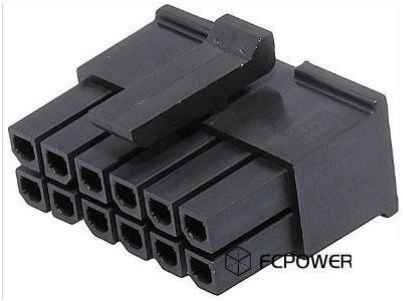
Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Applied Radio Electronics

[RE-41] POWER SUPPLIES AND POWER ELECTRONICS



Work program of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	17 - Electronics, Automation, and Electronic Communications
Specialization	172 - Electronic Communications and Radio Engineering
Educational program	All educational programs
Discipline status	Elective (F-catalog)
Form of higher education	Full-time
Year of training, semester	Available for selection starting from the 3rd year, fall semester
Scope of the discipline	4 credits (Lectures 18 hours, Practical classes 36 hours, Laboratory work 36 hours, Independent work 66 hours)
Semester Control/control measures	Credit
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian Information
about course coordinator/teachers	
Course location	

Curriculum

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

A power supply (PS) is an integral part of every radio-electronic device. They are used to power not only radio-electronic devices, but also power units in automated control systems. The set of circuit solutions for PS covers both the simplest options (parameter stabilizer) and modern ones using inverters, which allow you to generate signals of a given shape and frequency in a wide range of power.

Learning outcomes. Familiarization with the features of circuit solutions for modern power supplies.

Assessment of the impact of circuit solutions and component parameter values on the output parameters of power supplies. Analysis of signal conversion processes in power supply components (rectifier, smoothing filter, stabilizer). Methods of regulating load voltage and current. Means of protecting power supplies from overloads and high-frequency interference.

Ability to select the optimal circuit solution and types of radio components,
taking into account their operating limits (voltage, current, power). Implement a wide range of high-reliability, low-cost power supplies,
taking into account the design features of power electronics components. Also, the ability to identify weak points and diagnose possible defects in the most heavily loaded functional unit of a radio-electronic device.

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

Physics (electricity and magnetism, Ohm's and Kirchhoff's laws, Maxwell's equations), higher mathematics (fundamentals of differential and integral calculus, linear differential equations), fundamentals of radio electronics.

3. Contents of the discipline

Section 1. Linear power supplies

Topic 1.1. Introduction.

Basic information about power supplies. The concept of primary and secondary power supplies. Structural diagrams and principles of power supply design. Input and output parameters of power supplies.

Topic 1.2. Rectifiers.

Half-wave and full-wave single-phase power supply circuits. Rectifiers with voltage decoupling. Three-phase rectifiers. Valve selection. Transformer power rating. Efficiency of linear voltage sources. Voltage multiplier rectifiers. Lathour circuit. Basic relationships. Controlling the power of rectified voltage.

Topic 1.3. Filtering devices.

Ripple reduction using passive G-type and P-type filters. Active filters. Series and parallel active filters. Construction. Active filter parameters.

Topic 1.4. Linear voltage and current stabilizers. Schemes and parameters. Parametric stabilizers. Reference voltage sources. Transistor compensation stabilizers. Schemes, principles of operation. Stabilizing properties. Three-input and four-input industrial stabilizers

Section 2. Pulse power supplies

Topic 2.1. Pulse stabilizers.

Step-down and step-up voltage converters. Purpose and principles of operation. Calculation of chokes for energy storage. Pulse width modulation and pulse frequency modulation modulators. Relay stabilizers. Methods for reducing losses in the key transistor. Disadvantages of key stabilizers. Transistor voltage converters. Circuit solutions. Principle of operation.

Topic 2.2. Pulse power supplies.

Classification. Fundamentals of power supply design with pulse width modulation. Drivers of modern switching power supplies. Schemes for generating a control signal with pulse width modulation

Topic 2.3. Flyback switching power supplies.

Methods for increasing efficiency. Calculation of transformers. Selection of magnetic materials. Input filters for switching power supplies to reduce external in-phase and out-of-phase interference.

Topic 2.4. Power supplies with photovoltaic cells

Volt-ampere characteristics of solar cells. DC-to-AC converters. Inverters. Principle of operation. Main parameters. Key elements of inverters. Efficiency

Topic 2.5. Programmable power supplies and special-purpose power supplies.

