kiron

Module Catalogue

Mechanical Engineering

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Introduction

Curriculum Development at Kiron

The development and recognition of its study tracks lies at the heart of Kiron's mission. Kiron's core curriculum is designed according to the worldwide established quality standards and follows a coherent modularization structure as our partner universities do:

- For each study track, Kiron developed modules worth 5-10 credit points with clearly defined learning outcomes.
- The allocation of Massive Open Online Courses (MOOCs) to modules is based on a matching of learning outcomes and workload.
- Kiron modules aim to refer to as many standard undergraduate modules taught at (potential) partner universities.
- Fundamental guidelines for our work are the EHEA Tools (EAR 2015, ECTS Users' Guide, EQF) as well as specifications on a national level (Common Structural Guidelines, Guidelines of the German Accreditation Board, DQR) as well as current academic research[1].

Mechanical Engineering At Kiron

Kiron Mechanical Engineering Study Track provides the fundamental scientific and technical knowledge in the field of engineering at an entry level. It starts with the basics in subjects such as mathematics, physics and chemistry. These are followed by more technical foundations in mechanics, materials science, thermodynamics, electronics and manufacturing technologies. Interdisciplinary skills in project management, quality management and business administration are also covered to different extents.

Through the study track Kiron aims to establish an engineering perspective amongst its students based on the knowledge provided in different subjects. Accordingly, in the end of their Kiron studies, students are expected to demonstrate the following essential skills and mindset while facing real-world challenges and problems:

- explaining them scientifically and illustrating them in representative models,
- approaching them analytically and draft engineering solutions

[1] Universities interested in our quality assurance standards and our academic processes may be provided with a Quality Handbook on request.

Clusters and Subjects

Preparation for University and Online Education
Academic Skills for University Success Academic English Introduction to Online Learning and Scientific Thinking
Preparation for Science and Engineering
Mathematics Physics Chemistry
Scientific Fundamentals
Mathematics Physics General Chemistry
Engineering Fundamentals
Computer Science Mechanics Electrical Engineering Materials Science Thermodynamics
Mechanical Engineering
Manufacturing Technology
Interdisciplinary Skills
Business Administration and Financial Analysis

Module Overview

Study Phase	Cluster	Module Name	Credit Points	Total
Preparation	PU	Academic Skills for University Success		0
	PU	Academic English		
	PU	Introduction to Online Learning and Scientific Thinking		
	PT	Mathematics Prep		
	PT	Physics Prep		
	PT	Chemistry Prep		
Introductory	SF	Mathematics I - Single Variable Calculus	6	24
	SF	Mathematics II - Linear Algebra	6	
	SF	Physics	6	
	SF	General Chemistry	6	
	EF	Computer Science for Mechanical Engineers		
Intermediate	SF	Mathematics III - Differential Equations	6	46
	EF	Mechanics I	7	
	EF	Mechanics II	7	
	EF	Mechanics III	7	
	EF	Materials Science I	6	
	EF	Principles of Electrical Engineering	7	
	EF	Thermodynamics I	6	
Advanced	ME	Manufacturing Technology	6	14
	IS	Introduction to Business Administration and Financial Analysis	8	

· **Clusters: PU** - Preparation for University and Online Education, **PT** - Preparation for Science and Engineering, **SF** - Scientific fundamentals, **EF** - Engineering fundamentals, **ME** - Mechanical Engineering, **IS** - Interdisciplinary Skills

Phase Overview

	Theme Field						
Prep	Mathematics Prep		Physics Prep		Chemistry Prep		
	Preparation for Science and Engineering		Preparation for Science and Engineering		Preparation for Science and Engineering		
Introductory	Mathematics I - Single Variable Calculus	Mathematics II - Linear Algebra	Physics		General Chemistry		Computer Science for Mechanical Engineers
	Scientific Fundamentals	Scientific Fundamentals	Scientific Fundamentals		Scientific Fundamentals		Engineering Fundamentals
	6	6	6		6		6
Intermediate	Mathematics III - Differential Equations		Mechanics I	Materials Science I	Principles of Electrical Engineering	Thermodynamics I	
	Scientific Fundamentals		Engineering Fundamentals	Engineering Fundamentals	Engineering Fundamentals	Engineering Fundamentals	
	6		7	6	7	6	
Advanced		Mechanics II	Mechanics III	Manufacturing Technology			Introduction to Business Administration and Financial Analysis
		Engineering Fundamentals	Engineering Fundamentals	Mechanical Engineering			Interdisciplinary Skills
		7	7	6			8

Prep Phase

For Kiron students, it can be difficult to start studying within a study track right away -- especially if they have not taken any online courses before, or if it's their first time taking courses in English.

