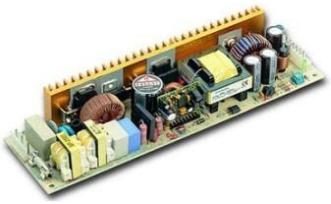
Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Radio Engineering Systems

[RE-63] POWER SUPPLY OF RADIOELECTRONIC EQUIPMENT





Work program of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	G - Engineering, manufacturing, and construction
Specialty	G5 - Electronics, electronic communications, instrument engineering, and radio engineering
Educational program	All
Discipline status	Elective (F-catalog)
Form of higher education	Full-time
Year of training, semester	Available for selection starting from the 2nd year, fall semester
Scope of the discipline	4 credits (Lectures 16 hours, Practical 0 hours, Lab 30 hours, Independent work 74 hours)
Semester	
Control/control measures	Credit
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian
Information about the course leader/teachers	Lecturer: V. O. Piddubnyi, Lab: V. O. Piddubnyi, Independent work: V. O. Piddubnyi
Course location	http://iot.kpi.ua/lms/course/view.php?id=37

Curriculum

1. Description of the course, its purpose, subject matter, and learning outcomes

The discipline "Power Supply of Radio-Electronic Equipment" belongs to the disciplines of professional practical training and is part of the disciplines related to the circuitry of radio-electronic equipment.

1.1. The purpose of the credit module is:

- to familiarize students with modern power supply sources for radio-electronic equipment (primary and secondary), their main characteristics, structure and design, operating principles, and main directions of development;
- apply the acquired skills to correctly select technical solutions for power sources and component bases during their development.
- Formation of an engineering-based approach to the design of power supplies for radio-electronic equipment.
- acquiring skills in objectively assessing the functional and parametric capabilities of power sources for radio-electronic equipment. component base.

1.2. The subject of the credit module is various power sources for modern radio-electronic equipment, which include both primary power sources (galvanic cells, batteries, AC mains, solar batteries, etc.) and secondary sources that provide REA with the voltages necessary for its operation (traditional and pulse sources).

1.3. Main objectives of the credit module.

In accordance with the requirements of the academic discipline program, after completing the credit module, students must demonstrate

knowledge of:

- the current state of power supply for radio-electronic equipment: characteristics and parameters of various types of power sources, their structure and principle of operation, main directions of their development and application;
- the basic principles of constructing structural diagrams of secondary power sources for radio-electronic equipment;
- the features of the design and circuit implementation of power sources, the component base used in DVEZ REA, and their application.

General competencies (GC):

- knowledge of the subject area and understanding of professional activity (GC 04);
- learning and mastering modern knowledge in any field of science and technology (GC 07);
- apply acquired knowledge to make the right choice of circuit solutions when developing power supplies for radio-electronic equipment and radio-technical systems (GC 02);
- think abstractly, analyze and synthesize REA DVEZ in the process of developing radio-electronic equipment (GC 01);
- identify, raise, and resolve issues that arise in the course of work (GC 08).

Professional competencies (PC):

- Solve standard tasks of professional activity based on information and bibliographic culture using information and communication technologies and taking into account the basic requirements of information security (PC 02);
- productively assimilate educational material, study scientific and technical information, domestic and foreign experience on the subject of investment (or other) projects for the development of telecommunications and radio engineering equipment (PC 14);
- competently and professionally perform calculations of simple electronic circuits when designing power supplies for information and telecommunications networks, telecommunications and radio engineering systems, in accordance with technical specifications using both standard and independently developed methods, techniques, and software tools for design automation (PC 15);
- accept and master new equipment necessary for researching power sources in accordance with current standards (PC 09);

- draw up regulatory documentation (instructions) for the operational and technical maintenance of power sources for telecommunications and radio engineering systems, as well as for test programs, draw up measurement reports and other technical documentation (PC 11).

Programmed learning outcomes (PLO):

- analyze, argue, and make decisions when solving specialized problems of designing secondary power sources for telecommunications and radio engineering systems, which are characterized by complexity and incomplete certainty of conditions (PLO 01);
- effectively adapt to changes in information and communication network technologies, telecommunications and radio engineering systems (PLO 05);
- apply the basic properties of the component base to ensure the quality and reliability of telecommunications and radio engineering systems and devices (PLO 13).

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2. Prerequisites and post-requisites of the discipline (place in the structural-logical scheme of training under the relevant educational program)

Interdisciplinary connections: the discipline is based on knowledge from the disciplines "Fundamentals of Metrology,"
"Introduction to the Specialty," and "Circuit Engineering. Part 1. Electronic Components" and forms the basis for the study of all subsequent specialized disciplines, together with which it creates the foundation for circuit engineering and design training in specialty 172 "Telecommunications and Radio Engineering." and is used as a basis for studying disciplines related to analog and digital circuitry and is used as a necessary component for studying all other disciplines in senior courses, because without knowledge of power sources and the element base used in them, it is impossible to design radio-electronic equipment in general.

3. Contents of the academic discipline

Section 1. General characteristics of radio-electronic equipment power sources.

Basic information about power sources. Division into primary and secondary power sources. The place of secondary power sources (SPS) for radio-electronic equipment in radio engineering. Definition of the concept of SPS. Main characteristics and parameters.

Section 2. Primary power sources.

Topic 2.1. Industrial network with a voltage of 380/220V and a frequency of 50Hz and on-board network – 115V; 400Hz or 27V DC. AC power stations. Long-distance transmission of electrical energy.

Topic 2.2. Direct current power sources (chemical sources, solar panels). Chemical current sources. Galvanic cells and batteries. Characteristics of galvanic cells (zinc, silver, mercury, and others). Accumulators. Types of accumulators. Charging batteries. Solar batteries.

Section 3. Linear (traditional) secondary power sources.

Topic 3.1. Classification of DPS. Structure of DPS and principles of construction. Linear (traditional). Pulse (with frequency conversion). Typical structural diagrams of DPS of various implementations. Main components of DPS. Comparative characteristics of linear and pulse DPS. Input and output parameters of power sources.

Topic 3.2. Rectifiers. Classification of rectifiers. Single-phase and double-phase single-phase power supply circuits. Voltage multiplier rectifiers. Basic relationships. Operation of

of rectifiers under different load conditions. Parameters of rectifying diodes.

Topic 3.3. Three-phase rectifiers. Classification of rectifiers. Rectifier circuits with center tap and bridge. Regulated rectifiers. Features of rectifier operation with rectangular input voltage.

Topic 3.4. Smoothing and filtering devices. Filter requirements. Main characteristics. Types of smoothing filters. Capacitive, combined, active. Main calculation formulas for filters based on passive elements.

Topic 3.5. Purpose of stabilizers. Linear voltage and current stabilizers. Parametric and compensation stabilizers. Reference voltage sources (Zener diodes). Schemes and principle of operation. Parameters. Three- and four-input industrial stabilizers. Microcircuits for voltage and current stabilization.

Section 4. Pulse secondary power supply sources.

Topic 4.1. Advantages and disadvantages of pulse sources. Generalized block diagram of a pulse source. Components. Types of pulse DVEZ (step-up, step-down, and inverting).

Top*ic 4.2.* Single-stage sources: forward and flyback.

Topic 4.3. Push-pull sources: two-phase (Push-Pull), bridge (Full-Bridge), half-bridge (Half-Bridge).

Section 5. Solar energy circuitry.

Topic 5.1. Solar cells. Volt-ampere characteristics of solar cells. Direct current to alternating current converters. Power inverters. Controllers.

Section 6. Uninterruptible power supplies.

Topic 6.1. Structure and principles of uninterruptible power supply sources. Main parameters and characteristics. Industrial uninterruptible power supply sources.

