Virginia Tech Course	HAW Hamburg course
2054: ELECTRONICS FOR AEROSPACE AND OCEAN ENGINEERS Electrical circuits. Discrete passive and active electrical components. Phasors and impedence. AC power analysis. Digital electronics. Electronics for autonomous and piloted aerospace and ocean systems. Electronics for vehicle navigation, guidance, and control. Instrumentation and data acquisition systems. (2H,3L,3C)	Studiengangsfremdes Wahlpflichtmodul "Elektronische Komponenten für den Flugzeugbau"
2074 (ESM 2074): COMPUTATIONAL METHODS Solving engineering problems using numerical methods and software, truncation and round-off error, root finding, linear and polynomial regression, interpolation, splines, numerical integration, numerical differentiation, solution of linear simultaneous equations. A grade of C- or better is required in the prerequisite. Pre: ENGE 1114. (2H,1.5L,2C)	Studiengangsfremdes Wahlpflichtmodul "Numerische Mathematik" mit CP-Ausgleich
2104: INTRODUCTION TO AEROSPACE ENGINEERING AND AIRCRAFT PERFORMANCE Overview of aerospace engineering from a design perspective; introductory aerodynamics, lift, drag, and the standard atmosphere; aircraft performance, stability, and control; propulsion; structures; rocket and spacecraft trajectories and orbits. Co: ESM 2104 or ESM 2114. Pre: ENGE 1216, PHYS 2305. (3H,3C)	"Flugzeugprojekt (FPR)"
3014: FLUID DYNAMICS FOR AEROSPACE AND OCEAN ENGINEERS Fundamentals of fluids: stress, statics, viscosity, laminar and turbulent flow. Conservation of mass and momentum. Vorticity, circulation, and lift. Navier-Stokes equations. Ideal flow in two dimensions, streamlines, stream function, velocity potential, superposition. Thin airfoil theory. Physics of laminar and turbulent boundary layers and of transition. Boundary layer equations and basic tools for boundary layer calculation. Collaborative problem solving. Pre: (2104 or 2204), MATH 2214, ESM 2304. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Fluiddynamik".
3034: SYSTEM DYNAMICS AND CONTROL Free and forced response of first, second, and higher order linear, time-invariant (LTI) systems in frequency and time domains. Modeling of low-order mechanical systems. Transmission and absorption of vibrations. Transient and steady state performance specifications. Introduction to closed-loop control using proportional-integral-derivative (PID) feedback. Closed-loop stability analysis using root locus method. Pre: ESM 2304, (MATH 2214 or MATH 2214H). (3H,3C)	"Regelungstechnik mit Labor (RTL)"
3044: BOUNDARY LAYER AND HEAT TRANSFER Concepts of viscous flows and physical properties equations of laminar motion with heat and mass transfer; exact and approximate solutions; finite-difference methods; transition to turbulence; analysis in turbulent flows. Conduction and convective heat transfer. Pre: 3014, (3164 or 3264 or ME 2134 or ME 3134), MATH 4564. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Grenzschichttheorie und Wärmeübertragung"
3054: EXPERIMENTAL METHODS Fundamental terminology of experimental work and testing in aerospace and ocean engineering. Flow quantities, displacement, and strain measurements of simple structures in both static and dynamic settings. Analog and digital instrumentation. Data acquisition systems and appropriate software. Through teamwork design, prepare, and conduct an experiment, and document its results and findings. Statistical concepts. Pre: 2054, 3014, 3034. (3H,3C)	„Grundlagen der Messtechnik (MTL)".