In order to prepare students for their (online and offline) studies, Kiron offers special **Preparation Courses** (Prep Courses) that are meant to reinforce study material and give them the foundations for courses they study within the study tracks.

Upon their start with Kiron, students are encouraged to take Prep Courses next to making use of the Kiron Language School.

Function and Content

The main function of taking Prep Courses for a Kiron student is to refresh and advance the skills necessary for studying at university level under the special circumstances of online studies. Additionally, the courses help build up motivation, practice key skills, and reinforce learning material.

We recommend students to take our Prep Courses in the beginning of their studies. However, students can refer back to Prep Courses anytime throughout their study experience. In order to be able to recommend individual sets of Prep Courses and encourage students to reflect on their skills and knowledge, Kiron is currently in the process of developing self-assessment tools and looking for different ways to embed these courses in the core studies in a more coherent way.

There are two different kinds amongst Prep Courses Kiron offers:

- General Prep Courses
- Study Track specific Prep Courses

While the general courses include topics that all students can benefit from (e.g. Academic Writing and Speaking Skills, Self-Management Skills, Digital Literacy, and Integrative History / Culture), the study track specific courses are focused on supporting students within certain study tracks. For instance this could mean taking a math and physics course before advancing to studying Computer Science or Mechanical Engineering.

Catalogue

The list of currently offered Preparation Modules and Courses in the Kiron Mechanical Engineering Study Track can be found below:

Introduction to Online Learning and Scientific Thinking

Module Name	Introduction to Online Learning and Scientific Thinking	
Total Workload	Name of the Courses / Link to MOOCs	Duration
2 h	How to Become an Online Learner (Onboarding Mission) https://courses.edx.org/courses/course-v1:KironX+X1+3T2017/course/	1 weeks
4 h	How to Become an Online Learner https://edge.edx.org/courses/course-v1:Kiron+Course+1/about	1 weeks
24 h	The Science of Everyday Thinking https://www.edx.org/course/science-everyday-thinking-uqx-think101x-1	12 weeks

Academic English

Module Name	Academic English: Speaking and Listening	
Total Workload	Name of the Courses / Link to MOOCs	Duration
20 h	Academic Listening and Note-Taking https://www.coursera.org/learn/note-taking	4 weeks
16 h	Presentations: Speaking so that People Listen https://www.coursera.org/learn/presentations-speaking-so-that-people-listen	4 weeks
20 h	Academic Discussions in English https://www.coursera.org/learn/academic-discussion-english	4 weeks
24 h	Advanced Speaking and Listening Project https://www.coursera.org/learn/speaking-listening-capstone	6 weeks

Module Name	Academic English: Writing Papers	
Total Workload	Name of the Courses / Link to MOOCs	Duration
20 h	Grammar and Punctuation https://www.coursera.org/learn/grammar-punctuation	5 weeks
12 h	Getting Started with Essay Writing https://www.coursera.org/learn/getting-started-with-essay-writing	4 weeks
8 h	Advanced Writing https://www.coursera.org/learn/advanced-writing	4 weeks
12 h	Introduction to Research for Essay Writing https://www.coursera.org/learn/introduction-to-research-for-essay-writing	4 weeks
18 h	Project: Writing a Research Paper	6 weeks

Module Name	Academic English: Science, Technology, Engineering and Mathematics	
Total Workload	Name of the Courses / Link to MOOCs	Duration
26 h	English for Science, Technology, Engineering, and Mathematics	5 weeks

	https://www.coursera.org/learn/stem	

Academic Skills for University Success

Module Name	Academic Skills for University Success	
Total Workload	Name of the Courses / Link to MOOCs	Duration
24 h	Information and Digital Literacy for University Success https://www.coursera.org/learn/digital-literacy	6 weeks
24 h	Problem Solving Skills for University Success https://www.coursera.org/learn/problem-solving-skills	6 weeks
24 h	Critical Thinking for University Success https://www.coursera.org/learn/critical-thinking-skills	6 weeks
24 h	Communication Skills for University Success https://www.coursera.org/learn/communication-skills	6 weeks
24 h	Academic Skills for University Success, Capstone Project https://www.coursera.org/learn/academic-skills-project	6 weeks

