Hochschule Düsseldorf
University of Applied Sciences

Fachbereich Maschinenbau
und Verfahrenstechnik
Faculty of Mechanical
and Process Engineering

Module Guide Master „Mechanical Engineering“

General Studies

Course
Engineering Mathematics
Simulation of Mechanical Systems
Computerbased measurement technology
Finite Element Method (FEM)
Computational Fluid Dynamics

Engineering Mathematics						
Modulnummer (Modulnumber)	**Workload**	**Präsenzzeit (Attendence time)**	**Selbststudium (Self-study)**	**Studiensemester (Study semester)**	**Angebot im (Offered in)**	**Dauer (Duration)**
	180 h	75 h	105 h	1. Semester	SS	1 Semester
Lehrveranstaltungen (Courses) a) Lecture 3 SWS b) Exercise 1 SWS c) Practical Training 1 SWS		**Credits** 6 LP	**Zuordnung zu den Curricula (Allocation to the curricula)** Courses: SET, ME			

1	**Lernergebnisse (learning outcomes) / Kompetenzen (Competences)** • The attendees have acquired basic understanding and ability on the application of mathematic methods in solving engineering problems.
2	**Inhalte (Contents)** • Multivariable Taylor expansion • Systems of nonlinear equations • Ordinary differential equations Linear first order Separable Inexact Second-order, linear, inhomogeneous, constant coefficients • Eigenvalues and Eigenvectors • Multiple integrals, Surface integrals • Fourier analysis • Partial differential equations (heat conduction equation, wave equation) • Transformations into arbitrary curvilined coordinates • Numerical integration (interpolation functions, Gaussian quadrature formulas) • Numerical methods for ordinary differential equations • Discrete Fourier transformation • Linear optimization
3	**Lehrformen (Teaching Forms)** • Lecture (Power Point, overhead)
4	**Empfohlene Voraussetzungen (Recommended prerequisites)** • Bachelor Degree in Mechanical Engineering (or in a related discipline).
5	**Prüfungsformen (Examination forms)** • This information will be provided at the beginning of the course.
6	**Voraussetzungen für die Vergabe von Leistungspunkten (Requirements for awarding credits)** • Passed examination
7	**Modulverantwortliche(r) (Responsible person for the module)** • Prof. Dr. Wilfried Scheideler
8	**Sprache (Language)** • English
9	**Literaturempfehlungen (references)** none

Simulation of Mechanical Systems						
Modulnummer (Modulnumber)	**Workload**	**Präsenzzeit (Attendence time)**	**Selbststudium (Self-study)**	**Studiensemester (Study semester)**	**Angebot im (Offered in)**	**Dauer (Duration)**
	180 h	75 h	105 h	1. Semester	SS	1 Semester
Lehrveranstaltungen (Courses) a) Lecture 2 SWS b) Exercise 2 SWS c) Practical Training 1 SWS		**Credits** 6 LP	**Zuordnung zu den Curricula (Allocation to the curricula)** Master Courses: ME			

1	**Lernergebnisse (learning outcomes) / Kompetenzen (Competences)** The students know • The theoretical and practical foundations for modeling of mechanical systems. They can • build up and simulate models of kinematic chains, open or closed by kinematic or control means, as well as optimizing them by simple parameter variation • Carry out scientific work in this area.
2	**Inhalte (Contents)** • Model building and simulation of mechanical systems
3	**Lehrformen (Teaching Forms)** • oral presentation with slides, computer based simulations • programming examples and exercises • practical evaluation of simulations by students themselves • guidance to independent scientific work
4	**Empfohlene Voraussetzungen (Recommended prerequisites)** • study of mechanics or technical mechanics approximately 12 ECTS on bachelor level
5	**Prüfungsformen (Examination forms)** • modeling and simulating of a given mechanical system with software at home or in the laboratory • oral examination and presentation of simulation results • examination duration 30 minutes
6	**Voraussetzungen für die Vergabe von Leistungspunkten (Requirements for awarding credits)** • examination passed
7	**Modulverantwortliche(r) (Responsible person for the module)** • Prof. Dr.-Ing. Andreas Jahr, lecturer
8	**Sprache (Language)** • English