Virginia Tech Course	HAW Hamburg course
3094 (MSE 3094): MATERIALS & MANUFACTURING FOR AERO & OCEAN ENGINEERS This course introduces the student of Aerospace and/or Ocean Engineering to the fundamental properties of materials typically required for structural design. The performance characteristics of metals, ceramics, polymers, and composites are presented and contrasted. Foundation principles underlying materials manufacturing are also presented with the goal of providing an understanding of how processing affects material properties and performance. Must have a C- or better in pre-requisite CHEM 1035. Non-MSE Majors only. Pre: CHEM 1035. Co: ESM 2204, PHYS 2305. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Werkstoffe und ihre Verarbeitung im Flugzeugbau"
3114: COMPRESSIBLE AERODYNAMICS Inviscid, compressible gas dynamics. Continuity, momentum and energy equations, shock waves, Prandtl-Meyer expansions. One-dimensional steady and unsteady flow, Rayleigh line, Fanno line, Shock Tubes. Method of Characteristics, supersonic thin airfoil theory and conical flow. Pre: 3014, ME 3134. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Höhere Aerodynamik"
3124: AEROSPACE STRUCTURES Inertia loads on aerospace structures, introduction to 3D elasticity including strain-displacement relations, stress-strain relations, stress transformation, and equations of equilibrium, plane stress and plane strain elasticity, stress concentration factors, aerospace materials and failure criteria, margins of safety analysis, plate bending, structural stability. Pre: 2024 or 3024. (3H,3C)	"Strukturkonstruktion 1 (SKO1)".
3134: AIR VEHICLE DYNAMICS Nonlinear kinematic and dynamic equations of aircraft motion; estimation of stability derivatives from aircraft geometry; determination of steady motions; linearization; longitudinal and lateral-directional small perturbation equations; static and dynamic stability of equilibrium flight. Pre: 3034. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Stabilitätstheorie und Regelungstechnik im Flugzeugbau"
3144: SPACE VEHICLE DYNAMICS Attitude representations and equations of rotational motion for rigid and multibody spacecraft; attitude determination; linearization and stability analysis of steady motions; effect of the gravity gradient; torque thrusters and momentum exchange devices. Pre: 3034, 3154. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Dynamik für Weltraumfahrzeuge"
3154: ASTROMECHANICS This course teaches the application of Newton's Laws to the dynamics of spaceflight. Topics include the two-body problem equations of motion, Kepler's Laws, classical orbital elements, energy and time-of-flight relations, orbit specification and determination, orbital maneuvering and orbit transfers, patched conic approximations, and relative motion. Pre: ESM 2304. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Astromechanik"
3164: AEROTHERMODYNAMICS AND PROPULSION SYSTEMS The fundamental principles of aerothermodynamics applied to aerospace propulsion system performance analysis and design. Foundations of thermodynamics, heat transfer, compressible fluid mechanics, and combustion. Applications of principles to air-breathing and rocket engines. Pre: 3014. Co: 3114. (3H,3C)	Wahlpflichtmodul "Flugzeugtriebwerke (FTW)"
4004: STATE-SPACE CONTROL Control design and analysis for linear, state-space system models. Properties of linear, time-invariant control systems: Input/output stability, internal stability, controllability, and observability. Performance and robustness measures. State feedback control design methods: pole placement, linear-quadratic control. State observers and output feedback control. Applications to control of mechanical systems including ocean, atmospheric, and space vehicles. Pre: 3034. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Regelungstechnik im Zustandsraum"

Virginia Tech Course	HAW Hamburg course
4024 (ESM 4734): AN INTRODUCTION TO THE FINITE ELEMENT METHOD The finite element method is introduced as a numerical method of solving the ordinary and partial differential equations arising in fluid flow, heat transfer, and solid and structural mechanics. The classes of problems considered include those described by the second-order and fourth-order ordinary differential equations and second-order partial differential equations. Both theory and applications of the method to problems in various fields of engineering and applied sciences will be studied. Pre: (CS 3414 or MATH 3414 or AOE 2074 or ESM 2074) or (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H). (3H,3C)	"Finite Elemente (FEM)"
4054 (ESM 4444): STABILITY OF STRUCTURES Introduction to the methods of static structural stability analysis and their applications. Buckling of columns and frames. Energy method and approximate solutions. Elastic and inelastic behavior. Torsional and lateral buckling. Use of stability as a structural design criterion. Pre: 3024 or CEE 3404. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Stabilität von mechanischen Strukturen"
4064: FLUID FLOWS IN NATURE Course designed to build upon and broaden a basic traditional engineering knowledge of fluid flows into areas concerning a variety of natural occurrences and phenomena that involve fluid motions in important ways. Drag of sessile systems and motile animals, gliding and soaring, flying and swimming, internal flows in organisms, low Reynolds number flows, fluid-fluid interfaces, unsteady flows in nature and wind engineering. Pre: 3014 or CEE 3304 or ESM 3024 or ME 3404. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Strömungslehre an Beispielen in der Natur"
4065-4066: AIR VEHICLE DESIGN Fundamental principles of innovative air vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4065: Proven conceptual design process. Tradeoff studies. Air vehicle weight estimation. Air vehicle concepts feasibility assessment; 4066: Preliminary design tools and processes. Efficient and light-weight air vehicles. Air vehicle design validation. Pre: 2104, 3054, 3114, 3124, 3134, 3164 for 4065; 4065 for 4066. Co: 4105 for 4065; 4106 for 4066. (2H,3L,3C)	Studiengangsfremdes Wahlpflichtmodul "Konzeption von Flugzeugen"
4084 (ESM 4084): ENGINEERING DESIGN OPTIMIZATION Use of mathematical programming methods for engineering design optimization including linear programming, penalty function methods, and gradient projection methods. Applications to minimum weight design, open-loop optimum control, machine design, and appropriate design problems from other engineering disciplines. Pre: (MATH 2224 or MATH 2204 or MATH 2204H). (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Mathematik der Design-Optimierung"
4140: SPACECRAFT DYNAMICS AND CONTROL Space missions and the way pointing requirements affect attitude control systems. Rotational kinematics and attitude determination algorithms. Modeling and analysis of the attitude dynamics of space vehicles. Rigid body dynamics, effects of energy dissipation. Gravity gradient, spin, and dual spin stabilization. Rotational maneuvers. Environmental torques. Impacts of attitude stabilization techniques on mission performance. Pre: 3034, (4134 or 3154). (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Dynamik und Regelungstechnik für Weltraumfahrzeuge"
4165-4166: SPACE VEHICLE DESIGN Fundamental principles of innovative space vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on collaboration, ethics, and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4165: Proven conceptual design process. Parametric analyses. Space vehicle mass estimation. Space vehicle concepts feasibility assessment; 4166: Preliminary design tools and processes. Efficient and light-weight space vehicles. Space vehicle design validation. Pre: 2104, 3054, 3114, 3124, 3144, 3154, 3164 for 4165; 4165 for 4166. Co: 4105 for 4165; 4106 for 4166. (2H,3L,3C)	Studiengangsfremdes Wahlpflichtmodul "Entwicklung von Weltraumfahrzeugen"