Mathematics - Prep

Module Name	Mathematics - Prep	
Total Workload	Name of the Courses / Link to MOOCs	Duration
48 h	Intro Algebra Review https://de.udacity.com/course/intro-algebra-review--ma004	5 weeks
30 h	On-Ramp to AP* Calculus https://www.edx.org/course/ramp-ap-calculus-weston-high-school-calc360x	6 weeks
48 h	Pre-University Calculus https://www.edx.org/course/pre-university-calculus-delftx-calc001x	6 weeks
150 h	College Algebra and Problem Solving https://www.edx.org/course/college-algebra-problem-solving-asux-mat117x	10 weeks

Physics - Prep

Module Name	Physics - Prep	
Total Workload	Name of the Courses / Link to MOOCs	Duration
48 h	Intro to Physics https://de.udacity.com/course/intro-to-physics--ph100	8 weeks
16 h	Basic Physics https://www.open2study.com/courses/basic-physics	4 weeks

Chemistry - Prep

Module Name	Chemistry - Prep	
Total Workload	Name of the Courses / Link to MOOCs	Duration
84 h	Chemistry https://www.coursera.org/learn/chemistry-1	7 weeks
16 h	Chemistry – Building Blocks of the World	4 weeks

	https://www.open2study.com/courses/chemistry	

Scientific fundamentals

ME_Ma1: Mathematics I - Single Variable Calculus

Module Code	ME_Ma1
Learning Outcomes	After successfully completing this module, students will be able to: 1. define functions and identify the graphical representations of polynomials, trigonometric, exponential and logarithmic functions 2. explain key concepts such as limits, convergence and orders of growth 3. calculate the limits of rational, radical, exponential and trigonometric functions 4. describe sequences and series and calculate their limits 5. explain the concepts of differentiation and integration 6. understand the relationship between indefinite and definite integrals and their connection to derivatives 7. calculate derivatives and integrals of different types of functions 8. apply advanced differentiation and integration techniques to one-dimensional functions 9. understand numerical concepts for solving ordinary differential equations and evaluating integrals 10. use Taylor-polynomials and linearization for approximation 11. apply calculus to solve problems in physics and other scientific fields
Content	The module introduces the concepts and methods of single variable calculus in the context of engineering studies. Topics include: - Functions, limits, convergence and orders of growth - Polynomials, trigonometric and exponential functions - Derivatives, differentiation techniques, one-dimensional differential calculus, differential operator, linearization - Series: convergence, computing and application of Power- and Taylor-Series - Integral calculus, integration techniques, integral operator - Geometric, probabilistic and physical application of integral calculus - Sequences as discrete functions, discrete calculus - Introduction to Euler and Runge-Kutta method, numerical integration
Credits	6 CP
Prerequisites	High school level competencies in mathematics or completion of Mathematics - Prep module.

Courses		
Name	Duration	Workload
Calculus: Single Variable Part 1 - Functions https://www.coursera.org/learn/single-variable-calculus	4 weeks	32 hours
Calculus: Single Variable Part 2 - Differentiation https://www.coursera.org/learn/differentiation-calculus	3 weeks	24 hours
Calculus: Single Variable Part 3 - Integration https://www.coursera.org/learn/integration-calculus	4 weeks	32 hours
Calculus: Single Variable Part 4 - Applications https://www.coursera.org/learn/applications-calculus	5 weeks	40 hours

Single Variable Calculus https://www.coursera.org/learn/discrete-calculus	5 weeks	40 hours

ME_Ma2: Mathematics II - Linear Algebra

Module Code	ME_Ma2		
Learning Outcomes	After successfully completing this module, students will be able to: 1. explain the basic principles of analytic geometry and calculate simple vector operations 2. classify matrices and calculate matrix operations 3. define and apply key concepts such as vector spaces and linear independence 4. recognize linear maps and represent them as matrices 5. apply notions such as range, null space, rank and isomorphism 6. solve systems of linear equations by using different methods (e.g. Gauss Elimination, QR and -LU factorization) and recognize their connection to matrices 7. define, interpret and compute eigenvalues and eigenvectors		
Content	The module introduces the concepts and methods of linear algebra in the context of engineering studies. Topics include: - Analytic geometry - Vector and matrix operations - Vector space theory - Linear maps - Systems of linear equations and Gauss Elimination - LU- and QR factorization, Linear Least Squares - Eigenvalues and Eigenvectors		
Credits	6 CP		
Prerequisites	High school level competencies in mathematics or completion of Mathematics - Prep module.		
Courses			
Name		Duration	Workload
Linear Algebra - Foundations to Frontiers (LAFF) https://www.edx.org/course/linear-algebra-foundations-frontiers-utaustinx-ut-5-04x		15 weeks	150 hours

