

AEROSPACE ENGINEERING CURRICULUM (INTERNATIONAL PROGRAM)

Aerospace engineers play an invaluable role in the development of modern aircraft and spacecraft. Ever since the advent of the first flying machines, new technologies have propelled us faster, further and more efficiently than ever before. Today there is an ever-increasing need for human resources with the capability to not only repair, maintain and construct today's aircraft, but also to look to the future and design those of tomorrow.

Global air travel is expanding at an unprecedented pace, prompting the foundation of many new commercial airlines in Southeast Asia. What's more, only aerospace engineers can provide the necessary innovation to advance strategic defence and satellite technologies. At a time when the big players in space travel are looking to set up lunar bases and manned missions to Mars, aerospace engineers are in high demand. Our AERO curriculum, developed by a collaboration of Chulalongkorn University with the Royal Thai Air Force, is tailor-made to meet this new hunger for aerospace expertise. Are you a high flyer?

Each student is required to accumulate a minimum of 139 credits to graduate for Bachelor of Engineering Program in Aerospace Engineering (International Program) which also includes 2 credits of industrial training and 3 credits of senior project.

Curriculum board

Joshua	Staubs	Ph.D.(Virginia)
Niphon	Wansophark,	D.Eng.(Chula)
Tawan	Papapote	Ph.D.(Illinois)
Pinunta	Rojratsirikul	Ph.D.(Bath, UK)
Pitaakphong	Pattanagraikanakorn	Ph.D.(Delft)

Professors

Electrical Engineering

Pramote	Dechaumphai,	Ph.D.(USA)
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Associate Professors

Mechanical Engineering

Asi	Bunyajitradulya	Ph.D.(UC.Lrvine)
Kuntinee	Maneeratana	Ph.D.(London)
Niphon	Wansophark,	D.Eng.(Chula)
Nopdanai	Ajavakom	Ph.D.(UC Berkeley)
Alongkorn	Pimpin,	Ph.D.(Tokyo)
Thanyarat	Singhanart	Ph.D.(Tokyo)

Metallurgical Engineering

Seksak	Asavavisithchai	Ph.D.(Nottingham)
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Electrical Engineering

Thavatchai	Tayjasanant	Ph.D.(Alberta)
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Assistant Professors

Mechanical Engineering

Tawan Paphapote	Ph.D.C.(USA)
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Lecturer

ISE Staffs

Prabhath	De Silva	Ph.D.(USA)
Pinunta	Rojratsirikul	Ph.D.(Bath, UK)
Joshua	Staubs	Ph.D.(Virginia)
Pitaakphong	Pattanagraikanakorn	Ph.D.(Delft)

Guest Lecturer

Boonchai	Watrakul	Ph.D. (Cranfield)
Jeerasak	Pitakarnnop	Ph.D.(France)
Wicha	Mektrakran	B.Eng(USA)

	Engineering II	
2145465	Topics in Engineering I	3(3-0-6)
2145466	Topics in Engineering II	3(3-0-6)
2145480	Topics and Projects in Aerospace Industry I	3(2-3-4)
2145482	Topics and Projects in Aerospace Industry II	3(2-3-4)
2145483	Topics and Projects in Aerospace Industry III	3(2-3-4)
2145484	Topics and Projects in Aerospace Industry IV	3(2-3-4)
2145485	Topics and projects in Aerospace Engineering I	3(2-3-4)
2145486	Topics and projects in Aerospace Engineering II	3(2-3-4)
2145495	Independent Studies	3(0-6-3)

3. Free Electives **6 credits**

Any two subjects at the university level that are taught in English

**AEROSPACE ENGINEERING CURRICULUM
(INTERNATIONAL PROGRAM)**

(B.ENG)

