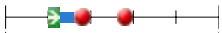
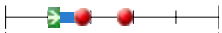
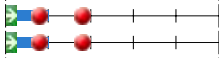
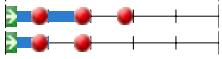
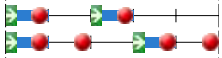
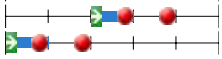
Program overview

29-Apr-2021 12:14

Year	**2020/2021**
Organization	**Mechanical, Maritime and Materials Engineering**
Education	**Master Mechanical Engineering**

Code	Omschrijving	ECTS	p1 | p2 | p3 | p4 | p5
ME Obligatory Courses (11 ECTS) for all ME Master			
ME46000	Nonlinear Mechanics	4	
ME46006	Physics for Mechanical Engineers	4	
ME46007	Measurement Technology	3	
ME Recommended courses (Select at least 5 ECTS)			
ME41105	Intelligent Vehicles	4	
ME44210	Drive & Energy Systems	3	
ME45001	Advanced Heat Transfer	4	
ME45042	Advanced Fluid Dynamics	5	
SC42001	Control System Design	5	
ME Social courses (Select min 3 ECTS, max. 6 ECTS)	**ME Social courses (Select min 3 ECTS, max. 6 ECTS)TS obligatory)**		
ID4235	Reflection on Designing	3	
SPM9448	Methods for Risk Analysis and Management	5	
TPM404A	Technology Entrepreneurship and Global Development	4	
TPM416A	Turning Technology into Business	6	
TPM420A	Ready to Start-up	6	
WM0320TU	Ethics and Engineering	3	
WM0349WB	Philosophy of Engineering Science and Design	3	
WM0801TU	Introduction to Safety Science	3	
WM1301TU	Ethics of Transportation	3	
WM1302TU	Ethics of Transportation	5	
WM1401TU	Ethics of Healthcare Technologies	3	

Year	**2020/2021**
Organization	**Mechanical, Maritime and Materials Engineering**
Education	**Master Mechanical Engineering**

ME Obligatory Courses (11 ECTS) for all ME Master	
Program Coordinator	S. van de Velde

ME46000	Nonlinear Mechanics	4
Responsible Instructor	Prof.dr.ir. A. van Keulen	
Instructor	Dr. F. Alijani	
Instructor	Dr. C. Ayas	
Contact Hours / Week x/x/x/x	0/4/0/0	
Education Period	2	
Start Education	2	
Exam Period	2 3	
Course Language	English	
Course Contents	Introduction Nonlinear mechanics (NM) builds upon the engineering mechanics (statics and dynamics) courses as embedded within the BSc curriculum. This compulsory MSc course will complete the education in engineering mechanics for a large group of students. Thus, this course should prepare them as good as possible for common problems faced by mechanical engineers without a specialisation in engineering mechanics. On the other hand, there is also a group of students who will continue their training in dynamics and/or statics. For this reason, this course serves as a first step into the more advanced engineering mechanics topics. Given the broad background of the students who will participate in this course, abstract formulations will be avoided. Moreover, many of the topics will be presented as introductions, creating awareness among the students. Detailed content: Introduction to nonlinearities in statics and dynamics Lagrangian and Eulerian descriptions Green-Lagrange strain tensor 2nd Piola-Kirchhoff stress tensor and equilibrium equations Alternative stress and strain tensors, Geometrical nonlinearity (finite rotations, finite deformations, geometric stiffness effects) Introduction to nonlinear discrete problems in statics Computational tools needed to solve nonlinear equations, including topics such as rate equations, physical stiffness, geometric stiffness, iterative solutions procedures, incremental procedures, incremental iterative procedures, path following, dynamic and static transient simulations, convergence, stability points, Linearized buckling analysis, Buckling and post-buckling behaviour Analytical approximations Introduction to nonlinear material models Nonlinear elastic models Simple plasticity models (elastic-ideally plastic, isotropic and kinematic hardening) Residual stresses and settling Collapse theorems Application to simple truss and beam problems 3D plasticity models work (yield surface, flow rule) Introduction to fracture mechanics Introduction to nonlinear dynamics Studying simple discrete nonlinear systems using the phase plane Quantitative analysis of weakly nonlinear single-degree-of freedom systems using general perturbation theory Periodic behaviour of simple nonlinear oscillators, limit cycles and softening/hardening responses Basics of bifurcation theory and stability for simple nonlinear dynamic systems	
Study Goals	Learning goals: Regarding nonlinear mechanics in general, students: are aware of the range of nonlinearities that are encountered in practical problems, including both static as well as dynamic settings, are capable of detecting when nonlinear analysis might be required for practical problems, have awareness of the role of the nonlinearities on both static as well as dynamic systems, are capable of formulating and solving simple nonlinear engineering mechanics problems. Regarding geometric nonlinearity (25%), students can distinguish when geometrical nonlinearity may be relevant (finite rotations, finite deformations, geometric stiffness effects), can identify effects caused by geometric nonlinearity, can work with Lagrangian descriptions, are aware of Eulerian descriptions can evaluate strains (Green-Lagrange), can evaluate 2nd Piola-Kirchhoff stress tensor and formulate equilibrium equations in nonlinear settings are aware of alternative stress and strain tensors, are aware of buckling phenomena and can determine buckling load and post-buckling behaviour for very simple problems, can make simple estimates, e.g., based on potential energy. Regarding computational nonlinear mechanics (25%), students can perform relatively simple nonlinear simulations, are aware of computational tools needed to solve nonlinear equations, including topics such as rate equations, physical stiffness, geometric stiffness, iterative solutions procedures, incremental procedures, incremental iterative procedures, path following, dynamic and static transient simulations, convergence, stability points, can identify when buckling might be one of the relevant failure mechanisms and have the knowledge to carry out a linearized buckling analysis, can make analytical estimates for nonlinear problems, e.g., based on minimum of potential energy. Regarding physical nonlinearity (25%), students have awareness of different nonlinear material models, are familiar and know when to use nonlinear elastic models, are able to describe the essential features of a nonlinear elastic model, are aware of simple plasticity models (elastic-ideally plastic, isotropic and kinematic hardening), are aware and can describe the practical relevance of yielding and the generation of residual stresses and settling, can make estimates using collapse theorems, are able to carry out stress analysis for simple problems, e.g., trusses and beams, using simple plasticity models,	