ME_Ma3: Mathematics III - Differential Equations

Module Code	ME_Ma3		
Learning Outcomes	After successfully completing this module, students will be able to: 1. model and evaluate sample problems in natural and engineering science (e.g. harmonic oscillator, growth models) 2. interpret and apply the Existence and Uniqueness Theorem 3. calculate analytical solutions for special cases, linear ODEs and Systems of linear ODEs 4. convert higher order linear equations in Systems of ODEs 5. analyze ODEs by usage of qualitative techniques such as phase portraits or bifurcation- and equilibria-detection 6. relate analytical and numerical solutions		
Content	The module introduces the concepts and methods of differential equations in the context of engineering studies. Topics include: - Existence and Uniqueness Theorem, Bifurcations, Equilibria - Analytical solution for separable and linear ODEs as well as Systems of linear ODEs - Phase portraits - Harmonic Oscillator, damped and forced oscillation - Euler's Method		
Credits	6 CP		
Prerequisites	ME_Ma1, ME_Ma2		
Courses			
Name		Duration	Workload
BUx: Introduction to Differential Equations https://www.edx.org/course/introduction-differential-equations-bux-math226-1x		9 weeks	90 hours
Linear Differential Equations https://www.edx.org/course/linear-differential-equations-bux-math226-2x		8 weeks	80 hours

ME_Ph1: Physics

Module Code	ME_Ph1
Learning Outcomes	After successfully completing this module, students will be able to: 1. explain the concepts of force, momentum, gravity and analyze their effects on a a point mass 2. explain the conservation of energy through the concepts of mechanical energy and work 3. differentiate types of oscillations and describe the simple harmonic motion 4. describe the basic wave phenomena and identify them in different physical systems 5. describe the nature of light and its propagation both as a wave and a particle 6. demonstrate the image formation through lenses and mirrors 7. define the electromagnetic properties and concepts such as charge, field, potential, current and state the laws of electromagnetism 8. describe the physical properties of the atomic nucleus and the origin of radioactivity
Content	The module covers the essential theories, laws and mathematical foundations of mechanics, optics, atomic and nuclear physics. Topics include: - Mechanics: Force, gravity, momentum, motion, work and energy - Oscillations and Waves: Harmonic oscillations, natural oscillations, interference, resonance - Optics: Nature of light, geometric optics, wave optics - Electricity: Electrostatics, electromagnetism - Atomic and nuclear physics: Atomic model, nuclei and radioactivity
Credits	6 CP
Prerequisites	High school level skills in physics or completion of Physics - Prep module

Courses

Name	Duration	Workload
How Things Work: An Introduction to Physics https://www.coursera.org/learn/how-things-work	8 weeks	13 hours
RiceX: AP® Physics 1 https://www.edx.org/course/ap-physics-1-ricex-advphy1x	18 weeks	72 hours
AP® Physics 1: Challenging Concepts https://www.edx.org/course/apr-physics-1-challenging-concepts-davidson-next-phy1apccx-0	8 weeks	32 hours
AP® Physics 2: Challenging Concepts https://www.edx.org/course/apr-physics-2-challenging-concepts-davidson-next-phy2apccx-0	9 weeks	36 hours

ME_Ch1: General Chemistry

Module Code	ME_Ch1
Learning Outcomes	After successfully completing this module, students will be able to: 1. summarise the essentials of atomic and molecular models 2. describe the arrangement of the periodic table 3. define and distinguish different types of chemical bonds and compounds 4. explain the principles of chemical synthesis and use chemical nomenclature 5. explain the law of conservation of mass and carry out simple stoichiometric calculations 6. describe the chemical kinetics of phase changes and reactions 7. describe the properties and chemical behaviour of substances such as acids, bases, redox systems 8. carry out and interpret simple acid-base, redox and electrochemical reactions 9. name important inorganic compounds, describe their properties and production reactions
Content	The module covers the essential scientific foundations of stoichiometry, chemical kinetics, electrochemistry and inorganic chemistry. Topics include: - Atomic structure, model concepts - Elements and periodic table - Chemical kinetics - Phase transitions and phase equilibrium - Ideal Gas Law and the Kinetic Molecular Theory - Bonding types and molecule structures - Classes and chemical properties of compounds - Dynamic properties of chemical reactions - Chemical equilibrium, stoichiometry - Acid-base reactions, redox reactions, electrochemistry - Inorganic chemistry, important inorganic chemicals
Credits	6 CP
Prerequisites	High school level skills in chemistry or completion of Chemistry - Prep module.