9	**Sonstige Informationen / Literaturempfehlungen (other information and references)** • pdf-files of lecture slides in MOODLE learning platform • pdf-files of exercises in MOODLE learning platform • pdf-files of former exercises, partly with solutions in MOODLE learning platform Recommended literatur (newest edition): • Henning, Jahr, Mrowka: Technische Mechanik mit Mathcad, Matlab und Maple, Vieweg Verlag, Wiesbaden, 2004 • John J. Craig: Introduction to Robotics, Pearson Prentice Hall, Upper Saddle River, 2005 • specific software literature, special scientific papers • MATLAB Simmechanics: http://de.mathworks.com/help/physmod/sm/getting-started-with-simmechanics.html

Computerbased measurement technology						
Modulnummer (Modulnumber)	**Workload**	**Präsenzzeit (Attendence time)**	**Selbststudium (Self-study)**	**Studiensemester (Study semester)**	**Angebot im (Offered in)**	**Dauer (Duration)**
	180 h	75 h	105 h	1. Semester	SS	1 Semester

Lehrveranstaltungen (Courses)	**Credits**	**Zuordnung zu den Curricula (Allocation to the curricula)**
a)Lecture 2 SWS b)Laboratory 3 SWS	6 LP	Masterstudiengänge: SET, ME

1	**Lernergebnisse (learning outcomes) / Kompetenzen (Competences)** Students are able to • handle with hard and software (i.e. calibration of accelerometers and microphones or oscilloscopes), • differ between steady-state, transient and dynamic data, • analyse signals in time and frequency domain, • verify overall levels in time and frequency domains (Parseval theorem), • use correlation measurement technique and know the concept of coherence, phase spectrum and time delay.
2	**Inhalte (Contents)** • overview of the typical measure principles for measurement of position, flow and current, pressure, sound pressure and vibration, • data acquisition, sampling-rate, • analogue-to-digital converters • windowing, frequency analysis, averaging • sound and vibration analysis • rotating machinery, Campbell diagram • discrete frequency analysis and fast Fourier analysis
3	**Lehrformen (Teaching Forms)** • a) lecture (PC with Beamer, overhead/blackboard), b) practical computer training (Dasylab/Matlab/Scilab/PAK), discussion about the experiments • c) practical training with digital oscilloscopes
4	**Empfohlene Voraussetzungen (Recommended prerequisites)** • basics of data acquisition and numerical mathematics
5	**Prüfungsformen (Examination forms)** • term paper • feedback talk with PC demonstrations (30 min duration)
6	**Voraussetzungen für die Vergabe von Leistungspunkten (Requirements for awarding credits)** • passed exam (feedback talk)
7	**Modulverantwortliche(r) (Responsible person for the module)** • Prof. Dr.-Ing. Jürgen Kiel / Prof. Dr.-Ing. Frank Kameier

8	**Sprache (Language)** • english
9	**Sonstige Informationen / Literaturempfehlungen (other information and references)** • lecture notes in progress (has to be translated …), software applications at http://ifs.mv.fh-duesseldorf.de/Vorlesung/master_SET/ Empfohlene Literatur: • Karrenberg, Ulrich, Signals, Processes, and Systems, An Interactive Multimedia Introduction to Signal Processing, 3rd edition, Berlin 2013.