	are able to the describe how 3D plasticity models work (yield surface, flow rule), are aware of fracture and can work with linear fracture models. Finally, regarding nonlinear dynamics (25%), students can perform qualitative analysis of simple discrete nonlinear systems using the phase plane, can carry out quantitative analysis of weakly nonlinear single-degree-of freedom systems using general perturbation theory, can discuss the periodic behaviour of simple nonlinear oscillators, limit cycles and softening/hardening responses, are aware of the basics of bifurcation theory and stability for simple nonlinear dynamic systems.
Education Method	Contact hours: Integrated plenary sessions, including lecture, exercises, and in-class tests (4 hours per week) In-class tests: In-class tests provide bonus credits Bonus credits are only valid for one academic year. Thus, the bonus credits evaporate at the end of the academic year For the in-class tests each student needs an account to use Learning Catalytics (https://learningcatalytics.com/). You may already have a Pearson account which can be used. Check before buying an account! Once you have an account, login. Go to "My Account" and enter as "Student Id" your study number. THIS IS CRUCIAL IN ORDER TO OBTAIN CREDITS!! During the in-class tests you may collaborate with your neighbor students and use internet info, slides, reader, books. Use of any type of electronic communication and social media (sms, cell phone, email, facebook, whatsapp, etc etc.) is considered exam fraud and will be treated as such Grade calculation: Provided the grade of the written exam is 5.00 or higher: Final-Grade = 0.7 * (Grade-written-exam) + 0.3 * MAX(Grade-written-exam, Grade-inclass-tests) Grade-inclass-tests is based on average of best 70% of individual test grades. No participation in a test leads to a 0 as grade for that particular test. In case the grade of the written exam is lower than 5.00, one can not benefit from the bonus credits. Example: the grade of the written exam is 4.95, in that case there can be no benefit from the bonus credits Study materials: Reader (available in pdf format). Becomes available during the course lecture slides Suggested literature: Nonlinear Finite Element Analysis of Solids and Structures, 2nd Edition; Rene De Borst, Mike A. Crisfield, Joris J. C. Remmers, Clemens V. Verhoosel; ISBN: 978-0-470-66644-9; 540 pages August 2012 Nonlinear Finite Elements for Continua and Structures, 2nd Edition; Ted Belytschko, Wing Kam Liu, Brian Moran, Khalil Elkhodary; ISBN: 978-1-118-63270-3; 830 pages December 2013, ©2013 Nonlinear Solid Mechanics: A Continuum Approach for Engineering Gerhard A. Holzapfel; ISBN: 978-0-471-82319-3; 470 pages February 2000 Applied Mechanics of Solids. Allan F. Bower, CRC Press, ISBN:978-1-4398-0247-2 (available freely from www.solidmechanics.org) Lecture Notes on Nonlinear Vibrations, Richard H. Rand, freely available at http://audiophile.tam.cornell.edu/randdocs/nlvibe52.pdf. Nayfeh, A. H., & Mook, D. T. (2008). Nonlinear oscillations. John Wiley & Sons.
Assessment	Normally a written (closed-book) exam. Because of Covid likely an online exam in the academic year 2020-2021
Department	3mE Department Precision & Microsystems Engineering

ME46006	Physics for Mechanical Engineers	4
Responsible Instructor	Prof.dr. P.G. Steeneken	
Instructor	Dr. G.J. Verbiest	
Contact Hours / Week x/x/x/x	4/0/0/0	
Education Period	1	
Start Education	1	
Exam Period	1 2	
Course Language	English	
Expected prior knowledge	Students are expected to have Physics knowledge at the level of the final exam of the physics exam at Dutch highschools (VWO). If they have not, they can still do the course but it will require more self-study from the book of Tipler.	
Summary	The course ME46006 Physics for Mechanical Engineers, aims to provide mechanical engineering students with a broad background in physics. The course offers basic understanding and skills in the field of physics, that will provide a background that can be useful in many engineering situations. It can serve as a starting point for more advanced physics studies and can also help mechanical engineers to interact with electrical engineers and physicists in their future career. Since the course aims for a broad coverage of the field of physics, the course material includes many different subjects at a basic to intermediate level. In contrast to other courses, this course favours to cover a relatively large number of different topics in order to provide a broad background, instead of covering a small number of topics in-depth. This means that the amount of material that needs to be studied is larger than for other courses. A bachelor degree in mechanical, electrical, aerospace, industrial engineering or applied physics is considered prerequisite.	
Course Contents	- Waves - Electrostatics and electricity - Magnetism - Electrodynamics - Optics - Interference and diffraction - Outlook into quantum mechanics	
Study Goals	At the end of the course, students should have knowledge, and should be able to solve problems on the following topics: Waves (Chapters 15&16 of Tipler): - The wave equation - Propagation, reflection and transmission of waves - The Doppler effect Electrostatics (Chapter 21-25): - Coulomb's law and electric forces - Electric fields and Gauss' law - Voltage and capacitors Electricity (Chapter 26-30): - Ohm's law and Kirchoff's law - DC and AC circuits Magnetism : - Gauss' law for magnetism - Lorentz', Ampere's, Lenz' and Faraday's law - Electromagnetic motors and inductors - Maxwell's equations Optics (Chapter 31-34): - Propagation and properties of light - Light-matter interaction - Imaging systems with light - Interference and diffraction - Limits of optical systems and quantum mechanics	
Education Method	Learning methods include power point presentations, class demonstrations, Kahoot quizzes and assignments. Lecture notes will be made available on the Brightspace. Assignments will be on the concepts discussed in the class and will be made available on the Brightspace. The solutions to the assignments will be discussed in class and will be evaluated during assignment sessions. Bonus points can be earned via Kahoot quizzes. The course ends with a written exam.	
Literature and Study Materials	The course will closely follow selected chapters of the book of Tipler. In addition lecture slides will be provided on Brightspace.	
Books	Physics for Engineers and Scientists, 6th edition by Tipler and Mosca	
Assessment	Online exam, complemented by online quizzes and homeworks.	
Department	3mE Department Precision & Microsystems Engineering	

ME46007	Measurement Technology	3
Responsible Instructor	Dr.ir. G.E. Elsinga	
Contact Hours / Week x/x/x/x	0/0/4/0	
Education Period	3	
Start Education	3	
Exam Period	3 4	
Course Language	English	
Summary	This master level course covers fundamental aspects of measurements useful for a mechanical engineer. It covers measurement of various physical quantities, signal conditioning, error analysis and statistical analysis of the data. A bachelor degree in mechanical, electrical, aerospace, industrial engineering or applied physics is considered prerequisite.	
Course Contents	topics: - General introduction to measurements - Measurement system behavior - Hypothesis testing - Uncertainty analysis - Sensor probes: variety of experimental techniques - Signal conditioning - Data acquisition and processing - Imaging and image processing - 3D techniques	
Study Goals	The general aim of this course is to provide students with a background in the theory of engineering measurements. At the end of the course, the students should be able to (1) analyze measurement systems and devices using the laws of mechanics and general physics, (2) evaluate the accuracy, sensitivity, spatial and temporal resolution of a measurement, (3) analyze and interpret datasets that contain errors, (4) design a measurement scheme and signal conditioning in order to enhance the significance of the results.	
Education Method	The main learning methods include lectures, take-home assignments and a textbook. The lectures cover the different topics of the course. Lecture slides will be made available on Brightspace. The recommended textbook is given below, however, you are encouraged to refer other books as well. Additional reading material, if necessary, will be made available on Brightspace. Assignments will be provided to practice the relevant problems and the concepts discussed in the class. They will be made available on Brightspace. The solutions to the assignments will be discussed in the class. The course ends with a written exam.	
Literature and Study Materials	The prescribed books will be followed during the course. Lecture slides will be made available on Brightspace. Additional study materials will be provided on Brightspace if necessary.	
Books	Theory and design for mechanical measurements, 6th edition by Richard S. Figliola & Donald E. Beasley	
Assessment	The examination will be as follows: Closed book written exam. In case of unforeseen circumstances or measures resulting from COVID-19, the prescribed assessment will be: Remote (online) open book with several fraud prevention measures.	
Department	3mE Department Process & Energy	