Courses		
Name	Duration	Workload
General Chemistry: Concept Development and Application https://www.coursera.org/learn/general-chemistry	11 weeks	44 hours
Introduction to Chemistry: Reactions and Ratios https://www.coursera.org/learn/intro-chemistry	7 weeks	70 hours
Introduction to Chemistry: Structures and Solutions https://www.coursera.org/learn/basic-chemistry	7 weeks	70 hours

Engineering fundamentals

ME_Cs1: Computer Science for Mechanical Engineering

Module Code	ME_Cs1		
Learning Outcomes	After successfully completing this module, students will be able to: 1. classify basic hardware and software technologies of computers and explain their use 2. name basic terms and concepts of computer science (e.g. number systems, Boolean algebra, algorithm, data structure) and explain their context 3. define data types and develop simple data structures to represent technical systems 4. define logical and relational operators and implement them in conditionals and loops 5. develop iterative and recursive algorithms with control structures such as methods and decision statements 6. manipulate data structures and algorithms for different problem settings 7. explain basic object-oriented programming concepts such as objects, classes and inheritance 8. analyse simple real world problems algorithmically following the object-oriented programming paradigm and develop solution algorithms in a programming language		
Content	The module provides fundamentals in computer science, covering the essential terminology and concepts of data processing, algorithms and object-oriented programming. Topics include: - Building blocks and architecture of computers - Representation of information, mathematical and technical fundamentals, basic terms and concepts - Data structures and processing - Simple data modeling, transformations and visualizations - Algorithms: Conditions, loops, recursions, static methods, functions - Object-oriented programming: Objects, classes, attributes, methods		
Credits	6 CP		
Prerequisites			
Courses			
Name		Duration	Workload
Computer Science 101 https://lagunita.stanford.edu/courses/Engineering/CS101/Summer2014/about		6 weeks	30 hours
Introduction to Computer Science https://www.edx.org/course/introduction-computer-science-harvardx-cs50x		12 weeks	180 hours
Introduction to Python for Data Science https://prod-edx-mktg-edit.edx.org/course/introduction-python-data-science-microsoft-dat208x		6 weeks	24 hours

ME_Me1: Mechanics I

Module Code	ME_Me1
Learning Outcomes	After successfully completing this module, students will be able to: 1. analyse arbitrary plane and spatial equilibrium systems based on the concept of forces and moments 2. calculate internal forces and moments of linear structures 3. calculate system parameters influenced by friction 4. apply the principle of virtual displacements 5. evaluate the stability of equilibrium positions
Content	The module gives an introduction to the basics of statics. The main focus is on the mathematical description of the performance of rigid structures carrying loads. Topics include: - Equilibrium of coplanar/spatial force systems - Stable and unstable equilibrium - Statics of rigid bodies - Moments and internal forces in bars and beams - Truss systems - Surface friction - Reduction of spatial force systems - Principle of superposition - Principle of virtual work
Credits	7 CP
Prerequisites	ME_Ph1

Courses

Name	Duration	Workload
Mechanik I https://www.edx.org/course/mechanik-i-rwthx-me101	15 weeks	75 hours
Introduction to Engineering Mechanics https://www.coursera.org/learn/engineering-mechanics-statics/	5 weeks	35 hours
Applications in Engineering Mechanics https://www.coursera.org/learn/engineering-mechanics-statics-2/	5 weeks	35 hours
Mechanics: Motion, Forces, Energy and Gravity, from Particles to Planets https://www.coursera.org/learn/mechanics-particles-planets	8 weeks	32 hours

