Ministry of Education and Science of Ukraine
National Aerospace University
"Kharkiv Aviation Institute"

Department of Mechatronics and Electrotechnics (305)

APPROVED BY
Project team leader

« 31 » __08__ 2020

COMPULSORY CURRICULUM WORK PROGRAM

ELECTRICAL ENGINEERING

Field of knowledge: 13"Mechanical Engineering"

Training direction: 134"Aviation and Space Technology"

Educational program:"Aircraft Engines and Power Plants"

Full-time Training

Education –Qualification Level: First (Bachelor)

Kharkiv 2020

Curriculum "Electrical Engineering":

is used for students **of training direction**: 134 "Aviation and Space Technology".

Educational programs: "Aircraft Engines and Power Plants"

"28" 08 2020 -- 10p

Course Convenor: Postnikov V. N., Associate Professor _____

Kosychenko O. N. Senior teacher _____

Protocol #1 of "28" 08 2020

Curriculum was examined on meeting of Mechatronics and Electrotechnics Department

Head of the Department d.t.s., Associate Professor _____ Sobchak A.P.

1. Course Description

<table>
<tr><td rowspan="2">Indicators

Credits points - 3</td><td rowspan="2">Fields of knowledge
Training direction
Education – qualification level</td><td>Characteristics of the discipline</td></tr>
<tr><td>Full-time study</td></tr>
<tr><td>Modules - 2</td><td rowspan="7">Field of knowledge
13 Mechanical Engineering

Training direction
134 Aviation and Space Technology

Specialization

Aircraft Engines and Power Plants

Education qualification:
first (bachelor)</td><td rowspan="2">General training cycle</td></tr>
<tr><td>Content modules - 2</td></tr>
<tr><td>Individual tasks

Full-time study- 90
Classes work /total hours - 40/90</td><td>Year of Training
2020/2021</td></tr>
<tr><td rowspan="2">Hours per week –
For full-time study
classes-2/3
independent work-3</td><td>Semester
3</td></tr>
<tr><td>Lectures - 16</td></tr>
<tr><td>Practical classes - 8</td></tr>
<tr><td>Laboratory classes - 16</td></tr>
<tr><td>Independent work -50</td></tr>
<tr><td>Test</td></tr>
<tr><td>Modular control
Pass</td></tr>
</table>

NOTE
Ratio number of classes to independent work hours are:

for full-time – 40/50.

The purpose and tasks of discipline

Learning Aims are

- to teach students the fundamentals of direct and alternating current electrical engineering and to equip them will the electrical skills and knowledge necessary for successful completion of the Aircraft Engineering course;
- to equip students with the knowledge and skills necessary to solve basic electrical problem likely to be encountered as an engineer in the aviation industry;
- to introduce the characteristics and applications of electrical components and devices used in DC and AC electrical engineering.

The Object of studied is electrical and magnetic circuits, electromechanics and electronic devices.

Subject of Studies. The subject of studies is fundamental laws and principles of electrical and magnetic circuits.

According to the requirements of the educational-professional program, students must achieve the following

general competencies:

-the knowledge and understanding of the subject area and general components of professional activity;

-to make informed decisions;

-to learn and to master modern knowledge.

Program learning outcomes:

- have the skills of self-study and autonomous work to improve professional skills and solve problems in a new or unfamiliar environment;

- formation of students' body of knowledge, skills and ideas of the basic principles of construction and use of direct current electric machines and elements of technical electronics, their use in practical activities in the specialty;

-ability to calculate the strength of elements of aerospace and rocket technology

2. Content the course

Content module 1

Analyses of Electrical and Magnetic Circuits

Theme 1. Fundamentals of Electrical Circuits.

Brief history of electrical engineering development. Subject of study and task of the discipline. Valuable advantages of electrical energy.

Elements of electric circuits. Analysis of direct current (DC) circuits. Electric circuit and its elements. Ohm's and Kirchhoff's laws. Work and power of electric current. Analysis of simple electric circuits.

Theme 2. **Complex circuit calculation.** Usage of Kirchhoff's laws in complex circuits calculation. Node-voltage method. Loop-current method. The

conversion of delta-connected resistances into an equivalent wye connection and vice versa. Superposition method. The nonlinear DC circuits and their analysis.

Theme 3. **Alternating Current Circuits.** The ordinary alternating current (AC) circuits. Generation of sinusoidal EMFs. Alternating current and its parameters. Vector diagrams. Complex representation of sinusoidal values of current, voltage, EMF. Circuit elements connected in series. Voltage resonance. Current resonance. Half power frequency, Bandwidth, Quality factor, Power factor. AC steady-state power. Three-phase electrical circuits.

Theme 4. **Magnetic circuits and their analysis.** Magnetic field and its displays. Magnetic flux density, magnetic flux, magnetic field intensity, magneto-motive force. The law of the total current. Magnetic properties of ferromagnetic materials. Permeability, hysteresis loop, residual induction, coercive force, reluctance, saturation point, eddy currents. Ohm's law for magnetic circuits. Electromechanical and inductive displays of magnetic field. Direct and reverse problems.

Coupled circuits. Self and mutual induction, emf, inductions. Solution of coupled circuits. Series and parallel connections of two coupled coils. Air transformers.

Transformer structure and principle of operation. General parameters and characteristics. Tests on transformers. Open-circuit and short-circuit tests.

Content module 2

AC and DC Electric Machines

Theme 1. **Asynchronous (induction) Machines.** Construction. The rotation field. EMFs of stator and rotor. The speed-torque characteristic of an induction motor. A slip-ring motor. Starting and speed control of induction motors. Losses and efficiency.

Theme 2. **Synchronous machines.** Construction. Synchronous generator. Armature reaction. Losses and efficiency of a generator. Parallel operation of generators. Synchronous motors and it’s characteristics.

Theme 3. **DC electric machines.** Function design of DC machines. Operation principle of DC machines. DC generator and motor and their characteristics. Armature reaction of DC machines. Starting and speed control DC motors. Losses and efficiency of DC machines.

3. Course Structure

Content modules and themes title	Number of hours				
	Total	Including			
		Lect.	Pract.	Lab.	Indep.
1	2	3	4	5	6
Module 1					
Content module 1 Analyses of DC and AC circuits					
Theme 1. Fundamentals of Electrical Circuits.	10	2	2	2	4
Theme 2. Complex circuit calculation	10	2	2	2	4
Theme 3. Alternating Current Circuits.	14	4	2	2	6
Theme 4. Magnetic circuits and their analysis.	6	2			4
Content module	4			2	2
Total for content module	44	10	6	8	20
Module 2					
Content module 2 AC and DC Electric machines					
Theme 1. Asynchronous (induction) Machines.	15	2	2	2	9
Theme 2. Synchronous machines.	11	2		2	7
Theme 3. DC electric machines.	16	2		2	12
Content module	4			2	2
Total for content module	46	6	2	8	30
Total	90	16	8	16	50

4. Practical classes

No	Theme's title	Number of hours
		Full-time education
1	Direct current circuit calculations	2
2	Alternating current circuit calculations	4
3	Analyses of magnetic circuits	1
4	Transformers	1
	Total	8

6. Laboratory Classes

No	Theme's title	Number of hours
		Full-time education
1.	Measurements in DC and AC circuits	2
2.	Investigation of single-phase sine current circuits with series connected R,L,C	2
3.	Investigation of single-phase sine current circuits with parallel connected R,L,C	2
	Module 1	2
4.	Investigation of the single phase transformer	2
5.	Investigation of the three-phase Induction motor	2
6.	Investigation of DC generator with shunt excitation	2
	Module 2	2
	Total	16

7. Self study

No	Theme's title	Number of hours
		Full-time education
1	Equivalent generator method	4
2	Voltage and current resonances	6
3	Mutual inductance circuit	4
4	Special transformers	6
	Module 1	2
5	Single phase induction motors	7
6	Special electric motors	9
7	DC machines	10
	Module 2	2
	Total	50

8. Individual Task

9. Teaching methods

Lectures, tutorials (laboratory, exercises, practical classes), individual and self-learning works.

10. Control methods

Current control test, final examination.

11.Assessment criteria and distribution of points that students will receive

11.1. Distribution of points that students will receive (quantitative assessment criteria)

Components of academic work	Points for one lesson (task)	Number of classes (tasks)	Total number of points
Current module 1			
Lecture work	0…1	4	0…4
Implementation and protection of laboratory (practical) works	0...5	4	0...20
Module work	0…18	1	18
Current module 2			
Lecture work	0…1	4	0…4
Implementation and protection of laboratory and practical works	0...5 0…2	4 4	0...20 0…8
Module work	0…22	1	0…22
Total			**0…100**

Final test (pass/exam) is held in case of refusal of points of current testing and in the presence of admission to the pass/exam. When passing the semester student may receive maximum 100 points.

Exam/pass ticket consists of 2 theoretical and 3 practical tasks. Maximum points for each task -20 points.

1. Complex circuit calculations. Node –Voltage method.
2. Voltage--resonance.
3. Load impedance 36+j48 are connected in delta, and the line voltage across the impedance equals 207.8 V. Calculate phase and line currents, power factor.
4. Basic parameters of magnetic field.
5. Open—circuit and short—circuit tests purposes?

11.2.Quality assessment criteria

Required volume of knowledge to obtain a positive assessment:

A student should know:

- methods of electrical and magnetic circuit calculation;
- design and operational principles of direct and alternating-current electrical devices and field of their application;

a student should be able:

- describe the structure, distribution, displacement and movement of electrical charges within materials used in electrical engineering, explain how electrical energy can be produced by: light, heat, friction, pressure, chemical action and magnetism and motion;
- define fundamental terms and units applied to in dc and ac electrical engineering, formulate associated rules and laws, perform the required calculations;
- describe the theory of magnetism, the properties of permanent and electromagnets and effects of magnetic fields.

11.3Assessment criteria of student's work in semester:

- **Satisfactory (60-74)** describe the structure, distribution, displacement and movement of electrical charges within materials used in electrical engineering, explain how electrical energy can be produced by: light, heat, friction, pressure, chemical action and magnetism and motion; most of the set work, however the report was unacceptable because it failed to compare experiment with Theory or was incomplete or illegible.

- **Good (75-89)** define fundamental terms and units applied to in dc and ac electrical engineering, formulate associated rules and laws, perform the required calculations; almost all of the set work was done and the report indicated that the student understood what was going on and carefully compared experiment and theory when requested, producing a complete and legible report.

- **Excellent (90-100)** describe the theory of DC , AC and magnetic circuits calculation; magnetism, the properties of permanent and electromagnets and effects of magnetic fields; the student showed real initiative, e.g. by making comparisons of experiment with theory which were not requested, by carefully investigating an unexpected result by making comments which indicate real insight, or by producing an exemplary report.

12. Grad/mark system: national and ECTS

Score achieved by student	Mark on National scale	
	for examination mark	for test mark
90 – 100	excellent	passed
75 – 89	good	
60 – 74	satisfactory	
0 – 59	Unsatisfactory	Failed

13. Methodological support

1. Basic Electrical Engineering / A.Ya. Zimovin, V.N. Postnikov, L.I. Volchanskaya. - Kharkiv: National Aerospace university “KhAI”, Part 1, 2008 – 106 p.
2. Basic Electrical Engineering / A.Ya. Zimovin, V.N. Postnikov, L.I. Volchanskaya. - Kharkiv: National Aerospace university “KhAI”, Part 2, 2011 – 116 p.
3. Aircraft Electrical Equipment, manual/ V.N. Postnikov, A.G. Kisly, O.N. Kosychenko, S.N. Firsov, K.F. Fomichev - Kharkiv: National Aerospace University , Part 1, 2018.-159 p.
4. Electrotechnics and Electronics, manual/ V. N. Postnikov, K.F. Fomichov, A. G. Kisly, O. N.Kosichenko. – Kharkiv: Nationak Aerospace University, 2019. -140p.

14. Recommended Reading

Basic literature

1. Kasatkin A. Basic Electrical Engineering. Moskow, Mir, 1976, 479 p.
2. А. М. Морозов. Электротехника, электроника и импульсная техника. - М.: Высшая школа, 1987, 448 с.
3. Jimmy J. Cathey, Syed A. Najar. Basic Electrical Engineering. Mc. Graw Hill, 1997, 335 p.
4. Giorgio Rizzoni. Principles and Applications of Electrical Engineering. Mc. Graw Hill, 2000, 976 p.
5. A textbook of Electrical Technology. / B.L. Theraja, A.K. Theraja, Volume 1. Basic Electrical Engineering, New Delhi, 2004. – 800 p.
6. Basic Electrical Engineering / U.A. Bakshi, V.U. Bakshi /. Technical Publication Pune, 2009, 628 p.

Additional literature

1. Popow V. S., Nicolayev S.A. Basic Electric and Electronics. Moskow, Mir, 1988, 622 p.
2. Irving Kosov. Electric Machinery and Transformers Pearson Education, Inc. New Delhi, 1991, 626 p.
3. Hand Book of Electrical Engineering. Rajlnder Kumar Dhawan, Delhi, 2004, 711 p.

15. Information Source

1. slideshare.net/OmkarRane15/lab.-manual-for-basic electrical and electronic engineering
2. studocu.com/en/document/benha-university/mechanical engineering/practical/bee-1|1