Year	**2020/2021**
Organization	**Mechanical, Maritime and Materials Engineering**
Education	**Master Mechanical Engineering**

ME Recommended courses (Select at least 5 ECTS)

ME41105	Intelligent Vehicles	4
Responsible Instructor	Prof.dr. D. Gavrila	
Instructor	J.F.P. Kooij	
Contact Hours / Week x/x/x/x	0/6/0/0 2 lecture/lab hours per week (lectures and labs alternating)	
Education Period	2	
Start Education	2	
Exam Period	2 3	
Course Language	English	
Required for	This course is obligatory for students in the Vehicle Engineering Track of the "Mechanical Engineering" Master program. Incoming students (academic year 2020-2021) of this track are strongly advised to switch to the new MS Robotics program.	
Expected prior knowledge	Linear algebra and probability theory. Python programming.	
Course Contents	Intelligent Vehicles (4 EC, ME41105) is the introduction course on the technology of automated driving at 3ME on the Masters level. It will be held 2020-2021 for the last time in the present form. This course is only meant for those students for whom it is obligatory for their MS program. ME41105 should NOT be chosen together with RO47004 ("Machine Perception") due to high content overlap between the two course. Students which were considering taking ME41105 as an elective, are recommended to take RO47004. The introduction lecture discusses the motivation for automated driving, levels of automation, current driver assistance systems on the market, future vehicle use scenarios. Various lectures thereafter address the main technological components of an automated vehicle: sensor processing (vision, radar, LiDAR), sensor fusion, situation analysis, motion planning and control. Concepts are further worked out in lab assignments (Python programming). The course also provides a sampling of recent research topics in the domain.	
Course Contents Continuation	This course mainly addresses the technology allowing a vehicle to drive in automated fashion. Complementary to this course is CIE 5805 Intelligent Vehicles for Safe and Efficient Traffic: Design and Assessment which focuses more on automated vehicles as part of a larger intelligent transportation system (i.e. including smart infrastructure, connected/cooperative driving) and on associated issues at the macro level (e.g. traffic flow efficiency, fuel consumption, behavior adaptation).	
Study Goals	At the end of the course students will understand the main technological components of a self-driving vehicle, and the underlying concepts. First-hand programming experiences will enrich this understanding. More broadly, students will be able to express an educated opinion on the benefits and risks of automated driving, the current developments from driver assistance to self-driving cars, and the forces driving this transformation.	
Education Method	Lectures (4 hours per week) Practicum (2 hours per week)	
Assessment	Practicum (30%) - No resit Final written exam (70%) - Because of measures resulting from COVID-19, the prescribed assessment will be as follows: Remote open book with several fraud prevention measures (for example, "live" camera feed). If the opportunity arises for examination on campus, the method of assessment will be: Written exam. Knock-out criteria - Each practicum assignment needs to be graded "Pass" or at least a 5 - The minimum overall practicum grade is 5 - The minimum final written exam grade is 5 - The minimum final course grade is 6	
Tags	Artificial intelligence Programming	
Department	3mE Department Cognitive Robotics	

ME44210	Drive & Energy Systems	3
Responsible Instructor	Dr.ir. H. Polinder	
Contact Hours / Week x/x/x/x	3/0/0/0 (1st part Q1 2x2 hours, 2nd part Q1 1x2 hours)	
Education Period	1	
Start Education	1	
Exam Period	1 2	
Course Language	English	
Expected prior knowledge	This course is designed for students without a BSc in Electrical Engineering. Therefore, it also covers some of the basics of electric circuits and electricity and magnetism. Proper knowledge of mathematics (differential equations, complex numbers) and mechanics is required.	
Course Contents	- DC and AC electrical circuits - Electricity and magnetism - Transformers - DC machines - Synchronous machines (including PM machines) - Induction machines - Basics of power electronics - Energy systems	
Study Goals	After following this course, students should be able to - Calculate DC and AC voltages and currents in simple electrical circuits with sources, resistive, capacitive and inductive loads using Kirchhoffs laws. - Construct phasor diagrams with voltage and current phasors. - Calculate active, reactive and apparent power in AC circuits. - Calculate energy stored in capacitors and inductors. - Calculate induced voltage using Faradays law. - Calculate electromagnetic forces using Lorentz law or the power balance. - Derive voltage equations and equivalent circuits of transformers, DC machines, synchronous machines, induction machines and permanent magnet machines. - Derive performance characteristics based on these equivalent circuits (torque-speed characteristics). - Describe advantages and disadvantages of electrification of drives. - Describe the most important power semiconductors (diodes, IGBTs, MOSFETs) and their switching behaviour. - Describe how power electronic converters use these switches to convert DC from one voltage level to another (choppers or phase legs using IGBTs or MOSFETs), AC into DC (passive rectifiers using diodes or active rectifiers using IGBTs or MOSFETs) or DC into AC (phase legs using IGBTs or MOSFETs). - Select suitable machine and drives for different applications.	
Education Method	Lectures	
Books	T. Wildi, "Electrical Machines, Drives and Power Systems"	
Prerequisites	Mathematics, Mechanics	
Assessment	Because of measures resulting from COVID-19, the prescribed assessment will be as follows: written exam, open book, online with Brightspace Assignments, partly multiple choice. If the opportunity arises for examinations on campus, the method of assessment will be: written exam, closed book, partly multiple choice.	
Department	3mE Department Maritime & Transport Technology	