ME_Me2: Mechanics II

Module Code	ME_Me2
Learning Outcomes	After successfully completing this module, students will be able to: 1. describe states of stress and strain and explain the principles of elastostatics 2. determine and calculate the stress and strain in structural elements for symmetric and asymmetric bending 3. calculate the stress and strain in structural elements under torsional load 4. calculate the stress and strain in structural elements under shear force load 5. analyse the stability of structural elements under compressive loads 6. apply energy methods for the determination of forces and moments in statically indeterminate systems
Content	The module gives an introduction to the basics of elastostatics. The main focus is on the mathematical analysis of deformations of one-dimensional structures due to stresses and strains. Topics include: - Stress and strain equations - Hooke's law - Deformation of statically determinate truss systems - Combined stress states - Mohr's circle for stress - Beam bending - Energy methods and deformation energy in elastostatics - Principle of virtual forces - Buckling of upright bars under compressive loads
Credits	7 CP
Prerequisites	ME_Me1

Courses

Name	Duration	Workload
Mechanics of Materials I: Fundamentals of Stress & Strain and Axial Loading https://www.coursera.org/learn/mechanics-1	5 weeks	35 hours
Mechanics of Materials II: Thin-Walled Pressure Vessels and Torsion https://www.coursera.org/learn/mechanics2	3 weeks	21 hours
Mechanics of Materials III: Beam Bending https://www.coursera.org/learn/beam-bending	5 weeks	35 hours
Mechanics of Materials IV: Deflections, Buckling, Combined Loading & Failure Theories https://www.coursera.org/learn/materials-structures	2 weeks	14 hours
Mechanical Behavior of Materials, Part 1: Linear Elastic Behavior https://www.edx.org/course/mechanical-behavior-materials-part-1-mitx-3-032-1x	6 weeks	60 hours
Mechanical Behavior of Materials, Part 2: Stress Transformations, Beams, Columns, and Cellular Solids https://www.edx.org/course/mechanical-behavior-materials-part-2-mitx-3-032-2x	4 weeks	48 hours

ME_Me3: Mechanics III

Module Code	ME_Me3
Learning Outcomes	After successfully completing this module, students will be able to: 1. derive equations to describe the motion of particles 2. compute kinematic quantities such as velocity or acceleration 3. describe the motion of systems of particles 4. apply the principles of energy conservation 5. derive the basic equations of vibration theory and compute vibrational motions of systems with 1 and 2 DOF
Content	The module gives an introduction to the basics of dynamics. The main focus is on the mathematical description of motion based on kinematic and kinetic theories in different coordinate systems. Topics include: - Kinematics of a single mass point in Cartesian, polar and natural coordinate systems - Kinetics of a single mass point in Cartesian, polar and natural coordinate systems - Newton's laws of motion - Systems of particles - Translational and rotational motion of rigid bodies - Principles of linear and moment of momentum for arbitrary plane motion - Impact problems - Theory of linear vibration, vibration of systems with 1 and 2 DOF
Credits	7 CP
Prerequisites	ME_Me2
Courses	

Name	Duration	Workload
Engineering Systems in Motion: Dynamics of Particles and Bodies in 2D Motion https://www.coursera.org/learn/dynamics	7 weeks	49 hours
Advanced Engineering Systems in Motion: Dynamics of Three Dimensional (3D) Motion https://www.coursera.org/learn/motion-and-kinetics	6 weeks	42 hours
Mechanics: Kinematics and Dynamics https://www.edx.org/course/mechanics-kinematics-dynamics-mitx-8-01-1x	5 weeks	60 hours
Mechanics: Momentum and Energy https://www.edx.org/course/mechanics-momentum-energy-mitx-8-01-2x	6 weeks	72 hours
Mechanics: Rotational Dynamics https://www.edx.org/course/mechanics-rotational-dynamics-mitx-8-01-3x	4 weeks	44 hours