Topic 6.2. Elements for protecting power supplies from short circuits at the output and input voltage instability.

Section 7. Prospects for the development of UPS.

Topic 7.1. Trends in the development of power supplies. Ways to increase efficiency and improve mass and size characteristics.

4. Training materials and resources

Recommended reading

Basic

1. Power supply for radio-electronic equipment: Laboratory practical [Electronic resource]: textbook for students majoring i n 172 "Telecommunications and Radio Engineering" / Igor Sikorsky Kyiv Polytechnic Institute; compiled by: V.O. Piddubny, I.O. Tovkach, T.V. Romanenko – Electronic text data (1 file: 4.5 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 60 p. – Title from the screen. URL: https://ela.kpi.ua/handle/123456789/54659
2. Power supply for radio-electronic equipment: Home assignment [Electronic resource]: textbook for students majoring in 172 "Telecommunications and Radio Engineering" / Igor Sikorsky Kyiv Polytechni c Institute; compiled by: V.O. Piddubny – Electronic text data (1 file: 2.0 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 45 p. – Title from the screen. URL: https://ela.kpi.ua/handle/123456789/57347

Auxiliary

1. *Radio Engineering*: Encyclopedic Educational Reference Book / Edited by Yu.L. Mazor, Ye.A. Machusky, V.I. Pravda. – Kyiv: Vyshcha Shkola, 1999. – 838 p.
2. *Shpika, M. I.* Power converters for automated electric drives: lecture notes for specialty 141 – Electric Power Engineering, Electrical Engineering, and Electromechanics / M. I. Shpika, S. O. Zakurday, V. A. Gerasymenko. – Kharkiv: Kharkiv National University of Municipal Economy named after O. M. Beketov, 2019. – 82 p. http://eprints.kname.edu.ua/55278/1/2019%20%D0%BF%D0%B5%D1%87%2080%D0%9B%20

%D0%A1%D0%9F_2019.pdf
3. Portal: Power Electronics. http://www.dstu.dp.ua/Portal/Data/3/22/3-22-b3/part2/part2.html
4. Portal: Controllers and drivers. Electronic circuit components http://www.dstu.dp.ua/Portal/Data/3/22/3-22-b3/part1/part1.html
5. *Electrical* devices of radio-electronic means: monograph / E.O. Chemes, Yu.S. Yampolsky . – Odessa: Bakhva, 2014. – 563 p.
6. *Verbytskyi E.V.* Power supply systems for electronic equipment. Lecture notes for students majoring in 171 "Electronics," specialization 8(7).050802 "Electronic Systems." - Kyiv: NTUU "KPI," 2016. - 180 p. http://ela/kpi.ua/21710/Power_Supply_Systems.pdf
7. *Zinkovsky, Yu.F.* Computer circuit modeling of radio electronics components. Textbook, Vol. 2 / Yu.F. Zinkovsky, A.V. Koval – Kyiv, NTU, 2013 – 376 p.

Recommendations:

1. Students should use the lecture notes and methodological recommendations posted on Moodle (log in to the MicroTik website iot.kps.ua/lms, course "Power Supply of Radio Electronics Equipment" and the Sikorsky platform https://do.ipo.kpi.ua/course/view.php?id=6395), sent to the Telegram group "Power Supply of Radio-Electronic Equipment 2023" for students studying the discipline. If questions arise, students can find answers themselves in the above-mentioned literature, which can be found on the Internet, or consult a teacher.

Educational content

5. Methodology for mastering the academic discipline (educational component)

List of questions covered in lectures (18 hours)

No	Lecture topic and list of main questions
1	Introductory lecture. Course objectives, requirements, and assessment methods. Basic information about power sources. Division into primary and secondary power sources. The place of secondary power sources (SPS) in radio engineering. Definition of the concept of SPS. Principles of SPS construction. Main characteristics, input and output parameters of power sources.
2	Primary power sources. Industrial electrical network with a voltage of 380/220V and a frequency of 50Hz and on-board network – 115V; 400Hz. Alternating current power stations. Long-distance transmission of electrical energy. Constant voltage power sources (chemical sources, solar panels). Chemical current sources. Galvanic cells and batteries. Characteristics of galvanic cells (zinc, silver, mercury, and others). Accumulators. Types of accumulators. Charging accumulators.
3	Classification of DC power supplies and typical structures. Components of transformer and pulse DC power supplies. Linear (traditional) secondary power sources. Structure of DC power supplies and principles of construction. Linear (traditional). Pulse (with frequency conversion). Typical structural diagrams of DC power supplies of various implementations. Main components of DC power supplies. Comparative characteristics of linear and pulse DC power supplies. Input and output parameters of power supplies .
4	Rectifiers. Classification of single-phase and three-phase power rectifiers. Determination of ripple level, ripple coefficient, and average rectified voltage. Single-phase and full-wave single-phase power circuits. Rectifiers with voltage multiplication. Basic relationships. Parameters of rectifier diodes. Structure, characteristics. Series and parallel connection of diodes. Selection of a valve diode taking into account the maximum reverse voltage, maximum effective current, and average valve current. Operation of rectifiers under different load conditions. Three-phase rectifiers. Classification of rectifiers. Center-tapped and bridge rectifier circuits. Adjustable rectifiers. Features of rectifier operation with a rectangular input voltage waveform.

5	Smoothing and filtering devices (capacitive, combined, and active). Filter requirements. Main characteristics. Types of smoothing filters. Main calculation formulas for filters based on passive elements. Reduction of rectified voltage ripple using filters based on L and C elements. Active filters. Series and parallel active filters. Principle of operation and parameters. Linear voltage stabilizers. Purpose of stabilizers. Basic concepts. Principle of operation, circuits, and parameters. Parametric and compensation stabilizers. Reference voltage sources (Zener diodes). Schemes and principle of operation. Parameters. Industrial stabilizers. Microcircuits for voltage stabilization.
6	Pulse secondary power supplies. Inverters. Advantages and disadvantages of pulse sources. Classification of pulse power supplies. Power supplies with pulse width modulation. Generalized block diagram of a pulse source. Components. Types of pulse DVEZ (step-up, step-down, and inverting voltage converters). Calculation of chokes for energy storage. Single-stroke and push-pull inverters. Self-oscillating and externally excited.
7	Converter operating modes. Single-stage sources: forward and flyback. Two-stage sources: push-pull, full-bridge, half-bridge. Converter operating modes. Circuits with transformerless input. Controllers. PWM operating principle. Keys for inverters. Drivers for modern pulse DWEZ. Controllers with built-in power key. Formation of variable 220 V 50 Hz voltage.
8	Uninterruptible power supplies (UPS). Classification of UPS. Structure and principles of uninterruptible power supplies. Main parameters and characteristics. Industrial uninterruptible power supplies. Elements for protecting power supplies from short circuits at the output and input voltage instability. Input and output filters of switching power supplies to reduce external in-phase and non-in-phase interference.
9	Solar cells and panels (SP). Types, characteristics. Solar stations. Volt-ampere characteristics of solar cells. DC to AC converters. Power inverters, principles of operation. Controllers for them. Features of using and installing SP. Trends in the development of power supplies. Ways to improve the tactical and technical characteristics of DVEZ. Summing up the work for the semester. Publication of preliminary assessments in accordance with the tasks performed.

Laboratory classes (36 hours) are held for:

- deepening and consolidating theoretical knowledge;
- acquisition of experimental research skills;
- acquiring skills in working with measuring equipment;
- acquiring skills in assessing the reliability of the results obtained;
- acquiring document preparation skills.

The following laboratory work is performed:

No.	Name of laboratory work (computer workshop)	Number of aud. hours
1	Study of rectifier circuits	6

2	Research on smoothing filters	6
3	Research on voltage stabilizers	6
4	Research on frequency conversion power supplies	6
5	Research on the efficiency of solar panels	6
6	Research on thyristors and thyristor voltage regulators	6

In distance learning mode, laboratory work is carried out on a home personal computer using the Multisim (Trial) application package.

All classes are held according to the schedule provided by the dean's office. Remote laboratory work begins with an introductory class in Zoom and is then carried out by students independently. When working in the laboratory, classes are held on laboratory models in room 201-17.

Individual assignments (homework tests) are planned for the study of the discipline. The purpose of this individual assignment is:

- to master the curriculum in its entirety;
- acquiring skills in working with literature, preparing technical documentation in accordance with DSTU 30088-2015, preparing short abstracts for publication at scientific and technical conferences, performing calculations and evaluating their results;
- to deepen and expand on the material presented in lectures.

The topics of individual assignments (homework) are chosen by students independently and agreed upon with the instructor.

The deadlines for submitting assignments are specified on the Moodle platform MicroTik.

6. Independent work of the student

66 hours are allocated for independent work by students. It consists of:

- Studying lecture materials based on lecture notes – 16 hours;
- preparation for laboratory work, performing the necessary calculations and completing laboratory work reports, preparation for the defense of laboratory work – 18 hours;
- completing homework assignments – 20 hours;
- preparation for modular tests – 6 hours;
- preparation for the test and test – 6 hours;

Policy and control

7. Policy of the academic discipline (educational component)

Students have the opportunity to gain knowledge on specific topics and sections of the academic discipline through training courses on the Coursera platform (https://www.coursera.org), Prometheus (https://prometheus.org.ua), and others, as part of blended or supplementary learning in accordance with the Regulations on the Recognition of Learning Outcomes Acquired in Non-Formal/Informal Education at Igor Sikorsky Kyiv Polytechnic Institute (https://osvita.kpi.ua/node/179).

System of requirements that the teacher sets for the student:

- **rules for attending classes** – all classes are held in the classroom or remotely in accordance with the schedule provided by the dean's office. Control is exercised by the teacher during the class if it is held in the classroom, or based on the results of answers to assignments if it is remote;
- **rules of conduct in class** – it is necessary to follow the generally established rules of conduct in class;
- **The rules for protecting** laboratory work and individual assignments are specified in the section on the rating system for assessing learning outcomes. Incentive points are awarded for active participation in department seminars, while penalty points may be awarded for late submission of tests and laboratory work reports (not awarded during wartime).
- **deadlines for submitting materials** are set individually and communicated to students on Moodle and sent to the Telegram group. Students who have earned a rating of less than 30 points

during the semester may improve their rating before the start of the exam session within a timeframe agreed upon with the instructor and be admitted to the exam. The exam grade is automatically calculated as the sum of the grades for each assignment.

- **The academic integrity policy** is the responsibility of the students and is monitored by the instructor by comparing the content of individual assignments, lab reports, etc.

8. Types of control and rating system for assessing learning outcomes

Current control: completion of laboratory work (reports on LR1...LR5 – 5x5 points, 25 in total, credit LR6 – 25 points), two MCWs (15x2 points, 30 in total), home control work (20 points, 20 in total).

Calendar control: conducted twice per semester as monitoring of the current status of syllabus requirements fulfillment.

Semester assessment: credit

Conditions for admission to semester control: a minimum positive grade for individual assignments and completion of all laboratory work. The semester rating must be more than 30 points.

The rating for the RD discipline (i.e., the semester grade) is calculated as the sum of the current academic performance points and is calculated on a 100-point scale.

The student's rating for the discipline consists of points that he receives for:

1. Completion and defense of 6 laboratory works.
2. Completion of an individual assignment (essay).
3. Modular control. Two 30-minute MCWs are performed (in Moodle).