ME45001	Advanced Heat Transfer	4
Responsible Instructor	Dr.ir. J.W.R. Peeters	
Instructor	Dr. R. Delfos	
Contact Hours / Week x/x/x/x	4/0/0/0	
Education Period	1	
Start Education	1	
Exam Period	1 2	
Course Language	English	
Expected prior knowledge	A BSc-course in Fluid Dynamics and Heat Transfer or in Transport Phenomena. Basic math in 1D (Taylor series & ODE's) and in multiple-dimensions (vector analysis & PDE's) in the BSc-ME in 3ME or equivalent; basic understanding of Fourier series.	
Course Contents	In this course the concepts & mathematics of heat transfer in the engineering context are treated. Elementary understanding of the three modes of heat transfer: conduction, convection and radiation, will be briefly reviewed during the first two lectures. During the remainder of the course, the underlying physics will be emphasized and advanced mathematical formulations will be explained. A large focus in the course will be on the analysis of heat transfer in real-life integrated systems. Subjects in order of appearance: - A refresher on the underlying thermodynamics; energy, enthalpy, specific heats and phase change enthalpy. - A refresher on Conduction, Convection and Radiation. - Integral and differential energy balances in a 1-D and multiple-D continuum; absorption, reaction and dissipation as source terms. - Stationary conduction: cooling fins, multi-dimensional conduction and Laplaces equation; boundary conditions; analytical techniques & numerical techniques; relaxation. - Phase change as a boundary phenomenon; melting and solidification fronts; Jakob number & Stefan condition. - Instationary conduction: Fourier and Biot number; boundary conditions; analytical techniques & numerical techniques; stability criteria. - Forced & Free convection: Nusselt, Stanton, Prandlt & Peclet numbers; Analysis & the physics behind empirical correlations. The role of boundary conditions. - Radiation: radiative exchange between grey bodies, solar radiation, spectral characteristics, surface characteristics.	
Study Goals	More specifically: The student is able to 1. Distinguish between the different modes of heat transfer, and divide real-life systems into subsystems of elementary heat transfer modes in a qualitative and quantitative manner. 2. For all of the below; give the physical interpretation of contributors and terms in balances in words and in sketches. 3. Set up appropriate integral and differential energy balances for one- and multidimensional instationary conduction. 4. Justify and apply simplifications and define the appropriate boundary conditions, including problems containing phase changes, i.e. Stefan conditions. 5. Indicate mathematical solution strategies - both analytical and numerical, and apply those for standard geometries. 6. Distinguish between different modes of convective heat transfer, and distinguish between the different physical mechanisms underlying empirical correlations. Indicate implications when more detailed distributions of convective heat transfer are involved. 7. Estimate the magnitude of radiative heat transfer, distinguish between thermal and short-wave properties and spectral distributions, qualify and quantify the role of surface properties in real-life applications.	
Education Method	- Lectures (2x2 hours per week) including experiments, computer demonstrations as well as instruction. In 2020, all lectures will be online. - After each lecture, book assignments, as well as custom assignments are given. Solutions will also be provided. - Weekly instruction/office hours (in 2020 online), during which students can discuss heat transfer problems with the instructors and/or during which instructors show how to solve an assignment.	
Computer Use	Computers are used for demonstrations of the lecture material during the course on the basis of TU Delft software. Students are invited to solve assignment problems using Matlab/Python/Maple - in some cases using given code, in others to start from scratch.	
Literature and Study Materials	Book: as a lead "Basic Heat and Mass Transfer" or just called "Mills" is used: A.F. Mills and C.F.M. Coimbra, 3rd edition, Temporal Publishing, ISBN 978-0-9963053-0-3 (available through MechEng study association 'Gezelschap Leeghwater'. The 2nd edition as by Pearson is out of print but still widely available; it is identical, but cheaper, and of lousy bookbinding quality. Derived versions like "Basis Heat Transfer", or "Heat Transfer" by Anthony Mills are nearly identical. Alternative books on heat transfer from your Bachelor's course (including Cengel & Incropera) can be used as well, but you might want to check with the teacher; just bring it to the first Office Hour if it's not standard. Lecture slides, short videos, Matlab scipts & other study materials required will be provided via Brightspace.	
Assessment	As a result of the COVID-19 measures, the assessment for this course will be remote off-campus. The assessment consists of a hand-written exam, which you will have to complete in a pre-determined timeslot of 3 hours (off-campus). An oath of integrity will have to be signed by all participating students. Afterwards, all answers will be checked on similarity. Finally, there will be an oral check directly after the exam.	
Permitted Materials during Tests	Only a non-programmable non-graphical calculator like Casio fx-82 MS is accepted. One (1) equation sheet of 2 sides A4 can be taken and/or is provided.	
Department	3mE Department Process & Energy	

ME45042	Advanced Fluid Dynamics	5

Responsible Instructor	Dr. D.S.W. Tam
Contact Hours / Week x/x/x/x	4/4/0/0
Education Period	1 2
Start Education	1
Exam Period	1 2 3
Course Language	English
Course Contents	This course surveys the principal concepts and methods of fluid mechanics. Topics include control volume analysis for mass and momentum, the derivation of Navier-Stokes equations from mass and momentum conservation for incompressible flows, boundary conditions at fluid/fluid and fluid/solid interfaces, dimensional analysis, interfacial tension, inviscid flows, circulation and vorticity, lift and drag, boundary layers, lubrication theory, classical instabilities and waves. Classical solutions of the Navier -Stokes equations are derived and Concepts are illustrated through practical examples from engineering, geophysics and biological fluid dynamics. NOTE: Knowledge of vector analysis and multivariable calculus is essential for this course. Students not familiar with vector analysis should follow wi3105me
Study Goals	The student is able to describe the basic fundamentals of classical, incompressible fluid mechanics and to apply the fundamental and mathematical principles of fluid mechanics. More specifically, the student must know how to: 1. formulate the conservation equations for mass and momentum 2. derive the governing equations of motion for an incompressible flow. (Starting from the conservation equations for mass and momentum, the constitutive equation for a Newtonian fluid, and the appropriate boundary conditions at a fluid/solid and fluid/fluid interface) 3. compute the stress tensor and the aero/hydrodynamic forces on a mechanical system 4. derive the vorticity equation and the consequence on the generation and transport of vorticity in 2D (Kelvin circulation theorem) 5. perform a dimensional or scaling analysis to identify the dominant terms in the governing equations. Also, use the non-dimensional numbers introduced in class to determine the flow regime (Reynolds, Strouhal, Froude, Bond, Capillary, Weber) 6. simplify the Navier-Stokes equations for the case of an inviscid flow (the Euler equations), a boundary-layer, a unidirectional flow, a creeping (Stokes) flow and in the lubrication limit. 7. apply appropriately the different forms of the Bernoulli equation The student must be able to derive classical solutions to the Navier-Stokes equations discussed in class. The student must be able to determine whether these classical solutions can be applied to a new problem and use them to compute the flow fields. These solutions include: 8. For ideal flows: a source, a sink, an irrotational vortex, a dipole, corner flows and the superposition of any combination of these using complex potentials (e.g. the 2D irrotational flow around a cylinder and the interpretation of Lift (Joukowski theorem) and Drag (d'Alembert Paradox)) 9. 3D axisymmetric irrotational flow around a sphere for steady and unsteady flows (added mass) 10. For viscous flows: Unidirectional laminar flows, Couette and Poiseuille flows, flow in a lubrication layer 11. Blasius solution for the boundary layer over a flat plate 12. Waves and instabilities in fluid mechanics, gravity waves, Kelvin-Helmholtz instability When facing a new problem in fluid dynamics, the student should be able to: 13. Write all the relevant governing equations 14. Use the appropriate formulation of mass and momentum transport (Control volume approach, Navier Stokes equations) 15. Simplify the governing equations using a dimensional/scaling analysis 16. Solve the governing equations for simple flows, when analytically possible 17. Use well-known solutions derived in class to model flows appropriately for the new problem. 18. Model the effect of aero/hydrodynamic forces on the dynamics of a simple mechanical system
Education Method	Lectures: 3 hours/week Recitations: 1 hour/week Office Hours: 1 hour/week
Books	Fluid Mechanics Sixth Edition Kundu, Cohen and Dowling
Assessment	Midterm Exam (35%) Final Exam (65%). Because of measures resulting from COVID-19, the prescribed assessment will be as follows: Both Midterm and Final will be remote open book exams with several fraud prevention measures. If the opportunity arises for examinations on campus, the method of assessment will be a proctored exam for the Midterm and the Final.
Department	3mE Department Process & Energy