Power supply protection elements against output short circuits and unstable input voltages.
Topic 2.6. Power supply devices for portable equipment. Galvanic cells and batteries. Characteristics of modern zinc, zinc oxide, and other galvanic cells. Galvanic cells with improved parameters.

4. Training materials and resources

Recommended basic

1. Brown, Marty. **Power supply cookbook / Marty Brown**.—2nd ed. p. cm. 288 p. ISBN 0-7506-7329-X

2. Zinkovsky, Yu.F., Koval, A.V. Computer circuit modeling of radio electronics components, textbook, T2, – K. NTU, 2013 – 376 p.

3. Irving M. Gottlieb Power Supplies, Switching Regulators, Inverters, and Converters. -544p. ISBN 5-901095-05-7

4. Severns R., Bloom G. Modern switch mode converter circuits. - 249 p. ISBN 0-442-21396-4

Supplementary

1. L:.H. Dixon, Deriving the Equivalent Electrical Circuit from the Magnetic Device Physical Properties, Unitrode/TI Magnetics Design Handbook, 2000, Topic R4, TI Literature No. SLUP132
2. Mammano R. "Switching Power Supply Topology Voltage Mode vs. Current Mode". App.Note, 1994 (SLUA119)

Educational content

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

Lectures

No No	Lecture topic and list of key questions (list of teaching aids, references to literature, and assignments for independent study)
1	Topic "Introduction" Basic information about power sources for electronic equipment and their role in the functioning of radio-electronic equipment. • The concepts of primary and secondary power sources. • Block diagrams of linear power supplies. • Principles of power supply design. Characteristics, input and output parameters of power supplies. References Brown, Marty. Power supply cookbook / Marty Brown.—2nd ed. p. cm. 288 p. ISBN 0-7506-7329-X

2	Topic: "Unstabilized power supplies. Rectifiers" Rectifier circuits. Half-wave and full-wave circuits of single-phase power supply when operating on active and complex (capacitive and inductive) loads. Basic relationships for single-cycle and double-cycle rectifiers. Rectifiers with power supply voltage decoupling. • Three-phase rectifiers as power electronics components. Determination of the ripple level, ripple coefficient, average rectified voltage, Selection of a valve taking into account the maximum reverse voltage and the maximum effective and average values of the valve current. • Calculation of the effective values of voltages and currents in the transformer windings. Overall power of the transformer. Efficiency of linear voltage sources. References Brown, Marty. Power supply cookbook / Marty Brown.—2nd ed. p. cm. 288 p. ISBN 0-7506-7329-X • Irving M. Gottlieb Power Supplies, Switching Regulators, Inverters, and Converters. -544p. ISBN 5-901095-05-7. Assignments for independent study • Review the material from the previous lecture
3	Topic: "Unstabilized power supplies. Rectifiers" • Symmetrical and asymmetrical rectifiers with voltage multiplication. • Lathour circuit. Conditions for symmetry of the circuit arms. • Features of calculating circuit parameters. Basic relationships. Control of rectified voltage power. References Brown, Marty. Power supply cookbook / Marty Brown.—2nd ed. p. cm. 288 p. ISBN 0-7506-7329-X Assignments for independent study • Review the material from the previous lecture
5	Topic: "Unstabilized power supplies. Filtering devices" .Features of application. Reduction of rectified voltage ripple using passive G-shaped and P-shaped filters on L, C elements. • Resonant filters. Active filters. Series and parallel active filters. Principle of operation. Parameters of active filters. Methods for improving filtering properties. References Brown, Marty. Power supply cookbook / Marty Brown.—2nd ed. p. cm. 288 p. ISBN 0-7506-7329-X Assignments for independent study • Review the material from the previous lecture
6	Topic: "Voltage and current stabilizers. Linear stabilizers" Linear voltage and current stabilizers. Basic concepts. Schemes and parameters. Parametric stabilizers. Transistor compensation stabilizers. Reference voltage sources. Schemes, operating principles. Methods for improving stabilizing properties. Three-input and four-input industrial stabilizers. References • Irving M. Gottlieb Power Supplies, Switching Regulators, Inverters, and Converters. -544p. ISBN 5-901095-05-7. Homework assignment: review the material from the previous lecture.
7	Topic: "Voltage and current stabilizers. Pulse stabilizers." Pulse stabilizers. Step-down and step-up voltage converters. Purpose and principles of operation. Calculation of chokes for energy storage. Pulse width modulation and pulse frequency modulation modulators. Literature Severns R., Bloom G. Modern switch mode converter circuits. - 249 p. ISBN 0-442-21396-4 Homework assignment: review the material from the previous lecture.
9	Relay stabilizers. Methods for reducing losses in the key transistor. Disadvantages of key stabilizers. Transistor voltage converters. Circuit solutions Principle of operation. Energy indicators Homework assignment: review the material from the previous lecture.