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
FIRST SEMESTER			FIFTH SEMESTER		
2183102*	Computer Aided Design for Engineers	3	2145311	Aerodynamics I	3
2145211	Introduction to Aerospace Engineering	3	2145326	Aircraft Structure	3
2301107	Calculus I	3	2145427*	Electronics for Aerospace Engineering	2
2304153	Physics for Engineers	3	2145327	Aircraft Performance	3
2304193	Physics Laboratory for Engineers	1	2145453	Materials for Aerospace Engineering	3
5501112	Communicative English I	<u>3</u>	xxxxxxx	General Education	<u>3</u>
		16			17
SECOND SEMESTER			SIXTH SEMESTER		
2145221	Introduction to Aircraft Design	1	2145312	Aerodynamics II	3
2140111	Exploring Engineering World	3	2145328	Aircraft Stability and Control	3
2301108	Calculus II	3	2145365*	Experiments in Aerospace Engineering	2
2302103	General Chemistry Laboratory	1	2145329	Aircraft Propulsion	3
2302105	Chemistry for Engineers	3	xxxxxxx	Free Elective	3
2304154	Physics and Electronics for Engineers	3	xxxxxxx	General Education	<u>3</u>
2304194	Physics and Electronics Laboratory for Engineers	1			17
5501123	Communicative English II	<u>3</u>	SUMMER SEMESTER		
		18	2140301	Industrial Training	<u>2</u>
					2
THIRD SEMESTER			SEVENTH SEMESTER		
2145218*	Scientific Programming	3	2145475*	Aerospace Engineering Project I	2
2183211	Engineering Mechanics	4	2145461	Aircraft Design	3
2183221	Thermodynamics	3	xxxxxxx	Approved Elective	3
2301215	Multivariable Calculus	3	xxxxxxx	Approved Elective	3
2301216	Linear Algebra and Differential Equations	3	xxxxxxx	General Education	3
5501214	Communication and Presentation Skills	<u>3</u>	xxxxxxx	AI & Big Data	<u>3</u>
		19			17
FOURTH SEMESTER			EIGHTH SEMESTER		
2182203	Probability and Statistics for Engineers	3	2145473	Rocket Propulsion	2
2183222	Fluid Mechanics	3	2145476*	Aerospace Engineering Project II	3
2183231	Dynamics	3	2145493	Space Environment and Space mission	2
2183381	Numerical Methods for Engineers	3	xxxxxxx	Free Elective	3
XXXXXX	Interdisciplinary & 21 st Century Skills	3	xxxxxxx	General Education	<u>3</u>
5501225	Technical Writing	<u>3</u>			13
		18			
TOTAL CREDITS FOR GRADUATION					<u>136</u>

**COURSES DESCRIPTIONS IN
AEROSPACE ENGINEERING
(B.ENG)**

1. General Education

Foreign Language

5501214 Communication and Presentation Skills 3(3-0-6)

CONDITION: PRER 5501123

Practice using English for social communication and giving oral presentation on engineering-related topics.

5501225 Technical Writing 3(3-0-6)

CONDITION: PRER 5501123

Students are to practice extensive academic writing at paragraph level. Selected readings in the related field are included. More discussion and presentation skills are to be taught including listening input.

General Education (Special)

2140111 Exploring Engineering World 3(3-0-6)

Engineering solutions to the 21st century problems, fundamental skill and tools in engineering; design thinking process; problem solving skill; introduction to data science, product design, ecological and pollution management and disaster mitigation, innovation business idea development; feasibility analysis, project planning, business idea presentation.

2145211 Introduction to Aerospace Engineering 3(3-0-6)

Overview of aerospace engineering with a focus on using group projects to enhance critical thinking and problem solving applied to aerospace engineering related problems; group projects will facilitate creativity in solving complex problems, as well as communication and collaboration between students; introductory aerodynamics including lift, drag and the standard atmosphere; aircraft performance, stability, and control; propulsion; structures; rocket and spacecraft trajectories and orbits; introduction to unmanned aerial vehicles and applications of artificial intelligence in autonomous flight.

2. Core Courses

Basic Sciences

2301107 Calculus I 3(3-0-6)

Limit, continuity, differentiation and integration of real-valued functions of a real variable and their applications; techniques of integration; improper integrals

2301108 Calculus II 3(3-0-6)

CONDITION: PRER 2301107

Mathematical induction; sequences and series of real numbers; Taylor series expansion and approximation of elementary functions; numerical integration; vectors, lines and planes in three-dimensional space; calculus of vector valued functions of one variable; calculus of real valued functions of two variables; introduction to differential equations and their applications.

2302103 General Chemistry Laboratory 1(0-3-0)

Standard solution preparation; qualitative analysis; titration; electrochemistry; pH metric titration; spectroscopy; calculation and evaluation of data; calibration curve; introduction to polymer.

2302105 Chemistry for Engineers 3(3-0-6)

Stoichiometry and basis of the atomic theory; properties of the three states of matter and solution; thermodynamics; chemical equilibrium; Oxidation; chemical kinetics; the electronic structures of atoms and the chemical bond; periodic table; nonmetal and transition metal.

2142153 Physics for Engineers 3(3-0-6)

Mechanics of particles and rigid bodies, properties of matter, fluid mechanics, heat, vibrations and waves, elements of electromagnetism, optics, modern physics.

2304154 Physics and Electronics for Engineers 3(3-0-6)

Electricity; DC circuit; AC circuit; basic electronics; solid state devices; electrical actuators.

2304193 Physics Laboratory for Engineers 1(0-3-0)

Measurement and precision; experiments on simple harmonic motion, radius of gyration, dynamics of rotation, velocity of sound, viscosity of fluids.

2304194 Physics and Electronics Laboratory for Engineers PHYS ELEC LAB ENGS 1(0-3-0)

Resistance and electromotive force measurements; experiments on amp meter, voltmeter, oscilloscope, AC circuit, transistor, lenses and mirrors, polarization, interference, diffraction.

Compulsory Courses

2140301 Industrial Training 2(0-6-0)

Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2182203 Probability and Statistics for Engineers 3(3-0-6)

CONDITION: PRER 2301108

Engineering basis in statistics and probability; discrete and continuous probability distribution; joint probability distribution; parameter estimation: estimator, bias, consistency; point estimation; interval estimation; engineering applications in measurement and uncertainty, linear regression, introduction to random process; integration of statistics in engineering applications; case studies.

2183102 Computer Aided Design for Engineers 3(2-3-4)

Introductory course in computer aided drafting/design; basic CAD commands, tools, multi view drawing and dimensioning techniques; sketching; solid modeling; engineering drawings; assembly model ling; parametric curves and surfaces; rotation, translation, scaling, and projection matrices

2183211 Engineering Mechanics 4(4-0-8)

Analysis of force systems and their equilibrium as applied to engineering systems; stresses and strains; mechanical properties of materials; Hooke's law, elastic modulus, stress in beam, shear force, bending moment diagram, torsion, buckling of columns, Mohr's circle.

2183231 Dynamics 3(3-0-6)

Kinematics of three-dimensional curvilinear motion of a particle; kinetics of a particle: force and acceleration, work and energy, impulse and momentum; kinematics of planar

motion of a rigid body: force and acceleration, work and energy, impulse and momentum; introduction to kinematics and kinetics of three-dimensional motion of a rigid body.

2145218* Scientific Programming 2(2-0-4)

Introduction to the concept of programming using a high-level language, focusing on Visual Basic in Excel and MATLAB. The topic includes variable types, mathematics computation, simple I/O, conditional and repetitive control structures, function, arrays, and symbolic computing, the procedure of running, testing, and debugging the computer code, Fundamental of data visualization, data analytics.

2301215 Multivariable Calculus 3(3-0-6)
CONDITION: PRER 2301108

Vector; curves, planes and surfaces; derivatives of vector-valued functions; partial, total and directional derivatives; implicit differentiation; maxima-minima; gradient, divergence, curl; scalar and vector fields; line integral; surface integral and volume integral; integral theorems of vector analysis.

2301216 Linear Algebra and Differential Equations 3(3-0-6)
CONDITION: PRER 2301108

System of linear algebraic equations; linear spaces; inner products; eigenvalues and eigenvectors; principal axis theorem; higher-order linear differential equations; method of variation of parameters; system of first-order linear differential equations; qualitative analysis and dynamical system.

2145221 Introduction to Aircraft Design 1(1-0-4)

Introduction to aerospace design methodology and system engineering with a focus on systematic and critical thinking skill; Group design projects based on real world problems to enhance creativity, team communication, collaboration; fundamental to aircraft systems; requirements discovery and analysis process; introduction to elements of aerodynamic, airfoils, and wings, aspect of vehicle conceptual design; configuration section; aircraft initial sizing; introduction to novel aerospace design concept such as unmanned aerial vehicles, urban air mobility vehicle, and integration of artificial intelligence in modern aerospace design.

2145311 Aerodynamics I 3(3-0-6)
CONDITION: PRER 2183222

Atmosphere and properties of air; airfoil geometry; aerodynamic forces; stream function; vorticity and circulation; elementary flows; incompressible flow over aerofoils; irrotational flow; lifting flow; the Kutta Joukowski theorem; Kutta condition; Kelvin's circulation theorem and starting vortex; thin aerofoil theory; flapped aerofoil; thick cambered aerofoil; maximum lift coefficient and stall; high lift devices; incompressible flow over finite wings; Prandtl's lifting line theory; elliptical and general lift distribution; fundamental of viscous flow; conservation of mass and continuity equation; conservation of momentum and momentum equation; boundary layers; flow instabilities; turbulence

2145312 Aerodynamics II 3(3-0-6)
AERODYNAMICS II
CONDITION: PRER 2183221
and 2145311

Fundamental of compressible flow, acoustic waves, normal and oblique shock waves, expansion waves, Prandtl-Meyer flow, convergent-divergent nozzle, flow with friction and heat transfer, unsteady wave motion, perturbation theory, linearized flow and theory of characteristics.

2145326 Aircraft Structure 3(3-0-6)

Overview of aircraft structural external loads analysis including criteria, design, analysis, fatigue, certification, validation, and testing. Covers FAR 23 and FAR 25 airplane loads requirements. Includes introduction to the use of finite element package in structural analysis. Course will provide students with an understanding of fuselage/wing design and analysis including frames and ribs. Also provides an introduction to structural dynamics including aeroelasticity.

2145328 Aircraft Stability and Control 3(3-0-6)

Equilibrium and stability; functions of aircraft controls; static stability and trim; stability derivatives for longitudinal motions; stick-fixed, stick-free and control stick forces; wing and tail contributions; maneuver stability; roll stability and roll control; yaw stability and yaw control; dynamic behavior of aircraft and equations of motion; phugoid and short period oscillation; Dutch roll; spiral mode and roll subsidence; dihedral effect and weathercock stability

2145327 Aircraft Performance 3(3-0-6)

Principles of jet and propeller aircraft performance; equations of motions; cruise flight, climb and descent; turning flight; takeoff and landing performance; range and endurance; payload-range diagram; maneuvering V-n diagram.

2145427* Electronics for Aerospace Engineering 2(1-3-2)

Introduction to electronics and sensors used in aerospace engineering applications; basic electronics circuits involving analog components; design electronic circuits for amplifying, detecting, timing, etc; introduction to computer-based data acquisition.

2145365* Experiment in Aerospace Engineering 2(1-3-2)

Concepts in experimentation introduction to systematic design of an experiment using data reduction diagram (DRD); setting up objectives of an experiment, constructing the set of data reduction diagrams (DRDs) of the experiment according to the objectives; measurement and instrumentation; uncertainty analysis; experiments and laboratories in aerodynamics, structure, propulsion, performance, dynamics, and control.

2145329 Aircraft Propulsion 3(3-0-6)
CONDITION: PRER 2183221 and 2183222

Introduction to propulsion, air-breathing and non-air-breathing engines; brief review of the thermodynamics and compressible flow; basic thrust equation of aircraft gas turbine and jet engines; Brayton cycle, axial flow turbomachines, momentum theory and blade element theory; gas turbine component performance, inlet, compressor, turbine and nozzle; cycle analysis of gas turbine engines, rocket, ramjet, turbojet, turbofan and turboprop covering introduction to preliminary propulsion design

2145461 Aircraft Design 3(3-0-6)

Fundamentals of aircraft design process including wing design, tail design, and undercarriage arrangement. Also covers initial take-off mass estimation, detailed mass

calculation, and mission fuel requirement. Incorporates principles from prior aerospace engineering courses including center of gravity calculation, basic aerodynamics estimation, static stability and control analysis, propulsion consideration and analysis, performance analysis, aircraft cost prediction, preliminary and detailed design concepts, quality control of aircraft design.

2145475* Aerospace Engineering Project I 2(0-3-3)

Design project of aerospace systems, components, and/or processes to meet a desired need with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors; follow a well defined design process by working on a team; project identification, selection, and team formation; definition of project including specifications and background research; project planning and definition of tasks; comprehensive literature review; preliminary design; oral presentation and submission of report.

**2145476* Aerospace Engineering Project II 3(0-6-3)
Condition: PRER 2145475***

Design project of aerospace systems, components, and/or processes to meet a desired need with consideration of public health, safety and welfare, as well as global, cultural, social, environmental, and economic factors; follow a well defined design process by working on a team; detailed design development and parts acquisition; system simulation and optimization; design iteration; construction and testing; final design review and assessment of limitations and flaws; oral presentation and final report

2183221 Thermodynamics 3(3-0-6)

Basic concepts; thermodynamic state and process; properties of pure substances and ideal gases; energy; the first law of thermodynamics and the first law analysis for isolated, closed, and open systems; entropy; the second law of thermodynamics and the second law analysis for isolated, closed, and open systems; gas power cycles; Carnot, Otto, and Brayton cycles; refrigeration cycle; introduction to gas mixtures; introduction to combustion.

2183222 Fluid Mechanics 3(3-0-6)

Basic concepts in physics: physical quantity and physical quantity relations, dimensions of physical quantity and the principle of dimensional homogeneity, dimensionless variables; basic concepts in fluid mechanics: continuum assumption, methods of description: Lagrangian and Eulerian descriptions, field quantity and classification of flow fields; geometric and kinematics of fluid motion: path lines, streamlines, and streak lines; forces and stresses in fluids: pressure and pressure force, shear stress and shear force: convection flux and Reynold's transport theorem; physical laws of finite control volume: conservations of mass, linear momentum, and energy; conservation of angular momentum with application to turbomachines; physical laws of infinite control volume: conservation of mass and linear momentum, introduction to Navier-Stokes and Euler's equations; Bernoulli's equation from momentum and conservation of mechanical energy viewpoints; introduction to vorticity and vortex; dimensional analysis: Buckingham's PI theorem, similarity, and model testing; internal viscous flows, energy consideration in pipe flows and piping system; external flows, boundary layer, and aerodynamic force and moment; applications: turbomachines, model testing, piping and pumping system, aerodynamic force and moment.

2183381 Numerical Methods for Engineers 3(3-0-6)

Basic numerical methods for solving algebraic and transcendental equations, simultaneous linear and nonlinear equations, ordinary and partial differential equations. Introduction to Computer Aided Engineering (CAE). Use of numerical and CAE software for physical modeling and simulation of engineering problems and related applications.

2145453 Materials for Aerospace Engineering 3(3-0-6)

Design, selection and utilization of engineering materials for aircraft structure and engine components; ferrous alloy, nonferrous alloys; aluminum, magnesium, copper, titanium, superalloy, polymer and composite materials; manufacturing process for composite materials; recycling and repair of composite materials; future trends in aerospace engineering materials.

2145493 Introduction to Space environment and Space mission 2(2-0-4)

Space environment, phenomena in space that affect space missions and various payload systems to enable satellites to complete their assigned mission.

2145473 Rocket Propulsion 2(2-0-4)

Fundamental rocket propulsion, covering classical chemical rocket propulsion for launch, orbital, and interplanetary flight; flight mission and performance; rocket equations, nozzle theory and design; future trend in rocket propulsion and the preliminary design of engine devices.

AI & Big Data

2100201* Introduction to Artificial Intelligence 3(3-0-6)

Introduction to artificial intelligence related to scope, historical background; Concept for design; knowledge representation; memory structure; probabilistic reasoning; decision making; fuzzy logic; genetic algorithms; chaotic.

2140200* Exploratory Data Analysis and Visualization 3(3-0-6)

Condition: PRER Probability and Statistics

To learn the essential fundamental exploratory techniques for analyzing and visualizing data, and to gain hands-on experience of using software tools for data analysis. The following topics are covered: overview of exploratory data analytics, data acquisition, data analytic tools, data pre-processing, pattern discovery, graphical visualization, data forecasting, storytelling with data, and case studies.

Interdisciplinary & 21st Century

2100223* Entrepreneurship and New Venture Creation 3(3-0-6)

Concepts of entrepreneurship, concepts and processes of business opportunity analysis, design thinking for innovation business idea development, identifying target customers, analysis of customer's problem and need, developing unique value position for product and service, business models and revenue models, legal aspects for innovative entrepreneur, business idea presentation

2100224* Technopreneurship 3(3-0-6)

Concept of technopreneurship, characteristics and motivation for technopreneurs, intrapreneurship,

entrepreneurial mindset and process, opportunity analysis of technology business, technology business model design, sources of fund for technology business.

2100225* Design Thinking Principle 3(3-0-6)

Principles of Design Thinking method; Basic concept of prototype design; Basic concepts of self-assessment; Self-assessment based on knowledge, skills, people and working conditions; Research and analysis of information given by professional opinions; Development of action plan for sustainability.

Approved Electives

2145421 Introduction to Computational Fluid Dynamics 3(3-0-6)

Physical and mathematical foundations of computational fluid mechanics with emphasis on applications; solution methods for model equations, the Euler and the Navier-Stokes equations; classification of partial differential equations and solution techniques.

2145422 Gas Dynamics 3(3-0-6)

Introduction to gas dynamics, covering fundamental concepts in thermodynamics and fluid dynamics; molecular and continuum concepts for fluids, first and second laws of thermodynamics, conservation laws for moving fluids, one-dimensional compressible flows, shock and expansion waves, flows in nozzles, and two- and three-dimensional compressible flows.

2142352 Finite Element Methods and Applications 3(3-0-6)

Basic principles of finite Element methods; applications of finite Element in analysis using computer programs.

2145460 Aircraft Repair Philosophy 3(3-0-6)

Aircraft repair terminology; introduction to aircraft repair philosophy and technique, holes, bushings, fasteners, washers, dents; damage tolerance; basic repair disposition; corrosion; aircraft loads; introduction to joint failures, splices, doublers, angles and straps; introduction to aircraft sealant and nondestructive inspection.

2145471 Flight Experience 3(2-3-4)

Aircraft characteristics; aerodynamics and flight control; basic aircraft instrument; basic aviation knowledge; basic flying skill of airline planes.

2145481* Introduction to Unmanned Aerial Vehicles (UAV) 3(3-0-6)

Introduction to unmanned aerial vehicles; UAV payload; communication system and data link; aircraft design process and initial sizing; basic aerodynamics of small UAVs; propulsion and flight control system for small UAV; structural design and basic detailed design, UAV construction; flight test.