ME_Ms1: Materials Science I

Module Code	ME_Ms1		
Learning Outcomes	After successfully completing this module, students will be able to: 1. label main crystallographic classes, describe their properties and name examples for respective materials 2. describe elastic and plastic deformation of materials and recall their practical cases 3. interpret and construct diagrams and graphs describing the main mechanical behaviour of materials 4. identify the main mechanical material properties and assess their significance 5. describe the main experiments for characterisation of mechanical properties 6. distinguish the composition and properties of common steel types, recognise their chemical notation and identify them on iron-carbon diagrams 7. explain the most important heat treatment processes for steel, state their goals 8. describe the composition and properties of non-crystalline and semicrystalline materials such as polymers, rubbers and glasses		
Content	Building on the foundations of physics and chemistry, the module covers the important characteristics of engineering materials and the methods for characterisation and enhancement. Topics include: - Atomic structure of solids: Binding types, crystal structures, crystallographic directions and planes, classification of materials - Mechanical properties: Strength, strength testing, elastic-plastic behavior, hardness testing, tensile and characteristics, fracture toughness, fatigue - Thermal and chemical properties: Thermal expansion, phase changes, corrosion - Ferrous Metals: Iron and steel production, iron-carbon diagrams, principles of heat treatment, classification and notations for steels, alloying elements - Basics of non-metallic materials: plastics, composites and ceramics		
Credits	6 CP		
Prerequisites	ME_Ch1, ME_Ph1		
Courses			
Name		Duration	Workload
Material Behavior https://www.coursera.org/learn/material-behavior		6 weeks	14 hours
Material Processing https://www.coursera.org/learn/material-science-engineering		2 weeks	25 hours
Materials Science: 10 Things Every Engineer Should Know https://www.coursera.org/learn/materials-science		5 weeks	15 hours
Materials Science and Engineering https://www.edx.org/course/materials-science-engineering-misisx-mse1x		7 weeks	28 hours
Materials Science https://www.oncampus.de/weiterbildung/moocs/material-science		9 weeks	72 hours
Introduction to Steel https://www.edx.org/course/introduction-steel-tenarisuniversity-steel101x		2 weeks	6 hours

ME_Ee1: Principles of Electrical Engineering

Module Code	ME_Ee1		
Learning Outcomes	After successfully completing this module, students will be able to: 1. describe and use electrical quantities, units and equations 2. describe how to build simple electrical circuits and how to measure circuit variables 3. describe the functionality of basic circuit components such as resistor, capacitor, coil and diode 4. explain the characteristics of the magnetic and electric fields, calculate their magnitudes and interpret their effects 5. describe the methods for analysing AC and DC circuits and calculate currents and voltages on them 6. distinguish linear and nonlinear circuits and their electrical properties 7. explain the phenomena of induction and its implementation in industrial applications for energy conversion 8. name the most important semiconductor components and describe how they function 9. distinguish the characteristics of single-phase and three-phase networks		
Content	The module introduces the electrical engineering fundamentals that are relevant for the field of mechanical engineering. Topics include: - Physical quantities, units, equations - Basic electronic circuits and components - Electrical measurements - Electric field - Magnetic field - Direct Current Circuits - Alternating AC Circuits - Introduction to Three-Phase networks		
Credits	7 CP		
Prerequisites	ME_Ph1		
Courses			
Name		Duration	Workload
Electricity & Magnetism, Part 1 https://www.edx.org/course/electricity-magnetism-part-1-ricex-phys102-1x		7 weeks	70 hours
Electricity & Magnetism, Part 2 https://www.edx.org/course/electricity-magnetism-part-2-ricex-phys102-2x		7 weeks	70 hours
Circuits and Electronics 1: Basic Circuit Analysis https://www.edx.org/course/circuits-electronics-1-basic-circuit-mitx-6-002-1x		5 weeks	30 hours
Introduction to Electronics https://www.coursera.org/learn/electronics		7 weeks	35 hours

ME_Th1: Thermodynamics I

Module Code	ME_Th1
Learning Outcomes	After successfully completing this module, students will be able to: 1. distinguish thermodynamic systems and identify their properties 2. explain the relationships between thermodynamic properties and states of a system and represent them mathematically 3. describe the properties of pure substances, ideal and real gases and mixtures 4. use thermodynamic tables, charts and equation of state (e.g. the ideal gas law) to obtain or calculate unknown property data 5. explain the thermal and chemical behaviour of fluids and solids by changes in pressure and temperature and describe respective phase transitions 6. define and distinguish different types of energy (e.g. work, heat, internal energy) 7. explain the concepts of enthalpy, entropy, specific energy, reversibility and irreversibility 8. state the first law of thermodynamics and illustrate it on different systems (e.g. closed systems, open systems under steady-state or transient conditions) 9. calculate unknown parameters of different systems using the first law of thermodynamics and determine the direction or equilibrium of energy and material transformation 10. state the second law of thermodynamics and explain the concept of exergy 11. assess energy conversion processes and energy quality by means of entropy balance and exergy analysis
Content	The module introduces the theoretical foundations of thermodynamics and their relevance for the operation of energy transforming machines. Topics include: - Introduction to Thermodynamics: Fundamental terms of thermodynamics, general principles of energy and material transformations - Properties of Pure Substances: State properties, variable equations for fluids, pure substances and mixtures - Material equilibrium: Matter Quantity balance for thermal, chemical and energy transformations - Energy: energy transfer through work, heat and mass - First Law of Thermodynamics: Forms of energy (internal energy, heat, work, enthalpy), thermodynamic equilibrium in thermal and chemical state changes - Second Law of Thermodynamics: Definition of entropy, entropy balances in chemical state changes, exergy analysis and energy quality
Credits	6 CP
Prerequisites	ME_Ch1, ME_Ph1