10	Pulse power supplies. Classification of pulse power supplies. Fundamentals of constructing power supplies with pulse width modulation. Development of pulse power supplies with pulse width modulation. Homework assignment: review the material from the previous lecture.
11	Drivers of modern pulse power supplies. Schemes for forming a control signal with pulse width modulation. Calculation of the circuit. Homework assignment: review the material from the previous lecture.
12	Reverse-running switching power supplies. Signal formation methods for increasing the efficiency of a switching power supply. Calculation of transformers. Selection of magnetic materials. Input filters for switching power supplies to reduce external in-phase and out-of-phase interference. Assignment for independent study: review the material from the previous lecture.
13	Solar power supplies. Volt-ampere characteristics of solar cells. DC-to-AC converters. Inverters. Principle of operation. Main parameters. Selection of converter frequency. Processes in key elements of inverters. Justification of transistor selection to increase efficiency. Independent study assignment: review the material from the previous lecture.
14	Programmable power supplies and special-purpose power supplies. Power supply protection elements against output short circuits and unstable input voltages. Portable equipment power supply devices Assignment for independent study: review the material from the previous lecture.

6. Independent work

Independent work by students is an integral part of successfully completing the course. It consists of studying literature on the topics of the discipline, preparing for the module test, preparing for laboratory work, and reviewing the results of laboratory work. One week is allocated for reviewing the results of laboratory work.

Policy and control

7. Policy of the academic discipline (educational component)

Attendance at both lectures and laboratory work is mandatory. In the case of distance learning, students must join the conference on time; tardiness of more than five minutes is not permitted. Laboratory work is performed by each student independently in accordance with the individual assignment. Before laboratory work, the instructor may check the level of competence of students in the topic of the laboratory work. During the conduct and defense of laboratory work, students are allowed to use any reference materials. The defense of laboratory work is conducted on an individual basis. One week is allocated for the completion and defense of laboratory work. Penalty points are imposed for failure to meet the deadlines for the defense of laboratory work: for each day beyond the deadline, the maximum number of points that a student can receive for laboratory work is reduced by one.

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

Current assessment: based on the results of students' laboratory work and Module Control Work (MCW).

Calendar control: carried out twice per semester as monitoring of the current status of syllabus requirements.

Semester assessment: credit

Conditions for admission to semester assessment: completion of all laboratory work. The RAS

provides for the following types of assessment and evaluation of learning outcomes:

Type of work:	Maximum number of points
MCW	20

test	20
Laboratory work No. 1, No. 2, No. 4.1 Laboratory work No. 4.2, No. 4.3	10 for each work 15 for each assignment

Table of correspondence between rating points and university scale grades

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)

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

Radio equipment design laboratory. Voltage and current measuring devices, oscilloscope. Laboratory work: "Investigation of the magnetization curve of a power transformer core and calculation of its efficiency"; "Investigation of a passive RC filter"; "Investigation of an active filter"; "Investigation of a parametric stabilizer"; "Investigation of a serial inverter"; "Investigation of a solar power supply"; "Investigation of a solar cell"; "Investigation of a solar panel"; "Investigation of a solar battery"; "Investigation of a solar inverter"; "Investigation of a solar power supply system"; "Investigation of a solar power generation system"; "Investigation of a solar power storage system"; "Investigation of a solar power distribution system"; "Investigation of a solar power transmission system"; "Investigation of a solar power generation system"; "Investigation of a solar power storage system"; "Investigation of a solar power distribution system"; "Investigation of a solar power transmission system"; "Investigation of a solar power generation system"; "Investigation of a solar power storage system"; "Investigation of a filter"; "Investigation of an active filter"; "Investigation of a parametric stabilizer"; "Investigation of a series inverter"; "Investigation of a solar battery power supply".

Work program for the academic discipline (syllabus):
Compiled by I. M. Kirpatenko;
Approved by the PRE Department (Minutes No. 06/2025 dated 24.06.2025)
Approved by the methodological commission of the faculty/research institute (protocol No. 06/2025 dated 26.06.2025)