Advanced Electrical Engineering
(Control Systems Engineering)

Instructor: Sychev Dmitry, Ph.D.

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Course Description:

This course aims to teach students how to design control systems for electric drives. The course has been designed to seamlessly combine theory and practice and to provide hands-on, reality-based learning experiences. Students learn to use methods of mathematical modeling. They are involved in the development of electromechanical converters. One of the class requirements is that students should participate in international conferences. They can also take part in research projects supported by Russian companies. Research results are to be published in a Scopus-indexed international journal.

Course Prerequisites: None

Course Policies:

1. *Assessment:* Students will be assessed on the basis of tests, papers, lab work, projects, quizzes and class participation.
2. *Plagiarism:* Submitting plagiarized work is considered misconduct.
3. *Lecture participation:* Students are encouraged to participate in learning process and are responsible for all the assigned readings. It is recommended that students complete each reading and assignment prior to the corresponding class.
4. *Lab participation:* Students are required to participate in all labs. Attending less than 80% of the labs results in an automatic failure of the course.
5. *Cell phones:* Cell phones must be kept out of sight and the ringer turned off at all times.
6. *Changes:* All changes will be announced in class or posted online

Course Evaluation:
Exams – 60%
Labs – 20%
Assignments – 10%
Recitation – 10%

Course Grading Scale:
100 – 95.0% 5
75.0 – 94.9% 4

60.0 – 74.9% 3

Learning Objectives:

Upon the completion of this course, a student will:

a) know:
- fundamental elements of drive systems;
- the steady-state characteristics of electric drives;
- the elements and applications of close-loop drive systems;

b) be able to (SWBAT):
- design drive systems which are appropriate for specific applications;
- use high-performance computing for modeling and analysis;
- use appropriate technical terminology;

c) have a good command of:
- calculation methods of steady-state characteristics of drives;
- methods of mathematical modeling.

Scope and types of instructional activities, the contents of the discipline

The course is worth 4 ECTS or 144 hours which include 16 hours of lectures, 32 hours of the supervised laboratory practical classes, 16 hours of the supervised practical classes, 80 hours of self-study activities.

Contents of the discipline, the types of instructional activities and workload

Section number	Name of sections	Workload according to the type of instructional activity (hours)			
		total	L	WS	LC
1	Introduction. Basic electromagnetic principles. Electromechanical energy conversion.		2	2	-
2	Drive types and core technology. Drive converter circuit topologies		4	4	16
3	Interaction between drives and motors		2	4	-
4	Installation and maintenance of motors		4	-	-
5	Torque and speed control		4	6	16
Total		64	16	16	32

Contents of the sections, topics of the discipline

Section number	Name of sections	Contents of sections

1	Introduction	*History of electrical engineering*
1	Basic electromagnetic principles. Electromechanical energy conversion	*The alignment of magnetic force/flux lines, The interaction between a magnetic field and a current-carrying conductor*
2	Drive types and core technology.	*D.C. motors, A.C. induction motors, A.C. synchronous motors, Reluctance motors, Motors for special applications*
2	Drive converter circuit topologies	*A.C. to D.C. power conversion, D.C. to D.C. power conversion, A.C. to A.C. power converters with intermediate D.C. link, Direct A.C. to A.C. power converters*
3	Interaction between drives and motors	*Drive converter effects upon D.C. machines, Drive converter effects upon A.C. machines*
4	Installation and maintenance of motors	*Motors (Installation, Maintenance guide, Brush gear maintenance)*
5	Torque and speed control	*Open-loop control, Closed-loop control, Controllers in a drive*

Contents of the workshops

Number of WS	Section number	Title of the workshop	Workload (hours)
1	1	Left-Hand and Right-Hand Rules	2
2	2	Calculation of mechanical and electromechanical characteristics (D.C. motors, A.C. motors)	4
3	3	Loss Calculation of asynchronous motor	4
4	5	Bode plot of system gain and phase	6

Contents of the lab practical classes

Number LC	Section number	Title of the lab practice	Workload (hours)
1	2	Operational characteristics of asynchronous motor	4
2	2	Operational characteristics of D.C. motor	4
3	2	Operational characteristics of synchronous motor	8
4	5	Open-loop and close-loop systems in electric drives	8

5	5	Close-loop control systems	8