Courses		
Name	Duration	Workload
Thermodynamics https://www.edx.org/course/thermodynamics-iitbombayx-me209-1x	20 weeks	160 hours
Introduction to Thermodynamics: Transferring Energy from Here to There https://www.coursera.org/learn/thermodynamics-intro	8 weeks	48 hours

Track-specific Electives

ME_Mt1: Manufacturing Technology

Module Code	ME_Mt1		
Learning Outcomes	After successfully completing this module, students will be able to: - list and classify industrial manufacturing processes according to their formative characteristics - explain and compare the characteristics, function and application field of different manufacturing processes - identify different types of manufacturing processes in a process chain and specify correlations between them - analyse manufacturing processes based on technical and economic aspects		
Content	The aim of the module is to introduce different manufacturing processes within the scope of industrial production and to analyse them based on their technical and economic characteristics. Topics include: - Classification of manufacturing processes - Primary shaping: Casting, sintering, plastics engineering, generative manufacturing processes - Forming: Plastic forming, solid forming, sheet metal forming - Cutting: Turning, milling, drilling, grating, threading, precision machining - Joining: Welding, soldering, bonding - Coating: Electroplating, painting - Material properties altering: Hardening, surface treatment, heat treatment - Process characteristics, process chains		
Credits	6 CP		
Prerequisites	ME_Ms1, ME_Me1, Me_Ma1		
Courses			
Name		Duration	Workload
Fundamentals of Manufacturing Processes https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x		10 weeks	60 hours
Manufacturing Engineering https://www.oncampus.de/weiterbildung/moocs/manufacturing-engineering		9 weeks	72 hours

Interdisciplinary modules

ME_Ba1: Introduction to Business Administration and Financial Analysis

Module Code	ME_Ba1		
Learning Outcomes	After successfully completing this module, students will be able to: 1. name different legal forms of business and describe their main characteristics 2. explain the main organisational units and business processes in a company 3. describe and compare different types of accounting 4. distinguish between tangible and intangible assets 5. classify costs into different categories 6. define the main components of balance sheets 7. calculate and interpret financial ratios 8. identify the depreciation and calculate the future value of a project for investment analysis 9. assess project or investment alternatives (e.g. equipment, technology, property, plant) based on their future values 10. use break-even analysis for operational assessment and technology management 11. describe the basics of human resources management 12. describe the components of the marketing mix (i.e. product, price, place and promotion) 13. explain the patent law and relevant legal ground for innovation		
Content	This module aims to establish the fundamentals of business administration and financial analysis for engineers. Topics include: - Entrepreneurship and Legal Forms Of Business - Corporate Governance, Key Figures, Groupings Of Companies - Organization Theory And Units, Process Management, - Business Life Cycle: Creation, Modification, Termination - Accounting, Controlling, Financial Management and Reporting - Investment Analysis and Profitability Accounting for Decision-Making - Financing and Banking - Sales and Marketing - Human capital and personnel management - Technology and Innovation Management		
Credits	8 CP		
Prerequisites			
Courses			
Name		Duration	Workload
Business Foundations https://www.edx.org/course/business-foundations-ubcx-bus1x		6-7 weeks	35 hours
Business Communications https://www.edx.org/course/business-communications-ubcx-bus2x		7 weeks	35 hours

Understanding Financial Statements: Company Position https://www.coursera.org/learn/financial-statements	4 weeks	16 hours
Understanding Financial Statements: Company Performance https://www.coursera.org/learn/income-statement	4 weeks	16 hours
Accounting for Business Decision Making: Measurement and Operational Decisions https://www.coursera.org/learn/business-accounting	4 weeks	12 hours
Introduction to Marketing https://www.edx.org/course/introduction-marketing-ubcx-busmktg1x	6 weeks	30 hours
Introduction to Corporate Finance https://www.coursera.org/learn/wharton-finance	4 weeks	28 hours
Preparing to Manage Human Resources https://www.coursera.org/learn/managing-human-resources	4 weeks	20 hours
Innovation Management https://www.coursera.org/learn/innovation-management	9 weeks	13 hours