Finite Element Method (FEM)						
Modulnummer (Modulnumber)	**Workload**	**Präsenzzeit (Attendence time)**	**Selbststudium (Self-study)**	**Studiensemester (Study semester)**	**Angebot im (Offered in)**	**Dauer (Duration)**
	180 h	75 h	105 h	1. Semester	SS	1 Semester
Lehrveranstaltungen (Courses) a) Lecture 3 SWS b) Practical Training 2 SWS		**Credits** 6 LP	**Zuordnung zu den Curricula (Allocation to the curricula)** Courses: ME, SET (Elective Course)			

1	**Lernergebnisse (learning outcomes) / Kompetenzen (Competences)** The attendees have acquired basic understanding and ability on the application of FEM in solving engineering problems, on its possibilities, assumptions and challenges. They have deep knowledge of the often used element types in technically problems and are able to interpret and rate the results.
2	**Inhalte (Contents)** • Numerical Solutions of differential equations using the Galerkin method • Virtual work principle for a deformable body • Displacements, strain tensors, stress tensors, material models • One-, two- and three dimensional Element types • Principal transformation, Invariants and equivalent stress
3	**Lehrformen (Teaching Forms)** • Lecture (Power Point, overhead)
4	**Empfohlene Voraussetzungen (Recommended prerequisites)** • Bachelor Degree in Mechanical Engineering (or in a related discipline).
5	**Prüfungsformen (Examination forms)** • This information will be provided at the beginning of the course.
6	**Voraussetzungen für die Vergabe von Leistungspunkten (Requirements for awarding credits)** • Passed examination
7	**Modulverantwortliche(r) (Responsible person for the module)** • Prof. Dr. Wilfried Scheideler
8	**Sprache (Language)** • English
9	**Sonstige Informationen / Literaturempfehlungen (other information and references)** • none

Computational Fluid Dynamics (CFD)						
Modulnummer (Modulnumber)	**Workload**	**Präsenzzeit (Attendence time)**	**Selbststudium (Self-study)**	**Studiensemester (Study semester)**	**Angebot im (Offered in)**	**Dauer (Duration)**
	180 h	75 h	105 h	1. Semester	SS	1 Semester
Lehrveranstaltungen (Courses) a) Lecture 3 SWS b) Exercise 1 SWS c) Practical Training 1 SWS		**Credits** 6 LP	**Zuordnung zu den Curricula (Allocation to the curricula)** Courses: SET, ME			

1	**Lernergebnisse (Learning outcomes) / Kompetenzen (Competences)** The attendees have acquired a basic understanding and ability on the application of CFD in solving engineering problems, on its possibilities, limitations and challenges. They are familiar with and have a deep understanding of the differential equations that describe the transport of momentum, heat and mass in Newtonian fluids, and with their boundary conditions for a single-phase, steady or unsteady, as well as compressible or incompressible flow. They have an overview of different physical flow states with corresponding mathematical and numerical implications. They have a basic knowledge on flow turbulence and turbulence modelling. They have a fundamental knowledge on discretization principles, gridding techniques and numerical solution procedures including the intricacies involved in modelling highly connective flows and Navier-Stokes solution techniques. At the end of the course, the attendees are able to apply a general-purpose CFD software to solve technical problems involving a laminar or turbulent single-phase flow, with or without heat transfer and analyse the results competently. Furthermore, the attendees are able to follow the course and communicate in English.
2	**Inhalte (Contents)** Overview of fluid mechanics applications in engineering. Basic ideas of Computational Fluid Dynamics (CFD). The role of CFD in solving engineering problems. Review of the relevant basic knowledge. Derivation of the unsteady, three-dimensional differential balance equations for a fluid. Discussion of the physical and mathematical meanings of the terms and their interrelationship. Boundary conditions. Assumptions and simplifications. The general convective-diffusive transport equation. Main ingredients of a numerical solution method. An overview of grid generation. An overview of discretization methods including Finite Difference, Finite Volume and Finite Element methods. Discretization of the general transport equation by the Method of Finite Volumes. Accuracy estimation. Direct and iterative methods for the solution of the discretization equations. Convergence control. Unstructured meshes. Discretization in time. Stability conditions. Treatment of flows with strong convection. Pressure correction and other methods for treating Velocity Pressure-Coupling in solving the Navier-Stokes equations for incompressible and compressible flows. Turbulent flows with and without heat transfer. Turbulence Modelling.
3	**Lehrformen (Teaching forms)** Lecture. Seminar. Discussion. Independent elaboration.
4	**Empfohlene Voraussetzungen (Recommended prerequisites)** Bachelor Degree in Mechanical Engineering (or in a related discipline). Fluid Mechanics. Heat Transfer, Mathematics. Differential Equations, English.
5	**Prüfungsformen (Examination form)** Written examination.

6	**Voraussetzungen für die Vergabe von Leistungspunkten (Requirements for awarding credits)** Passed examination
7	**Modulverantwortliche(r) (Responsible person for the module)** Prof. Dr.-Ing. Ali Cemal Benim
8	**Sprache (Language)** English
9	**Sonstige Informationen / Literaturempfehlungen (other information and references)** C. Hirsch, „Numerical Computation of Internal and External Flows, Volume I: Fundamentals of Discretization“, Wiley, 1994, C. Hirsch, “Numerical Computation of Internal and Ex-ternal Flows, Volume II: Computational Methods for Inviscid and Viscous Flows”, Wiley, 1995.

Specialisation

Course
Elective Course I (to be chosen from the catalog of elective courses)
Elective Course II (to be chosen from the catalog of elective courses)
Elective Course III (to be chosen from the catalog of elective courses)
Elective Course IV (to be chosen from the catalog of elective courses)

Projects, R&D

Course
Project incl. Project seminar (Research & Development)
Engineering Conferences
Master Thesis incl. Colloquium

Studienprojekt inkl. Seminar (Forschung & Entwicklung)
Project incl. Project seminar (Research & Development)

Modulnummer (Modulnumber)	Workload	Präsenzzeit (Attendence time)	Selbststudium (Self-study)	Studiensemester (Study semester)	Angebot im (Offered in)	Dauer (Duration)
	180 h	30 h	150 h	2. Semester	SS / WS	1. Semester

Lehrveranstaltungen (Courses)	Credits	Zuordnung zu den Curricula (Allocation to the curricula)
Seminar 2 SWS	6 ECTS	Masterstudiengänge: SET, IWI, ME

1	**Lernergebnisse (learning outcomes) / Kompetenzen (compentencies)** Die Studierenden können das im Studium erlernte fachliche und methodische Wissen anwenden und erweitern. Sie wurden mit fachübergreifenden Fragestellungen, Erfahrung ziel- und terminorientierten Arbeitens im Team und damit Stärkung der sozialen Kompetenzen, Förderung des strukturierten und vernetzten Denkens, Außendarstellung und Präsentation konfrontiert. *(The students can apply and extend the methodic and specialized technical knowledge that is learnt during the study. They will be faced with interdisciplinary questions, goal- and deadline-oriented work in a team, and, thus, strengthening their social competences, encouragement of structured networked thinking, external image and presentation.)*
2	**Inhalte (content)**: Selbstständige Bearbeitung einer konkreten, praxisnahen und motivierenden Aufgabenstellung aus den Gebieten Prozesstechnik, Energietechnik, Umwelttechnik, Produktion oder eines gebietsübergreifenden Themas im Rahmen von Arbeitsgruppen. Besondere Betonung liegt auf Teamarbeit, auf der Notwendigkeit, sich viele Daten und Unterlagen selbst beschaffen zu müssen und auf der Verpflichtung, die Ergebnisse schriftlich und mündlich zu präsentieren. *(Independent elaboration of a specific task with a practical orientation form the areas process technology, energy technology, environmental technology, production or an interdisciplinary task in work groups, with special emphasis on team work, the necessity of obtaining much of the data and documents by themselves and the obligation of presenting the results written and oral)*
3	**Lehrformen (teaching format)** Einführende Vorstellung und Erläuterungen, Selbststudium, Teamarbeit, regelmäßige Betreuung und Diskussion mit den Dozenten. *(Introductory presentation and explanations, self-study, teamwork, regular supervision and discussion with the lecturer)*
4	**Empfohlene Voraussetzungen (recommended prerequisites)** Fachbezogener Bachelor sowie die für das konkrete Projekt relevanten Teilmodule aus den Gebieten Prozess-Energie- und/oder Umwelttechnik, Managementtechniken, Produktion. *(Specialized Bachelor as well as partial modules that are relevant to the specific project from the areas process, energy and/or environmental technology, management techniques, production)*
5	**Prüfungsformen (types of exams)** • Schriftliche Dokumentation der Projektarbeit, Präsentation, mündliche Prüfung *(Written documentation, project work, presentation, oral examination)*