SC42001	Control System Design	5
Responsible Instructor	Dr.ir. A.J.J. van den Boom	
Contact Hours / Week x/x/x/x	4/0/0/0	
Education Period	1	
Start Education	1	
Exam Period	1 2	
Course Language	English	
Course Contents	State-space description of single-input, single-output linear dynamic systems, interconnections, block diagrams. Linearization, equilibria, stability, Lyapunov functions and the Lyapunov equation Dynamic response, relation to modes, the matrix exponential. Realization of transfer function models by state space descriptions, coordinate changes, canonical forms. Controllability, stabilizability, uncontrollable modes and pole-placement by state-feedback. Application of LQ regulator. Observability, detectability, unobservable modes, state-estimation observer design Output feedback synthesis and separation principle. Reference signal modeling, integral action for zero steady-state error; Analysis in robust stability and robust performance. Basics of model predictive control (MPC). Different model-structures. Prediction models in state-space setting. Standard predictive control scheme. Relation standard form with GPC, LQPC and other predictive control schemes. Solution of the standard predictive control problem. Stability and (initial) tuning.	
Study Goals	By taking this course, the student - will be able to master the introduced theoretical concepts in systems theory and feedback control design - will be able to practically apply these concepts to design projects and tasks - and will be able to relate the learned concepts and techniques to other more specialized ones, to potentially integrate them by taking adjacent courses. - will be able to translate a predictive control problem into a standards setting and solve the predictive control problem. More specifically, the student will be able to: - Translate differential equation models into state-space and transfer function descriptions - Rationalize differences between state-space and transfer function approaches - Linearize a system, determine its equilibrium points, analyze directly its local stability, leverage Lyapunov theory to study general stability properties - Describe the effect of eigenvalue/pole locations to the dynamic system response in time/frequency domain. Contrast step and impulse responses. Analyze transients and steady-state - Investigate model controllability. Formulate and apply the procedure of pole-placement by state-feedback, as well as LQ optimal state-feedback control - Derive observability properties. Formulate and apply the procedure of state estimation and build converging observers - Formulate the separation principle and employ it for the design of output feedback - Build reference models and achieve zero steady-state error using integral control. - set up a predictive control problem. - Solve the standard predictive control problem; - Master the main analytical details in stability proofs of predictive control schemes;	
Education Method	Lectures 4/0/0/0	
Literature and Study Materials	Textbook (its use is strongly recommended): K.J. Astrom, R.M. Murray, Feedback Systems: An Introduction for Scientists and Engineers, Princeton University Press, Princeton and Oxford, 2009 Available online for download: http://www.cds.caltech.edu/~murray/amwiki/index.php?title=Main_Page The link for downloading the lecture notes for model predictive control will be available in the first quarter.	
Assessment	Written examination. Due to COVID-19 the exam will be an online exam.	
Department	3mE Department Delft Center for Systems and Control	

Year	**2020/2021**
Organization	**Mechanical, Maritime and Materials Engineering**
Education	**Master Mechanical Engineering**

ME Social courses (Select min 3 ECTS, max. 6 ECTS)	
Introduction 1	One course to select, or not more than 6 ECTS to select

ID4235	Reflection on Designing	3
Course Coordinator	Dr.ir. M.H. Sonneveld	
Contact Hours / Week x/x/x/x	2/0/0/0	
Education Period	4	
Start Education	4	
Exam Period	none	
Course Language	English	
Course Contents	By designing products for people and putting them in the world, designers have a big impact on our environment, behaviour and well-being. This course is designed to stimulate a critical reflection on this societal role of the designer and the students own design process. This is achieved by presenting students with ethical, philosophical and societal ideas about design and showing them how creators in related disciplines, such as architects, graphic designers, photographers and artists, approach their work and the impact it has.	
Study Goals	The main objective of this course is to contribute to the development of a critical, conscious and personal design philosophy or design attitude.	
Education Method	The course consists of a mix of lectures, workshops and individual assignments, partly delivered by the staff and dealing with theoretical reflections on design practice, partly delivered by guest practitioners who will reflect on the goals and approach of their creative work.	
Literature and Study Materials	The lectures must be attended in person.	
Assessment	Students will write a take-home assignment (essay) in which they must explicate their personal vision on design. This essay can take any form deemed appropriate, such as a movie, a written essay (with images), or a computer presentation.	
Enrolment / Application	A mandatory application for all courses (mandatory and electives courses) shall be made via the electronic applications system Osiris in the period that Osiris there to is opened. This period closes about 5 calendar weeks prior to the first day of the semester in which the programme starts; the faculty announces the exact deadline for application timely. The application for courses has to take place per semester, meaning for courses of 2 quarters at once. See http://www.io.tudelft.nl/osiris for deadlines and details.	

SPM9448	Methods for Risk Analysis and Management	5
Module Manager	Prof.dr. G.L.L.M.E. Reniers	
Instructor	Prof.dr. G.L.L.M.E. Reniers	
Instructor	Y. Ming	
Responsible for assignments	Prof.dr. G.L.L.M.E. Reniers	
Co-responsible for assignments	Prof.dr.ir. P.H.A.J.M. van Gelder	
Contact Hours / Week x/x/x/x	0/0/0/4	
Education Period	4	
Start Education	4	
Exam Period	4 5	
Course Language	English	
Course Contents	This course consists of three blocks following a risk analytical approach: (A) introduction, (B) analysis, (C) assessment, treatment and follow-up. In block A Students will get familiar with the concepts and definition used in safety science and the basic steps of a risk analysis. In block B the course will focus on identification of hazards and qualitative/semi quantitative risk analysis. A selection of methods is explored to get acquainted with its application and limitations. For instance: Fault tree analysis, Event tree analysis, Bowtie diagram, Reliability Block Diagram, Markov Chain Analysis, Bayesian networks, Decision making under uncertainty. In block C the assessment of the outcomes of a risk analysis are put central. This includes acceptance, stakeholder perspectives, decision making and monitoring.	
Study Goals	After taking this course the student will have knowledge about: * the basic concepts of safety science and risk analysis * risk acceptance and decision making about risks After following this course, the student will be able to: * apply structured methods for risk identification and risk analysis	
Education Method	The following methods may be used: Lectures, exercises and workgroup assignments	
Literature and Study Materials	The following textbook is mandatory: Engineering Risk Management (Meyer and Reniers, 2016; De Gruyter Publishing) Other required and additional material will be announced via Brightspace	
Assessment	The following assessment methods may be used according to the need: written examination and/or take-home exam.	
Category	MSc level	

TPM404A	Technology Entrepreneurship and Global Development	4
Module Manager	Dr. J.O. Kroesen	
Responsible for assignments	Dr. J.O. Kroesen	
Co-responsible for assignments	E. van Andel	
Contact Hours / Week x/x/x/x	2/0/0/0	
Education Period	1	
Start Education	1	
Exam Period	1 2	
Course Language	English	
Required for	Various masters, incl. SET and IE.	
Course Contents	Development is in this course interpreted from the perspective of the interaction between society (institutions), values and technology. Development projects and business plans/practices are the embodiment of such interactions at any given moment. Special attention is focused on the social transformation taking place in emerging economies on the level of the business itself, of civil society and governance. Enterprises and development projects have to steer their way in this landscape of social transformation and contribute to the strengthening of institutions and a vibrant civil society.	
Study Goals	The participants are able to interpret and analyze the interaction between technology, society and value preferences in concrete business plans and development projects, and contribute to such business plans and development projects from that perspective.	
Education Method	The first hour will be a general introductory lecture. The second hour will be spent on a case study. The case study will be discussed in small groups, followed by a plenary discussion. As the lectures proceed the case studies will more and more consist of cases dealt with in the group essays. Groups of three persons, by exception at maximum four, work on a particular essay theme.	
Literature and Study Materials	On Brightspace it is indicated what should be read in preparation of each lecture separately.	
Assessment	The participants write an essay focusing on a particular case study and interpret and evaluate this case from the perspective of the triangle of society, values and technology.	
Category	MSc level	

TPM416A	Turning Technology into Business	6
Module Manager	Dr. L. Hartmann	
Responsible for assignments	Dr. L. Hartmann	
Co-responsible for assignments	Dr.ing. V.E. Scholten	
Contact Hours / Week x/x/x/x	0/4/0/0	
Education Period	2	
Start Education	2	
Exam Period	none	
Course Language	English	
Course Contents	Turning Technology into Business (TTiB) aims to equip participants with a strong conceptual foundation to actively understand the dynamic process of technology-based entrepreneurship. Participants learn how business strategies are best formulated and how (through entrepreneurship) technology can create value. TTiB consists of seven lectures, introducing the theoretical backgrounds of technological, market and business analyses. A unique aspect of TTiB is that existing technologies (developed and patented by the TU Delft) are used as case subjects. The patent project is the focal point of the curriculum. Each group of 4-5 students will be assigned an original patent, and is expected to evaluate the commercial potential of this technology. This includes choosing promising applications (products) for the technology, and making recommendations for the most suitable business model to commercialize the technology. The patent project should provide a coherent and structured answer to the central question: which strategy is most likely to generate business from this patent? In addition to equipping participants with a thorough knowledge of the course subject, the section Technology, Strategy & Entrepreneurship (TSE) hopes that this course will be the starting point for a variety of university spin-offs in which the students will participate. To accommodate this, TSE offers the course TPM420A- Ready to Startup!	
Study Goals	This course aims to equip students with a strong conceptual foundation to an active understanding of two domains: (1) The dynamic process of technological innovation through concepts such as technology life-cycles, dominant design, disruptive technologies, Schumpeterian competition and the diffusion of innovations (2) How business strategies are formulated and, through entrepreneurship, technology can create value. This multi-faceted process of technology commercialization process is addressed in terms of assessing technology position, discovering market opportunities, competitive analysis, appropriability and the various modes of entrepreneurship.	
Education Method	7 interactive lectures, participant-centered case studies, homework assignments, classroom assignments, individual group coaching. Final Presentations in February.	
Literature and Study Materials	Will be provided during the course	
Assessment	Each group writes a report on their findings, analysis and recommendations for the technology (patent) they used as a case for this course. On the Final Day, the group has to give a 10 minute oral presentation. The report makes up 80% of the final grade. This team grade will be modified according to the individual student's class contributions and his/her performance within the group (peer review).	
Enrolment / Application	MAXIMUM CAPACITY is limited to 75 participants. Register on BrightSpace from October 1. Because of the huge popularity of this course, there is a selection procedure which consists of pre-course assignments. One of these assignments is a letter of motivation: why do you want to participate in this course? Based on the motivation and the other pre-course assignments, the final selection of 75 participants will be made.	
Targetgroup	Advanced Master students, PDEng and PhD students, and staff researchers from all faculties within the TU Delft.	
Category	MSc level	

TPM420A	Ready to Start-up	6
Module Manager	Ir. B.R. Joseph	
Module Manager	Dr.ing. V.E. Scholten	
Responsible for assignments	Dr.ing. V.E. Scholten	
Co-responsible for assignments	Dr. L. Hartmann	
Contact Hours / Week x/x/x/x	x/x/x/x	
Education Period	1 2 3 4	
Start Education	1 3	
Exam Period	none	
Course Language	English	
Summary	This course is offered twice in a year; First starting and ending in Q2 and second starting mid Q3 until end Q4 Ready to Startup (RtS) is an elective master course that has been the crown jewel of entrepreneurial education at TU Delft for over two decades. Bringing together business experts and students eager to start companies, it has one simple goal: turn engineers into successful founders.	
Course Contents	RtS focuses predominantly on Business Strategy: gaining market traction, prototyping, growing the team, devising a financial plan and fundraising strategy, protecting IP, and foundational activities (setting up a company, sharing ownership, etc.) The course has the prerequisite that teams should be formed and have business ideas that are analysed and validated. It is meant for students who plan to start a company. After RtS, teams must be at the level required for YES!Delft incubation and Delft Enterprises investments.	
Study Goals	At the end of the course, you will be able to - Reflect on your current business model and identify further necessary validation activities. Analyse market entry strategies and consider alternative models. - Learn how to negotiate, attract first users, and seek endorsement of stakeholders (such as investors and advisors). - Plan your core operational activities such as company foundation, IP protection, product development strategy and team development - Devise financial plans and appropriate fundraising strategies - Convey a convincing narrative of your business and be able to provide constructive feedback to other startup plans. - Demonstrate effective entrepreneurial behaviour by making swift decisions based on newly gathered information and adjusting your model accordingly	
Education Method	The course is spread out over 8 sessions (online in case of persistent Covid-19 restrictions for on campus education) in the afternoon (13h30-17h30) where the core elements of a startup plan are a presented. You work on assignments that are aimed at specific elements of the core startup plan, and you will by apply them to your startup project and present your findings during the course. In this way you make evident progress with your startup. The course combines state of the art business methods, translated to the needs of starting entrepreneurs, with consults from practictioners. Topics are discussed using case studies. You will present your progress, provide peer-feedback as well as receive advice from mentor experts. The course ends with a jury pitch and an executive summary.	
Literature and Study Materials	Handouts and literature are available trough in Brightspace.	
Prerequisites	Enthusiasm, entrepreneurial spirit and a good business idea.	
Assessment	The course has 3 grading components that are Covid-19 proof. - Individual: Active online participation and constructive peer review feedback on other business plans (30%) - Team: class-based assignments (20%) and a final startup plan report (40%) supported by an online jury pitch (10%)	
Enrolment / Application	Application process a coherent and validated business model. Taking and performing well in ACT or THINK class from Delft Centre for Entrepreneurship (codes starting with TPM4**) would be a great preparation to be selected for the class.	
Targetgroup	The course is designed for students who intend to start a business.	
Category	MSc level	

WM0320TU	Ethics and Engineering	3
Module Manager	Dr. F. Santoni De Sio	
Co-responsible for assignments	Dr. J.B. van Grunsven	
Contact Hours / Week x/x/x/x	4/0/4/0	
Education Period	1 3	
Start Education	1 3	
Exam Period	1 3	
Course Language	English	
Course Contents	This course is identical to the initial part of the course WM0329TU. You will explore the ethical and social aspects and problems related to technology and to your future work as professional or manager in the design, development, management or control of technology. You will be introduced to and make exercises with a range of relevant aspects and concepts, including professional codes, philosophical ethics, individual and collective responsibilities, ethical aspects of technological risks, responsibility within organisations, responsible conduct of companies and the role of law. You will analyse legal, political and organisational backgrounds to existing and emerging ethical and social problems of technology, and you will explore possibilities for resolving, diminishing or preventing these problems.	
Study Goals	After having completed the course you: can better recognise and analyse ethical and social aspects and problems inherent in technology and in the work of professionals and managers active in the design, development, management and control of technology. have insight into how these ethical and social aspects and problems are related to legal, political and organisational backgrounds. are able to explore and assess possibilities for solving or diminishing existing and emerging ethical and social problems that attach to technology and the work of professionals and managers. are better prepared to perform your future work as a professional or manager in the design, development, production and control of technology in an ethical and socially responsible way.	
Education Method	A series of 6 lectures and interactive work sessions with partial assessment, concluded with a written test.	
Literature and Study Materials	Reader Ethics and Engineering, available at Nextprint and as PDF files in Brightspace; Powerpoint slides, materials used in the working groups, and lecture notes.	
Assessment	Written exam (60%), presentation and active participation during the working group sessions (40%). In order to pass the course, a minimal grade of 5.5 should be obtained *both* in the exam *and* in the working group, and the average grade should be higher than 5.75. It is possible to re-take the exam without re-taking the working groups, in this case the working group grade will be kept. If you re-take the exam, it is also possible to re-attend the working groups to improve the final grade.	
Enrolment / Application	Enrolment via Brightspace is required for this course. This is needed in order to plan the workgroups. Please enrol as soon as possible and check Brightspace for more information on the enrolment on the enrolment procedure and timeline.	
Remarks	The course is run twice each year in the first and third quarter. The course is identical to the initial part of the course wm0329tu (6 ects).	
Category	MSc niveau	

WM0349WB	Philosophy of Engineering Science and Design	3
Module Manager	Dr. M.P.M. Franssen	
Instructor	Dr. M.P.M. Franssen	
Instructor	Dr. M.R. Theunissen	
Responsible for assignments	Dr. M.P.M. Franssen	
Co-responsible for assignments	Ir. S.J. Zwart	
Contact Hours / Week x/x/x/x	4/0/0/0 for students in the MSc programme Systems and Control 0/0/0/4 for students in the MSc programme Mechanical Engineering Students of Systems and Control who expect that it will be very awkward or impossible for them to attend the course in Q1, e.g. due to spending the semester abroad or due to other schedule- or study-related reasons, can send a request to the course manager to be allowed to attend the course in Q4. Similarly students of Mechanical Engineering who expect difficulties to attending the course in Q4 can send a request to be allowed to attend the course in Q1.The granting of such a request, however, is conditional on (1) the students motivation being judged compelling and (2) the availability of seminar instructors being judged sufficient to allow it, given the expected attendance of regular students. Cross-attendance without prior permission will not be accepted.	
Education Period	1 4	
Start Education	1 4	
Exam Period	1 2 4 5	
Course Language	English	
Course Contents	Course contents: (1) The goals of science; the character and scope of scientific claims. (2) The goals of engineering design; the nature of technical artefacts; the value-neutrality of technology. (3) The scientific method and the validation of scientific claims. (4) Methods of engineering design; the character and scope of design claims; the decision-making aspect of design. (5) The development of science; the objectivity of science; the notion of scientific progress. (6) The development of technology; social determinism and technical determinism. (7) The place and role of values in science and in engineering design.	
Study Goals	This course aims first of all to support students in developing a reflective and critical attitude with regard to empirical research underlying engineering science and engineering design at an academic level. Additionally, and in support of this primary goal, it aims to make students acquainted with views on the nature and goals of science and engineering design and how in these activities facts and values both have their role to play and how they interact.	
Education Method	The course is taught in the form of seven weekly sessions which each consist of a plenary lecture of two hours and a seminar of two hours during which students articulate and discuss their answers to a number of questions in smaller groups. Each seminar will be prepared and chaired by a team of about three students. For this task general and specific instructions, recommendations and suggestions will be available.	
Assessment	Assessment is through (1) a final individual written exam, (2) participation in the seminars and (3) performance in preparing and chairing a seminar. The exam result forms 50 percent of the final grade, assessment of general seminar participation 25 percent and assessment of the preparing and chairing role also 25 percent. Assessment of general participation may be done through peer grading; what method will in fact be used will be announced at the start of the course and on the course's Brightspace site. The written exam will either be held on campus or in the form of an on-line exam, depending on the university's policy to be in accordance with the government's restrictions in force at the time of the (re)examination.	
Category	MSc level	

WM0801TU	Introduction to Safety Science	3
Module Manager	Prof.dr.ir. P.H.A.J.M. van Gelder	
Contact Hours / Week x/x/x/x	0/3/0/0	
Education Period	2	
Start Education	2	
Exam Period	2 3	
Course Language	English	
Required for	Students wishing to graduate with a final project in the area of safety supervised by the Safety Science and Security Group should have followed this course or one of the other introductory courses run by the group (WM0808TU, WM0821TU or WM0822TU)	
Expected prior knowledge	Technical academic BSc and common (scientific) sense	
Summary	System Safety Engineering focuses on development of a safety oriented pattern of thinking and a holistic approach. The tools that will be gained in this course will be helpful in recognizing, understanding, and analyzing hazards; and assessing risks in contemporary complex systems. Areas included are (1) Hazard analysis and safety assessment, (2) Human reliability assessment, and (3) Safety management.	
Course Contents	Introduction to system safety engineering Safety performance measurement Hazard analysis Failure modes and effects analysis Preliminary hazard analysis System safety assessment Reliability block diagram Fault & event trees Markov chain analysis Bayesian network Consequence assessment Risk ranking Human reliability assessment Decision making under uncertainty	
Study Goals	The students will learn how to perform safety assessment, reduce risk within acceptable levels, manage risk, improve system safety, and make risk-informed decisions to benefit the organization and the community.	
Education Method	Plenary lectures (mandatory) Exercises (carried out in small groups of 4-5 students)	
Literature and Study Materials	Clifton A. Ericson, Hazard Analysis Techniques for System Safety, John Wiley and Sons; ISBN: 978-0471720195. Harold E. Ronald and Brian Moriarty. (1990). System Safety Engineering and Management, John Wiley and Sons, 2nd Edition.	
Prerequisites	Technical background preferred but certainly not mandatory	
Assessment	Multiple-choice exam (40 questions) based on book, papers, exercises and lecture slides.	
Enrolment / Application	Enrol through Brightspace. Minor students are automatically enrolled into the course.	
Remarks	This course can be expanded to a System Safety/Reliability project	
Category	MSc level	

