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

Subject name and Neptun-code:
Systems and Control Theory **(BMXRIE2MNE)** **Credit points of the Subject: 4**
Full time training. Spring Semester of the Academic year of 2017/2018.

Course available at: MSc in Mechatronics.

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

Requirements of the course: (Neptun Codes)	Applied Mathematics (NIMAM11NNE), Selected Chapters of Mechanics (BGBMV11MNE)

Lessons per week:	Theory: 2	Practice (in Auditorium):	Lab: 1	Consultation: available by request.

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

The Syllabus

Aim: to give an overview about control engineering of modern automatic control systems.

Topics: State space method of the multivariable dynamical systems. State space representations. Controllability and observability by R. Kálmán. Canonical forms of multivariable dynamical systems. Design of multivariable control systems using pole place method. Optimal control systems. Design of closed loop optimal control systems using LQR design method. Random multivariable control systems. Design of closed loop optimal control systems using LQG design method. Robust control systems. Modelling parameter uncertainties. Design of robust closed loop control systems using H_2 and H_∞ design methods. Nonlinear control systems. Nonlinearities of the control systems. Stability analysis of the nonlinear systems. Describing functions. Taylor-series. Popov criteria of the stability. Design of the nonlinear systems using Lyapunov-method. Sliding mode control systems. Solution of complex control problems using MATLAB.

Schedule and Requirements

Weeks	
1.	Registration week.
2.	Introduction to the subject. Syllabus overview. Requirements of the course. Short overview of the automatic control systems.
3.	Automatic control systems vs Modern control systems. Solution of modern control engineering problems using MATLAB.
4.	State space method of the multivariable dynamical systems. State space representations. Controllability and observability by R. Kálmán. Canonical forms of multivariable dynamical systems.
5.	Design of multivariable control systems using pole place method. Optimal control systems. Integral performance index used for performance evaluation.
6.	Design of closed loop optimal control systems using LQR design method. Random multivariable control systems. Solution of modern control engineering problems using MATLAB.
7.	1st Test.
8.	Robust control systems. Modelling parameter uncertainties. Random multivariable control systems. Design of closed loop optimal control systems using LQG design method.
9.	Design of robust closed loop control systems using H_2 and H_∞ design methods. Solution of modern control engineering problems using MATLAB.
10.	2nd Test.
11.	Nonlinear control systems. Nonlinearities of the control systems. Harmonic linearization using describing functions. Time domain linearization using Taylor-series expansions.
12.	Stability analysis of the nonlinear systems.
13.	Popov criteria of the stability. Design of the nonlinear systems using Lyapunov-method. Sliding mode control systems.
14.	3rd Test.
15.	Gaining signature and practice mark.

All main three areas of the course are evaluated by test papers. The course is successfully executed if and only if all the three test papers are evaluated with grade higher than Grade2 (‘Satisfactory’). If a single test is failed and Grade 1 (‘Unsatisfactory’) is provided for, and it is not improved, the signature must be denied. If any of the tests 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): Average of the grades provided for the test papers.

References

1. Burns, R. S. Advanced Control Engineering, Butterworth-Heinemann, Oxford-Auckland-Boston-Johannesburg-Melbourne-New Delhi, 2001.
2. Franklin, G. F. – Powell, J. D. – Emami-Naeini, A. Feedback Control of Dynamic Systems, Prentice-Hall, Pearson Education International, 2002.
3. Stefani, R. T. – Shahian, B. – Savant Jr., C. J. – Hostetter, G. H. Design of Feedback Control Systems, Oxford University Press, New York-Oxford, 2002.
4. Nise, N. S. Control Systems Engineering, John Wiley & Sons, Inc., 2004.
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., 12th Edition, 2014.
8. 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 modern control engineering, and systems' theory, which represent the rapidly growing and revolutionally developing area of the modern robotics; having very strong skills and knowledges in automatic control systems' theory.

Besides, or, instead of traditional lecture delivering and conducting labs, in case of students' choice, a project-based learning teaching method can be implemented.

15 December 2017, Budapest, Hungary.

Prof. Dr. Róbert SZABOLCSI
Course Leader