6	**Voraussetzungen für die Vergabe von Leistungspunkten (requirements for credits)** • Teilnahme am Projekt sowie bestandene Präsentation der Ergebnisse *(Participation in the project as well as the passed presentation of the results)*
7	**Modulverantwortliche(r) (instructor in charge)** • Verschiedene *(Different)*
8	**Sprache (language)** • Deutsch / English *(German / English)*
9	**Sonstige Informationen / Literaturempfehlungen (other information and references)** Spezielle Literatur wird je nach Aufgabenstellung empfohlen. *(Special literature will be recommended, depending on the task)*

Engineering Conferences						
Modulnummer (Modulnumber)	**Workload**	**Präsenzzeit (Attendence time)**	**Selbststudium (Self-study)**	**Studiensemester (Study semester)**	**Angebot im (Offered in)**	**Dauer (Duration)**
	180 h	60 h	120 h	2./3. Semester	SS / WS	2. Semester
Lehrveranstaltungen (Courses)		**Credits**	**Zuordnung zu den Curricula (Allocation to the curricula)**			
Seminar 4 SWS		6 ECTS	Masterstudiengänge: SET, IWI, ME			

1	**Lernergebnisse (learning outcomes) / Kompetenzen (compentencies)** Students … • know the steps which are necessary to participate in a scientific conference/ • are introduced to the art of effective academic writing • learn to adapt their writing to the target audience • are familiar with the techniques of producing a formal scientific paper • develop confidence and eloquence when presenting their ideas orally • are able to write a convincing abstract • design effective posters for international conferences • maximize the impact of their work through group discussions and peer feedback
2	**Inhalte (content)**: • Stages from first draft to a manuscript suitable for submission • Linguistic components of effective writing (academic style, tenses, action verbs, cohesion) • Studying example conference papers • Discussing and assessing scientific papers • Technical aspects of poster design (layout, visuals, software) • Interaction with the audience • Scientific in-house conference: poster session and short oral presentation
3	**Lehrformen (teaching format)** • group work, discussions, individual written and oral exercises
4	**Empfohlene Voraussetzungen (recommended prerequisites)** • English B2
5	**Prüfungsformen (types of exams)** • oral short presentation (30 min), poster preparation and presentation, group work assessments
6	**Voraussetzungen für die Vergabe von Leistungspunkten (requirements for credits)** • poster completed and successful oral presentation
7	**Modulverantwortliche(r) (instructor in charge)** • Prof. Dr.-Ing. Thomas Zielke, Prof. Dr.-Ing. Matthias Neef
8	**Sprache (language)** • English

9	**Sonstige Informationen / Literaturempfehlungen (other information and references)** List of recommended literature: • Alley, Michael (2013): The craft of scientific presentations. Critical steps to succeed and critical errors to avoid. Second edition. New York: Springer. • Alley, Michael (2014): The craft of scientific writing. 4. ed. New York, NY: Springer. • Cargill, Margaret; O'Connor, Patrick (2013): Writing scientific research articles. Strategy and steps. 2. • ed. Chichester: Wiley-Blackwell. • Hofmann, Angelika H. (2014): Scientific writing and communication. Papers, proposals, and presentations. 2. ed. New York, NY: Oxford Univ. Press. List of important/popular conferences within the scope of our master courses: • http://icpr-eame.com • CIRP Conference on Industrial Product Service Systems • ISES Solar World Congress • Solar Heating and Cooling for Buildings and Industry conference (SHC) • ASME Turbo Expo (https://www.asme.org) IEEE engineering publications: http://ieeexplore.ieee.org

