MASTER OF SCIENCE
IN ENGINEERING

Module Description, available in: EN

Vectors and Tensors in Engineering Physics

General Information

Number of ECTS Credits

3

Module code

FTP_Tensors

Valid for academic year

2026-27

Last modification

2025-01-07

Coordinator of the module

Lorenz Martin (BFH, lorenz.martin@bfh.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Physics, analysis and linear algebra at Bachelor’s level

Brief course description of module objectives and content

The course starts with an overview of classical engineering physics with special emphasis on balance and constitutive equations (i.e. continuity equations and material laws). The concepts of vector analysis are introduced and then applied to describe spacial phenomena in electrodynamics and thermodynamics. In a next step, this knowledge is extended towards tensors algebra. Tensors enable the description of typical anisotropic effects of solid state physics and modern materials such as stress and strain, double refraction and layered structures. Some of the topics in the course are also treated using mathematical software such as Matlab with the goal to facilitate the student’s understanding and application of numerical simulation methods (e.g., FEA, multiphysics).

Aims, content, methods

Learning objectives and competencies to be acquired

- Students are familiar with the most important basic laws of engineering physics for isotropic materials in general form, recognise analogies between different application areas and exploit these for analyzing systems
- Students know about the generalization of the laws for anisotropic materials and can interpret these, especially with regard to application in numerical simulation
- Students master vector analysis and the algebra of tensors together with the standard notation conventions
- Students understand the basics of electrodynamics and thermodynamics transport phenomena in anisotropic systems
- Students understand mechanical elasticity with 3D strain and stress states and are familiar with the material laws in general form for isotropic and anisotropic bodies
- Students understand the piezo-electric effect and its applications in engineering (sensors and actuators)

Module content with weighting of different components

- Recapitulation of isotropic material laws (Ohm, Hooke, Fourier, etc.)
- Introduction to vector and tensor calculation: scalar, vectorial and tensorial parameters, tensor algebra,
- Transformation behavior of vectors and tensors
- Hands-on calculation of vector analysis and tensor algebra: electrodynamics, thermodynamics and anisotropic transport phenomena
- Elasticity theory with emphasis on 3D stress states
- Piezo-effect: physical fundamentals

Teaching and learning methods

Frontal teaching (approx. 60 %)
Presentation and discussion of case studies and problems, individual problem solving (approx. 40 %)

Literature

[1] R.E. Newham, Properties of Materials, Oxford, 2005

[2] J.F. Nye, Physical Properties of Crystals, Oxford Science Publication, 2004

[3] J. Tichy, Fundamentals of Piezoelectric Sensorics, Springer 2010

[4] E. Kreszig, Advanced Engineering Mathematics, 10th edition, Wiley, 2011

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Written matter (open book), pocket calculator

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted