Óbuda University Donát Bánki Faculty of Mechanical and Safety Engineering	Institute of Mechatronics and Vehicle Engineering

Subject name and Neptun-code:
Automatic Flight Control Systems of the Unmanned Aerial Vehicles (UAV) (BGRLRSVNEC)

Credit points of the Subject: 3

Full time training. Spring Semester of the Academic year of 2017/2018.

Course available at: BSc and MSc in Mechatronics, BSc and MSc in Mechanical Engineering.

Supervised by:	Prof. Dr. Róbert SZABOLCSI	Lectured by:	Prof. Dr. Róbert SZABOLCSI

Requirements of the course: (Neptun Codes)	—		

Lessons per week:	Theory: **1**	Practice (in Auditorium): **1**	Lab: **0**	Consultation: **0**

Level of exam:	Practice mark (**p**)

The Syllabus

Aim: to give an overview about civil and public applications of the UAV and UAS with emphasis on necessity of the automatic flight control of the UAV improving flight safety.

Topics: History of the powered flight. Airplanes, helicopters, drones and UAVs. Basics of flight mechanics of the rigid-body aircraft. Coordinate systems used in flight mechanics and flight dynamics. Equations of motion of the rigid-body aircraft. Translational motion of the UAV. Rotational motion of the UAV. Dynamic models of the aircraft: SISO-, and MIMO-models. Static and dynamic stability problems of the UAV. Automatic flight control systems of the UAVs. Position control of the UAVs. Flight path control of the UAVs. Speed control of the UAV. Analysis of the closed loop automatic flight control systems of the UAV: reference signal tracking and noise attenuation ability. Controller synthesis for UAV closed loop automatic flight control systems.

Schedule and Requirements

Weeks	
1.	Registration week.
2.	Introduction to the subject. Syllabus overview. Requirements of the course. Flight history of the powered flight. Airplanes, helicopters, drones and UAVs.
3.	Control forces and control moments generated by control surfaces. Thrust vectoring technology. Aircraft airframe, propulsion systems, and avionics.
4.	Civil and public applications of the UAV and UAS. Basics of flight mechanics of the rigid-body aircraft.
5.	Coordinate systems used in flight mechanics and flight dynamics. Equations of motion of the rigid-body aircraft. Translational motion of the UAV. Rotational motion of the UAV.
6.	Dynamic models of the aircraft: SISO-, and MIMO-models. Static and dynamic stability problems of the UAV.
7.	Flying and handling qualities of the UAVs. Dynamic performances of the UAVs.
8.	Automatic flight control systems of the UAVs. Position control of the UAVs. Roll angle control systems, tracking problem analysis and disturbance attenuation evaluation.
9.	Pitch angle control systems, tracking problem analysis and disturbance attenuation. Directional angle control systems, tracking problem analysis and disturbance attenuation evaluation.
10.	UAV flight path control. UAV height control systems.
11.	UAV speed control system.
12.	Modern ground control stations. Unmanned Aerial Systems. Modern automatic flight control systems technologies of the UAV.
13	Fly-by-Wire systems. Active Control Technology of the UAV. Control Configured UAVs.
14.	Test Paper writing and test evaluation.
15.	Writing/Retaking the test. Gaining signature and practice mark.

All main areas of the course are evaluated by a single test paper. The course is successfully executed if and only if the test paper is evaluated with grade higher than Grade2 ('Satisfactory'). If the test is written and failed, and Grade 1 ('Unsatisfactory') is provided, the signature must be denied. If the test paper is the not written one, the student must be cancelled from the course.

To improve: If the test paper is evaluated with Grade1 'Unsatisfactory', the student must be provided 2 occasions to improve. The 15th lecture is also among those of available for improving.

Participation: The participation is not obligatory at all lectures with the exception of the test paper lectures.

Practice mark (p): Minimum grade provided for test paper (Grade2 'Satisfactory').

References
1. Dr. Róbert Szabolcsi: Automatic Flight Control Systems (in Hungarian), Zrínyi Miklós National Defense University, University Press, 2004. 2. Prof. Dr. Róbert Szabolcsi: Modern automatic Flight Control Systems (in Hungarian), Zrínyi Miklós National Defense University, ISBN 978-963-7060-32-8, University Press, p 415, 2011. 3. Prof. Dr. Róbert Szabolcsi: Computer Aided Design of Modern Control Systems (in Hungarian), Zrínyi Miklós National Defense University, ISBN 978-615-5057-26-7, p415, 2011. 4. Nelson, R. C. Flight Stability and Automatic Control, McGraw-Hill, Inc. 1989. 5. McLean, D. Automatic Flight Control Systems, Prentice-Hall, International Ltd., 1990. 6. Blakelock, J. H. Automatic Control of Aircraft and Missiles, John Wiley & Sons, Inc., 1991. 7. Dorf, R.C. – Bishop, R.H. Modern Control Systems, Prentice-Hall International Inc., 2011. 8. Prof. Dr. Szabolcsi Róbert: Légi robotok automatikus repülésszabályozása. Óbudai Egyetem, ISBN 978-615-5460-23-4, p478, 2016. 9. Lecture notes of the students.
Quality Assurance: using feedback provided by the students for improving content and methods of teaching of the subject. This course is warmly welcoming emotionally-driven, pro-active, and self-motivated students eager to gain brand-new knowledges and skills in automatic flight control of the UAV, which is a rapidly growing and revolutionally developing area of the modern robotics.

15 December 2017, Budapest, Hungary.

Prof. Dr. Róbert SZABOLCSI
Course Leader