the end of the module the student is expected to have acquired:

1) *Knowledge and understanding*: Knowledge of excipients, production methods and control procedures of pharmaceutical forms
2) *Ability to apply knowledge and understanding*: Ability to independently apply acquired knowledge to identify the most appropriate excipients and preparation methods for the development of a given dosage form.
3) *Communication skills*: Ability to use the specific language of this specialist discipline.
4) *Autonomy of judgement*: Being able to evaluate the implications and results of studies aimed at clarifying the influence of dosage form on the activity of the active ingredient.

The module will be taught by using study letters flanked by video demonstrations of the basic technological processes. Examination will be done in written form.

For graduates in scientific disciplines, GMP training is a fundamental part of their education. GMP, which stands for Good Manufacturing Practices, is a set of rules and standards that regulate the manufacture of pharmaceutical products and establish the requirements that must be met during the manufacture, and control of pharmaceutical products. It includes specifications for ensuring quality, consistency and safety in the manufacturing of medicinal products.

Attending this training module, which focuses on knowledge of GMP standards, will enable participants to acquire one of the most sought-after skills by companies in the sector and the Regulatory Competent Authority.

Participants will be introduced to the key concepts relating to the principles and basic requirements of cGMP, where "c" stands for current, processes of continuous improvement designed to minimize the risks associated with any pharmaceutical production and to build quality into the manufacturing process.

This module includes the following 15 unit's title

1) GMPs in pharmaceutical production: history and structure
2) How a Manufacturing site works: from the raw materials to the finished drug
3) Guidelines and Standards for Good Manufacturing Practice
4) Organization chart and personnel's roles in a Manufacturing Site with particular reference to Annex 16 EU GMP
5) Lay-out of a production Manufacturing Site, flow of materials and personnel with particular attention to aspects relating to environmental requirements
6) Hygiene, sanitization and Pest control
7) Premises and equipment GMP requirements
8) Clean room classifications, qualification and validation concept
9) GMP documentation
10) Production and in-process controls
11) Quality control: role and laboratory organization
12) Quality Management System; change control, deviation and CAPA
13) Selection and qualification of Suppliers and Providers
14) Quality Agreements: a tool for the definition of responsibilities and tasks
15) Investigational Medicinal Products: what special features

An introduction is provided for each lesson unit defining the content and the material available, such as training slides, videos, a syllabus of key definitions, and reference documents.

Questionnaires with multiple-choice answers or essay questions relating to practical examples of GMP deviations are provided and each possible answer is discussed/shared during the lesson to provide the participants with the reason/rationale for the incorrect or correct answer. It is essential that participants read the Introduction before they start the learning lesson.

This course introduces epidemiologic concepts and how to quantitatively describe population patterns of health inequalities and their determinants. Epidemiology is the science of understanding the causes and distribution of population health so that we may intervene to prevent disease and promote health. The focus will be on what to measure, how to measure it, whom to measure it on, and how to do so in ways that minimize bias. These concepts and skills are used to critically review the public health evidence base.

You will use R software as a tool to help you understand how concepts, such as how to compute a risk, are connected with real life data analysis. You will learn to conduct basic data analyses (descriptive statistics; measures of occurrence, association, and uncertainty; confounding adjustment) using R. You will be expected demonstrate competency in applying epidemiological methods to the breadth of settings and situations in public health, selecting quantitative and qualitative data collection methods appropriate for a given public health context, and interpreting results of data analysis for public health research, policy or practice.

Chapter 1 discusses the measures of disease occurrence (i.e. incidence, prevalence, risk, and rates). These are used in quantifying the burden of disease in populations. Chapter 2 covers measures of association and comparison (i.e. ratios and differences). These are often used in identifying risk factors of disease in populations. In Chapter 3, you will be introduced to measures of uncertainty in epidemiological studies, including random and systematic error, confounding and bias (i.e. selection and information bias). Chapter 4 discusses the common epidemiologic study designs (cohort, cross-sectional, case-control, etc.). An understanding of the concepts will be emphasized.

Chapter 5 discusses clinical trials, where basic terms and concepts (e.g., randomization, placebo controls and blinding) are introduced. The different phases used to classify clinical trials, and experimental designs applied in practice, are described. Moreover, statistical aspects relevant for clinical trials are covered, including power and sample size calculation, subgroup and interim analyses and bioequivalence tests used for generic drugs.