Masterarbeit und Kolloquium **Master Thesis and Colloquium**						
Modulnummer (Modulnumber)	**Workload**	**Präsenzzeit (Attendence time)** 360h	**Selbststudium (Self-study)** 360h	**Studiensemester (Study semester)** 3. Semester	**Angebot im (Offered in)** SS / WS	**Dauer (Duration)** 1 Semester
Lehrveranstaltungen		**Credits** 24 LP	**Zuordnung zum Curriculum** Master ME			

1	**Lernergebnisse (Learning outcomes) / Kompetenzen (competencies)** Die Kandidatin/der Kandidat ist in der Lage, innerhalb einer vorgegebenen Frist ein anspruchsvolles Problem aus ihrem/seinem Fach selbständig nach wissenschaftlichen Methoden auf hohem Niveau zu bearbeiten. Die Kandidatin/der Kandidat ist befähigt, die Ergebnisse der Abschlussarbeit, ihre fachlichen Grundlagen, ihre fächerübergreifenden Zusammenhänge und ihre außerfachlichen Bezüge mündlich darzustellen, selbständig zu begründen, gegen Einwände zu verteidigen und ihre Bedeutung für die Praxis einzuschätzen. *(The candidate is able to treat a demanding problem from her/his area independently, using scientific methods at high level, within the given deadline.* *The candidate is enabled to present the results of the thesis, their technical principles, their interdisciplinary correlations and their non-technical references orally, justify them independently, defend them against objections and assess their importance for the practical application)*
2	**Inhalte (contents)** Die Abschlussarbeit dient zur Bearbeitung einer wissenschaftlichen Aufgabenstellung mit einem festgelegten Umfang und in einem vorgegebenen Zeitraum (16 Wochen). Das Thema der Abschlussarbeit kann theoretischer oder experimenteller Natur sein und kann aus allen Lehr- und Forschungsgebieten des Fachbereichs stammen. Das Kolloquium ergänzt die Abschlussarbeit, wird als mündliche Prüfung durchgeführt und von den Prüferinnen und Prüfern der Abschlussarbeit gemeinsam abgenommen und bewertet. Das Kolloquium kann ein Kurzreferat des Studierenden zu den Inhalten und Ergebnissen der Abschlussarbeit beinhalten. *(The thesis serves for the treatment of a scientific task with a prescribed extent within a given time period (16 weeks). The subject of the thesis can be of theoretical or experimental nature, and can stem from all teaching and research areas of the department. The colloquium complements the thesis, will be conducted as oral examination and will jointly be evaluated by the examiners of the thesis. The colloquium can include a short presentation of the student to the contents and results of the thesis)*
3	**Lehrformen (teaching format)** keine *(none)*
4	**Teilnahmevoraussetzungen (Pre-requisites for participation)** Bestätigung einer mindestens ausreichenden Leistung in der Thesis durch die Prüfer. *(Confirmation by the examiner that the minimum passing grade is at least achieved by the work done)*
5	**Prüfungsformen (types of exams)** Die Abschlussarbeit ist eine schriftliche Prüfungsarbeit. Das Kolloquium ist eine mündliche Prüfung und dauert 45 Minuten. *(The thesis is a written examination paper. The colloquium is an oral examination and takes 45 minutes)*

6	**Voraussetzungen für die Vergabe von Leistungspunkten (requirements for credits)** keine *(none)*
7	**Modulverantwortliche(r) (instructor in charge)** Dekan *(Dean)*
8	**Dozent(in) (lecturer)** Verschiedene Betreuer *(Different supervisor)*
9	***Sonstige Informationen / Literaturempfehlungen (other information / references)*** Die Abschlussarbeit kann auch in der Forschungsabteilung eines Industrieunternehmens oder einer anderen wissenschaftlichen Einrichtung des Berufsfeldes durchgeführt wer-den, wenn sie dort ausreichend betreut werden kann. *(The thesis can be conducted in the research department of an industrial enterprise or in another scientific organization of the professional field, provided that it can be sufficiently supervised)*