2142433 Failure Analysis and Nondestructive Testing 3(2-3-4)

Analysis and diagnosis of the causes of failure; physics of failure; concepts of reliability, the use of failure analysis as part of the design process, time based/related failure modes,

safety factors; case studies; elimination of failures through proper material selection, treatment and use; case histories; examination of fracture surfaces; laboratory investigations of different failure mechanisms.

215440 Airframe Structure and Systems 3(3-0-6)

Introduction to airframe structure and systems; introduction to product design and related philosophy; introduction to airframe design; introduction to detailed part fabrication; introduction to aircraft systems; introduction to bonding and grounding; introduction to newly designed aircraft and materials.

2183321 Heat Transfer Condition: PRER 2183222 3(3-0-6)

Modes of heat transfer; general forms of heat conduction equations; steady one-dimensional heat conduction; steady two-dimensional heat conduction, transient one-dimensional heat conduction; introduction of convection and boundary layer; external flow; internal flow; free convection; heat exchangers; introduction of radiation of black body and gray surfaces; view factors; radiation exchange between gray, diffuse surfaces in an enclosure.

2184407 Quality Design and Innovation Management 3(3-0-6)

Key issues and core concept of quality design and innovation management, innovation strategy; project management; concept formation and selection, quality design and innovation development process, business plan, risk management, techniques and tools for effective implementation of innovation.

2145420 Avionics 3(3-0-6)

Basic avionic system, air data system, flight instrument, terrestrial enroute radio navigation system, terrestrial landing aids, satellite navigation system, radar systems, indicators and displays, airborne communications, autopilot and flight management system, avionic systems intergration.

2145420 Unmanned Aerial Vehicle Flight Operation An Certification 3(3-0-6)

Topics on UAV laws, operational guidelines and regulations that are stipulated by both domestic and overseas aviation organizations; aviation meteorology; mission planning and weight calculations; communication with flight controllers, including estimation of flight operation risk.

2145494 Advanced Unmanned Aerial Vehicle 3(3-0-6)

Advanced UAV platform which are more complex in engineering system and flight operations multicopter and hybrid vertical takeoff landing (VTOL) UAVs; applications of the knowledge in assembling of UAS and fine tuning system parameters to operate in real-world missions.

2145462 Topics in Aerospace Engineering I 3(3-0-6)

Selected technical topics in aerospace engineering.

2145463 Topics in Aerospace Engineering II 3(3-0-6)

Selected technical topics in aerospace engineering.

- 2145465 Topics in Engineering I 3(3-0-6)**
Selected technical topics in engineering.
- 2145466 Topics in Engineering II 3(3-0-6)**
Selected technical topics in engineering.
- 2145480 Topics and Projects in Aerospace Industry I 3(2-3-4)**
Topics and projects in aerospace industry. An engineering project in aerospace engineering is required.
- 2145482 Topics and Projects in Aerospace Industry II 3(2-3-4)**
Topics and projects in aerospace industry. An engineering project in aerospace engineering is required.
- 2145483 Topics and Projects in Aerospace Industry III 3(2-3-4)**
Topics and projects in aerospace industry. An engineering project in aerospace engineering is required.
- 2145484 Topics and Projects in Aerospace Industry IV 3(2-3-4)**
Topics and projects in aerospace industry. An engineering project in aerospace engineering is required.
- 2145485 Topics and projects in Aerospace Engineering I 3(2-3-4)**
Topics and projects in aerospace engineering. An engineering project in aerospace engineering is required.
- 2145486 Topics and projects in Aerospace Engineering II 3(2-3-4)**
Topics and projects in aerospace engineering. An engineering project in aerospace engineering is required.
- 2145495 Independent Studies 3(0-6-3)**
Self-study on topic relate to aerospace engineering with consent of the instructor, the study may theoretical or experimental in nature.