Module IM1: Innovation Management

The interdisciplinary module "Innovation Management" is structured to provide students with the critical skills and knowledge to create innovative solutions that support the Sustainable Development Goals (SDGs). Over 90 hours of blended learning, students will delve into the principles of innovation, problem-solving, and evidence-based argumentation, with a strong emphasis on creativity, critical thinking, and ethical decision-making. The course encompasses theoretical lectures, practical workshops, and collaborative projects, facilitating a comprehensive understanding of how innovation can effectively address global challenges. By the end of the module, students will have honed their abilities to analyze societal problems, develop and prototype innovative solutions, and communicate their ideas persuasively, preparing them to contribute meaningfully to sustainable development efforts.

This course, led by Prof. Dr. Claudia Hensel, spans 90 hours and grants 3 ECTS credits. It combines theoretical insights with practical exercises and projects, encouraging students to explore the principles of innovation, problem-solving, and effective presentation techniques. The course focuses on fostering creativity, critical thinking, and ethical decision-making to address real-world challenges.

Key learning outcomes include the ability to analyze and evaluate the role of innovation in addressing global challenges, apply problem-solving techniques to prioritize societal issues, utilize evidence-based reasoning to support decisions, and develop persuasive arguments for innovative solutions considering ethical and social implications. Teaching methods encompass asynchronous video lectures, synchronous face-to-face tutorials, online team coaching, and self-study assignments.

Turning a scientific idea into a startup company can be a great way to translate research into real-world impact. Managing this transition requires learning a range of new skills though. To establish a startup, an inventor must successfully navigate several phases - from evaluating the invention, protecting the intellectual property by patenting, making a decision on its exploitation (licensing or spin-off), and finally drawing up and executing the business plan. While there are risks involved, proper planning, strategic advice, and a clear focus on market needs can help turn an invention into a profitable venture. The module on “Entrepreneurship” provides a clear breakdown of the entire process.

The module focuses on various phases of transforming a scientific idea into a startup company:

1. Invention phase
2. Invention Evaluation
3. Advisory and Support
4. Patent Strategy and Patent Application
5. Decision on Exploitation
6. Exploitation through Licensing or Spin-off
7. Business Plan Development
8. Business Pitch (Pitch Deck)
9. Starting the Startup

In a world characterized by increasing globalization and cultural interconnectivity, inter-cultural competence has become a vital skill for both personal and professional success. This 3 ECTS online module, "Inter-Cultural Competence," provides a comprehensive exploration of cultural diversity across continents, incorporating immersive Virtual Reality (VR) technology to enhance learning experiences. Designed for interdisciplinary engagement, the module is structured around Bloom's Taxonomy to facilitate progressive learning outcomes—from remembering and understanding cultural knowledge to applying, analyzing, evaluating, and creating culturally responsive solutions.

The module is divided into thematic units focusing on Asia, Africa, Europe, the Americas, and Oceania. Each unit explores the unique cultural norms, traditions, and communication styles of these regions through interactive VR experiences, case studies, group discussions, and reflective exercises. Assessments include quizzes, reflective essays, group projects, comparative analysis papers, and digital storytelling, ensuring a comprehensive evaluation of students' understanding and application of inter-cultural competence.

Teaching methods combine online face-to-face sessions with self-paced learning, utilizing a blend of interactive lectures, VR simulations, group collaborations, and self-reflection tasks. By engaging with this module, students will develop a nuanced understanding of cultural dimensions, enhance their cross-cultural communication skills, and cultivate cultural sensitivity. The module also encourages students to reflect on their personal cultural biases and develop strategies for effective interaction in multicultural environments.

Ultimately, this module aims to prepare students to become informed, empathetic, and effective global citizens. Equipped with the skills and attitudes necessary to navigate and thrive in diverse cultural settings, students will be better positioned to contribute positively to an increasingly interconnected world. Through this comprehensive and immersive approach, the "Inter-Cultural Competence" module offers a unique and essential learning experience for students of all disciplines.

Being able to communicate science effectively is a key skill in today's world. It is crucial to advancing your career, raising funding, winning collaborators, managing teams and projects efficiently, publishing your results, and generally receiving recognition for your work. Moreover, when communicating well to non-experts, it can foster understanding of scientific concepts, inform decision-making on critical issues like health or climate change, build trust in science and generally help create a more scientifically literate society.

The module equips participants with the skills to effectively communicate scientific data, concepts and ideas and engage diverse audiences. This includes the following topics:

- Targeting your audience: How to know, engage and convince your audience
- Keeping it simple: How to simplify scientific information without losing accuracy
- Effective messaging: How to craft effective messages and tailor them to various target audiences
- Storytelling in science: How to use narrative techniques to make scientific information more relatable and memorable
- Visual communication: How to use visuals to enhance understanding and engagement
- Public speaking: How to prepare for and deliver convincing oral presentations and how to overcome fear of public speaking
- Getting feedback: How to obtain and incorporate feedback to continually improve your communication skills
- Summary of key points: Regular recap of the main concepts and skills covered in the module

Hands-on activities complement the theoretical session, such as interactive parts where participants practice crafting messages, creating visuals, and engaging with different audiences.

Time permitting, participants will prepare and present a science communication project, applying the skills and knowledge gained throughout the module, and receive feedback.

Module EM1: Facility Management

The module "Systems Engineering in Facility Management" provides a comprehensive introduction to the technical systems and equipment that are essential for the operation of buildings and infrastructures and that secure and optimise them. It is a central component of technical facility management and covers the areas of heating, ventilation and air conditioning technology (HVAC), electrical engineering, sanitary engineering, safety technology, communication technology, compressed air and hydraulic systems and building automation. Heating, ventilation and air conditioning systems for pleasant room temperatures and good air quality. Electrical engineering systems ensure a stable power supply, efficient lighting and emergency power solutions. Sanitary technology includes the water and waste water infrastructure, while security technology with fire alarm, burglar alarm and video surveillance systems ensures the protection of buildings.

The tasks of systems engineering include the planning and installation of new systems, operation and continuous monitoring, regular maintenance and servicing as well as the optimisation and modernisation of existing systems. This ensures compliance with security standards and legal regulations. Diagnosing technical problems and developing solutions to optimise the operation of technical systems is one of the central tasks of systems engineering.

In addition, local conditions are analysed to ensure that technical systems can be adapted to local building regulations and infrastructural conditions. The adaptation of system technology to climatic and geographical characteristics plays an important role here. Another focus of the course is on the energy efficiency and sustainability of the systems. Students will learn methods for increasing energy efficiency in technical systems and how energy management systems (EMS) can be implemented. The module also provides knowledge about the current state of the art in facility management. This includes current developments and innovations in plant engineering, the use of modern technologies and digitalisation as well as future trends and their influence on facility management. Students learn how modern technologies such as the Internet of Things (IoT) and sensors can be used to monitor and optimise technical systems.

Overall, the module aims to prepare students for the diverse challenges in the field of systems engineering in facility management. They acquire detailed knowledge of the various technical systems and equipment, specific knowledge of compressed air and hydraulic technology, as well as the ability to analyse and adapt to local conditions and the state of the art. This enables them to analyse technical and organisational challenges in facility management and develop practical solutions.

The course module "Environmental Management" provides students with in-depth knowledge of the key aspects, methods and concepts of environmental protection. It aims to create a deep understanding of the historical development and importance of environmental protection. Students will explore the influences of environmental history on public opinion, business strategies and legal frameworks.

A central component of the course is the fundamentals of sustainability and its integration into corporate environmental protection measures and environmental management systems. Students will learn how sustainability principles are applied in organisations and the role of environmental management systems.

Furthermore, methods for evaluating environmental impacts are dealt with in depth. Different types of footprints, such as the carbon footprint, water footprint and ecological footprint, are introduced to equip students with tools to measure and analyse environmental impacts.

The section on resources and raw materials provides a detailed insight into the classification of natural resources according to VDI 4800 and discusses the potential for conflict due to regionally limited availability. The German resource efficiency programme Progress is used as a case study.

Finally, the importance of resource efficiency is emphasised. Students analyse the reasons for the increased demand for resources, understand the concept of resource criticality and explore how resource efficiency in production can contribute to the conservation of natural resources.

The Energy Management module provides a comprehensive exploration of key topics in the field. Covering both theoretical foundations and interactive applications, this module equips students with essential knowledge for the energy sector. The module addresses several subtopics, leading from the fundamentals to latest optimizations and integration into real world scenarios.

Beginning with the fundamentals of energy technology, students delve into the principles underlying energy systems, including generation, conversion and use as well as looking into different forms of energy sources, such as oil, coal, sunlight, wind and water.

After that, the section of measurement technology, control engineering and automation focuses on techniques for monitoring and regulating technical processes. Students gain hands-on experience with software simulation of e.g. sensors, actuators, and control systems.

Due to sustainability and mobile applications, there is a subtopic examining specifically energy sources like solar, wind and water, emphasizing their environmental impact, efficiency, and integration into existing grids and mobile applications. To be aware of the usage of this energy, students explore various methods of energy conversion (e.g., from mechanical to electrical) and learn about energy storage technologies.

Furthermore, safety protocols, electromagnetic interference, and compliance with standards are discussed to ensure safe energy systems.

Finally, the module concludes by addressing strategies for efficient energy use and optimization in industrial, residential and mobile settings.

By engaging with these topics, students gain a holistic understanding of energy systems, preparing them for any task in renewable energy, power generation, and sustainability. The course is headed to be interactive and supported by various media, such as tests for self-monitoring, videos or text- sections to deepen the knowledge gained.