Items 1-3 constitute the sum of points for current academic performance and are the main component of the discipline, which can be improved by passing a test.

Rating point system and assessment criteria:

1. Laboratory work.

Points are awarded for each LR class:

- preparation of a report in accordance with the requirements and timely submission (within a week after completion of the work) – 5 points;
- defense of laboratory work in the last class (test in the Moodle system, login at iot.kpi.ua/lms, discipline "Power Supply of Radio-Electronic Equipment") – 25 points.

The maximum number of points for LR is 50 points.

1. The MCR modular control has 2 questions. Points are awarded for each question:

- complete answer – 15 points;
- sufficiently complete answer (with minor inaccuracies) – 12 points;
- answer does not fully cover the question, there are some errors – 10 points;
- no answer, incorrect answer – 0 points.

The maximum number of points for one MCW is 15 points. The total number of points for two MCWs is 30

points.

1. Individual (home) assignments are completed in the form of a report.

   It is assessed as follows:

- full disclosure of the topic, presence of well-founded conclusions, references to contemporary sources of information 20 points – "excellent";
- the topic is generally covered, conclusions are made, personal position is reflected – 17 points – "good";
- the topic is not fully covered, the essay is at a compilation level, references to outdated sources – 12 points – "satisfactory";
- the topic is not covered, no conclusions, references to outdated sources of information – "unsatisfactory." The work is not accepted.

The work must be submitted for review within the deadlines specified in Moodle. The maximum possible number of points for control measures (items 1-3) during the semester is: RD= 500+30+20 = 100 points.

Student assessment:

- at the first assessment (8th week), the student receives a "pass" if their current rating is at least 5 points;
- at the second assessment (14th week), students receive a "pass" if their current rating is at least 20.

The condition for admission to the exam is a score of at least 30 points.

- Students with an $R_{(C)\ of}$ less than 30 points are given the opportunity to improve their rating and pass the exam before the start of the exam session.
- Students who have scored 60-65 points take the exam or, if they wish, receive a passing grade.

Students who have scored more than 65 points receive a credit grade and have the right to improve their credit grade by completing individual assignments.

RD course grades are recorded in the grade book and transcript.

Table of correspondence between rating points and grades on the university scale

Number of points	Grade
100-95	Excellent
94	Very good
84	Good
74-65	Satisfactory
64-60	Sufficient
Less than 60	Unsatisfactory
Admission requirements not met	Not admitted

9. Additional information on the discipline (educational component)

Available on the distance learning resource: Moodle – iot.kpi.ua/lms, http://iot.kpi.ua/lms/course/view.php?id=37 and on the Sikorsky platform https://do.ipo.kpi.ua/course/view.php?id=6395

Description of material, technical, and informational support for the discipline

Laboratory work No. 1 "Investigation of rectifier circuits" (10 models)

Laboratory work No. 2 "Investigation of smoothing filters" (10 models)

Laboratory work No. 3 "Investigation of voltage stabilizers" (10 models)

Laboratory work No. 4 "Investigation of frequency conversion power supplies" (10

models) Laboratory work No. 5 "Investigation of the efficiency of solar panels" (1 stand)

The following devices are used for laboratory work (LR) at workplaces: Laboratory model

(LM1, LM2).

Oscilloscope (Osc).

Laboratory autotransformer (LATR). Voltmeter for measuring alternating voltage (V).

Polycrystalline solar panels with dimensions of 1640 mm in height and 990 mm in width and a power of 250 W (on the roof of building No. 17)

Laboratories, equipment, software, description of models for laboratory work and their quantity

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Work program for the academic discipline (syllabus):
Compiled by V. O. Piddubny;
Approved by the RTS department (protocol No. 06/2025 dated 06/24/2025)
Approved by the methodological commission of the faculty/research institute (protocol No. 06/2025 dated 25.06.2025)