Virginia Tech Course	HAW Hamburg course
4234 (ME 4234): AEROSPACE PROPULSION SYSTEMS Design principles and performance analysis of atmospheric and space propulsion engines and systems. Application of thermodynamics, compressible fluid flow and combustion fundamentals to the design of gas turbine and rocket engines and components, including inlets, turbomachines, combustors, and nozzles. Matching of propulsion system to vehicle requirements. Pre: (3114, (3164 or 3264 or ME 3134) or (ME 3404 or ME 3414), ME 2134 or ME 3124). (3H,3C)	Wahlpflichtmodul "Flugzeugtriebwerke (FTW)"
4274: INTERMEDIATE SHIP STRUCTURAL ANALYSIS Analysis of plate bending, buckling, and ultimate strength using computational tools and methods. Calculation of elastic buckling of stiffened panels. Eigenvalue methods for buckling and vibration. Incremental plastic collapse; other progressive collapse. Ultimate strength of large structural modules due to combined	Studiengangsfremdes Wahlpflichtmodul "Spezielle Methoden der Festigkeitslehre"
4324: ENERGY METHODS FOR STRUCTURES Work and energy relationships in structures, flexibility and stiffness influence coefficients, Maxwell and Betti-Rayleigh reciprocal theorems, strain energy and complementary strain energy for thin-walled structures, Castigliano's first and second theorems for trusses and frames, unit action and unit displacement states, direct stiffness method, principles of minimum total potential energy and total complementary energy for bars, beams, and plates, Ritz method, finite element method for bars and beams. Pre: 2024, (3124 or 3224). (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Energiemethoden in der Festigkeitslehre"
4454: SPACECRAFT POSITION/NAVIGATION/TIMING AND ORBIT DETERMINATION Position/Navigation/Timing (PNT) measurements and optimal batch filter estimation methods for spacecraft with emphasis on orbit determination; GPS position/velocity/time point solutions; linearized state transition matrices; batch least-squares filter Orbit Determination (OD) solutions from a time series of observations; precision and accuracy assessment using covariance and overlap statistics; one-way and two-way radio range and range-rate observations; optical bearings observations; non-Keplerian orbital effects. Pre: 3154. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Navigation von Weltraumfahrzeugen"
4474: PROPELLERS AND TURBINES Theory, numerical methods, and experimental techniques for analysis and design of propellers and turbines. Geometry description and creation of computer models. Analysis of inflow from wakes and atmospheric boundary layers. Performance characteristics including open-water and multi-quadrant operation, scale effects, and standard series data. Theoretical analysis and selection of airfoil and hydrofoil sections. Theory and numerical methods for propellers and turbines, including computational fluid dynamics (CFD) simulation. Design of wake-adapted propellers. Design of wind-turbine rotors in steady wind. Structural analysis of propeller and turbine blades. Wind- and water-tunnel testing for thrust and torque. Pre: 3014. (3H,3C)	"Strömungsmaschinen (SM)"
4624: FOUNDATIONS OF AERO AND HYDROACOUSTICS Fundamental background to the field of aero/hydroacoustics. Quantifying sound levels, acoustic intensity, the acoustic wave equation, and linear acoustics. Fluid dynamics, turbulence, and thermodynamics in aeroacoustics. Lighthill 's equation, and Curle's equation. Characterization and identification of aeroacoustic sources. Leading and trailing edge noise. Basics of aeroacoustic wind tunnel testing. Pre: 3014, 3054. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Grundlagen der Aero- und Hydro-Akustik"