WM1301TU	Ethics of Transportation	3
Module Manager	Dr. F. Santoni De Sio	
Co-responsible for assignments	Dr. J.B. van Grunsven	
Contact Hours / Week x/x/x/x	0/0/2/0	
Education Period	3	
Start Education	3	
Exam Period	3 4	
Course Language	English	
Course Contents	In this course you will explore some ethical and societal aspects and problems related to the design, development, management and use of transportation systems, with a particular focus on their digitalisation and robotisation. You will be introduced to a range of relevant aspects and concepts, including Responsible Innovation, moral dilemmas with self-driving cars, philosophical theories of freedom and justice, moral and legal responsibility, privacy, and the future of human employment. You will analyse ethical, legal and social problems of transportation in relation to case studies, and you will explore possibilities for resolving, diminishing or preventing these problems.	
Study Goals	After having completed the course you: can better recognise and analyse ethical and social aspects and problems inherent in (automated) transportation and in the work of professionals and managers active in the design, development, management and control of (automated) transportation systems can see these problems within the broader background of moral, legal and political philosophy have insight into how these ethical and social aspects and problems are related to legal, political and organisational backgrounds are able to explore and assess possibilities for solving or diminishing existing and emerging ethical and social problems that attach to (automated) transportation and the work of professionals and managers in this domain. are better prepared to perform your future work as a professional or manager in the design, development, production and control of (transportation) technology in an ethical and socially responsible way	
Education Method	A series of 6 lectures and some working group sessions, focused on the discussion and application of the theories presented in the course	
Assessment	Written exam and assessment participation in working groups	
Remarks	For ethics teaching at TU Delft check https://www.tudelft.nl/ethics/ethics/teaching-activities/ethics-teaching/	
Category	MSc level	

WM1302TU	Ethics of Transportation	5
Module Manager	Dr. F. Santoni De Sio	
Co-responsible for assignments	Dr. J.B. van Grunsven	
Contact Hours / Week x/x/x/x	0/0/2/0	
Education Period	3	
Start Education	3	
Exam Period	3 4	
Course Language	English	
Course Contents	This course is identical to the WM1301 course, with the addition of a final essay. In this course you will explore some ethical and societal aspects and problems related to the design, development, management and use of transportation systems, with a particular focus on their digitalisation and robotisation. You will be introduced to a range of relevant aspects and concepts, including Responsible Innovation, moral dilemmas with self-driving cars, philosophical theories of freedom and justice, moral and legal responsibility, privacy, and the future of human employment. You will analyse ethical, legal and social problems of transportation in relation to case studies, and you will explore possibilities for resolving, diminishing or preventing these problems.	
Study Goals	After having completed the course you: can better recognise and analyse ethical and social aspects and problems inherent in (automated) transportation and in the work of professionals and managers active in the design, development, management and control of (automated) transportation systems can see these problems within the broader background of moral and political philosophy have insight into how these ethical and social aspects and problems are related to legal, political and organisational backgrounds are able to explore and assess possibilities for solving or diminishing existing and emerging ethical and social problems that attach to (automated) transportation and the work of professionals and managers in this domain. are better prepared to perform your future work as a professional or manager in the design, development, production and control of (transportation) technology in an ethical and socially responsible way can write a short academic essay of critical analysis of an ethical or societal issue related to transportation technology	
Education Method	A series of 6 lectures, active participation in some working groups, and the writing of an essay on ethical, social or legal aspects of technology to be written under the supervision of an instructor from the section Ethics of Technology at TBM	
Assessment	Written exam, assessment participation in working groups and the writing of an essay the ethical, social or legal aspect of technology to be written under the supervision of the course manager or an instructor from the section Ethics of Technology at TBM. In order to pass the course both the exam and the essay should be graded with at least 5.5 (and the average should be sufficient, that is higher than 5.75)	
Remarks	For ethics teaching at TU Delft check https://www.tudelft.nl/ethics/ethics/teaching-activities/ethics-teaching/	
Category	MSc level	

WM1401TU	Ethics of Healthcare Technologies	3
Module Manager	Dr. S.M. Copeland	
Co-responsible for assignments	Prof.dr. S. Roeser	
Contact Hours / Week x/x/x/x	2/0/0/0	
Education Period	1	
Start Education	1	
Exam Period	1 2	
Course Language	English	
Course Contents	Introduction Ethics and Healthcare Technologies introduces students to the range of ethical issues that tend to arise during the development, design and application of devices used in healthcare or for medical purposes. The class will gain insight into the different aspects of healthcare ethics, such as the distinction between medical research and practice, the ethics of using human or animal research participants, and the ethics of technology, as well as value-sensitive design and responsible innovation approaches within the context of healthcare technologies. The course will provide students with skills in critical reflection, sensitivity to ethical concerns, and the ability to take up considerations of value to society as well as governance in the development and applications of technology. Assignments and cases examined in class will address contemporary developments in these technologies, the reasons behind new regulations that pertain, as well as giving a historical perspective on the ethical principles that underlie current approaches. Thus, the course should prepare students for common problems they will face in their current studies and prepare them for addressing issues that will arise in their future careers. Topics include: Introduction to ethics in medicine and healthcare: The research-practice and normative-descriptive distinctions, Bioethics, and the ethics of clinical research (historical and present), Medical devices and some relevant regulations & codes. Applying ethical frameworks e.g., utilitarianism, principalism, care ethics; Scientific integrity and the social value of research. Introduction to ethics of technology: Technology as a socio-technical system, Innovation in healthcare, Value-sensitive design, responsible innovation. Specific issues in developing healthcare technologies, such as: wearable and other health tracking devices; transhumanism and augmentation; human and animal research ethics; genetic modification; 3D tissue/organ printing; datamining, imagery and related privacy issues; the role of AI, machine learning and robotics.	
Study Goals	Regarding healthcare ethics & ethics of innovation in healthcare, students can: identify and describe various canonical forms of debate and ethical approaches within healthcare and biomedical ethics, compare diverging viewpoints in the field and assess the strength of an argument made in the field, evaluate different ethical issues as they arise at different points along the development and application trajectory. Regarding ethics and technology, students can: identify and describe normative aspects of technology; analyse and evaluate the ethical and social aspects of a case in contemporary healthcare technology development and application, and make recommendations for value sensitive design.	
Education Method	Contact hours: Plenary sessions that include blended learning activities, 2x Tutorials, Online discussion forums. Study materials: Reader (online) - becomes available during the course; Lecture slides, available on Brightspace after the lecture; Online materials to prepare for in-class activities, including self-directed research.	
Assessment	Grade calculation WM1401 (3ECs): Mandatory attendance in tutorials and short formative assignments, Exam (multiple choice and/or short open questions).	
Remarks	For ethics teaching at TU Delft check https://www.tudelft.nl/ethics/ethics/teaching-activities/ethics-teaching/	
Category	MSc level	

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