Virginia Tech Course	HAW Hamburg course
4634: WIND TURBINE TECHNOLOGY AND AERODYNAMICS Aerodynamics and elastic behavior of a modern wind turbine. Internal and aerodynamic loads of wind turbines. Locating wind turbines with respect to fatigue, annual power and noise productions. Aeroelastic behavior of wind turbine blades. Generators, transformers and power converters used in wind energy. Historical, economic, political, and innovation issues related to wind energy and power grid integration. Pre: 3014, 3124. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Windenergieanlagen und deren Aerodynamik"
4654 (ECE 4154): SPACE WEATHER: THE SOLAR WIND AND MAGNETOSPHERE Solar-terrestrial interactions and space weather: the sun, solar wind, and interplanetary magnetic field; space plasma physics and magnetohydrodynamics; Earth's magnetosphere and ionosphere; geomagnetic storms and auroral substorms; societal impacts of space weather; planetary magnetospheres; space science instrumentation. Pre: ECE 3105 or AOE 3014. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Weltraumwetter: Sonnenwind und Magnetosphäre"
4804: SPECIAL TOPICS IN DYNAMICS, CONTROL, AND ESTIMATION Advanced undergraduate topics in dynamics, control, and estimation related to a particular class of aerospace and ocean engineering systems. Sample course topics include navigation and guidance, aircraft flight control, and ocean vessel motion control. May be repeated 2 times with different content for a maximum of 9 credits. Pre: 4004. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Spezielle Gebiete der Dynamik und Regelungstechnik". Je nach konkretem Inhalt des Semesters kann der Titel stärker spezifiziert werden.
4814: SPECIAL TOPICS IN PROPULSION Advanced undergraduate topics in propulsion for aerospace and ocean vehicles. Covers technical, environmental, and economic challenges and opportunities in contemporary and future propulsion concepts. Comparative analyses of conventional and advanced propulsion systems and propulsion/vehicle integration concepts based upon first principles. Topics include distributed propulsion, green propulsion and propulsion/airframe integration. May be repeated with different content for a maximum of 6 credits. Pre: 3164 or 3264. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Spezielle Gebiete des Antriebs von Flugzeugen". Je nach konkretem Inhalt des Semesters kann der Titel stärker spezifiziert werden.
4824: SPECIAL TOPICS IN ENERGY AND THE ENVIRONMENT Advanced undergraduate topics in energy and the environment related to aerospace and ocean engineering systems. Sample course topics include renewable energy and energy management. Pre: 3014. (3H,3C)	Studiengangsfremdes Wahlpflichtmodul "Spezielle Gebiete der Energie- und Umwelttechnik". Je nach konkretem Inhalt des Semesters kann der Titel stärker spezifiziert werden.

- Diese Tabelle wurde vom Prüfungsausschuss der Fakultät Luftfahrt- und Fahrzeugsysteme erarbeitet. Sie dient den Studierenden, um ihre Module an der Virginia Tech zu planen und diese Planung dem Prüfungsausschuss vor dem Austausch vorzustellen.

- Die Tabelle ersetzt die früheren Ausgaben vom 2017-10-17, 2020-12-19 und 2021-10-10. Diese verlieren ihre Gültigkeit mit Erscheinen dieser Ausgabe.

- Die Genehmigung der Modulkombinationen sowie ein evtl. zwischen Modulen erforderlicher Ausgleich der Credit Points wird vom Prüfungsausschuss für Austauschstudierende einzeln schriftlich genehmigt.

- Es sind zwei *studiengangsfremde* Wahlpflichtmodule möglich. Für die beiden übrigen Module und Wahlpflichtmodule besteht eine Bindung zum Modulkatalog der Bachelor-Prüfungsordnung.

- Die Tabelle bezieht die Prüfungsordnungen für Fahrzeugbau /Flugzeugbau von 2015 und 2022.

2026-03-01

Prof. Dr.-Ing. Sven Füser

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