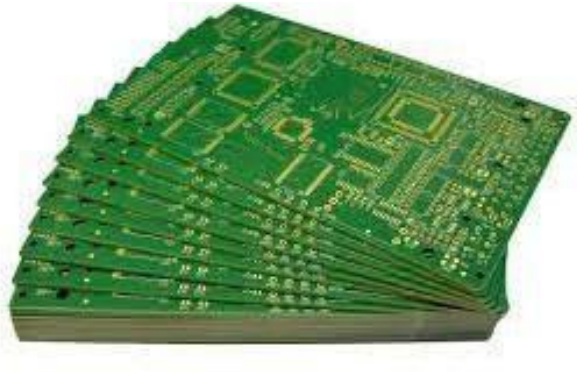
Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Applied Radio Electronics

# [RE-25] DESIGN OF PRINTED CIRCUIT BOARDS



## Course syllabus (Syllabus)

## Course details

| | |
|---|---|
| Level of higher education | First (bachelor's) |
| Field of knowledge | G Engineering, Manufacturing and Construction |
| Specialization | G5 Electronics, Electronic Communications, Instrument Engineering and Radio Engineering |
| Educational program | Intelligent technologies of radio electronics |
| Discipline status | Regulatory |
| Form of higher education | Full-time |
| Year of training, semester | 3rd year, spring semester |
| Scope of the discipline | 5 credits (Lectures 16 hours, Practical 60 hours, Laboratory hours, Independent work 74 hours) |
| Semester Control/control measures | Exam |
| Class schedule | https://schedule.kpi.ua |
| Language of instruction | Ukrainian Information |
| about course coordinator / teachers | Lecturer: Zinger Y. L., |

Course placement https://classroom.google.com/c/ODMwODE4MjY4NzM0?cjc=poijn7fk

# Curriculum

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

The course "Printed Circuit Board Design" is devoted to the study of the process of designing printed circuit boards (PCBs) based on the Altium Designer software product.

The discipline includes the following components:

- Printed circuit board development;
- Ordering a board from the manufacturer (uploading to the manufacturer's website);
- Creation of design documentation.
- Device enclosure development.

*At the student's request, the following components can be added during consultations:*

- *Assembly of a prototype device based on the developed board;*
- *Testing of the prototype;*
- *Refinement of the prototype.*

The aim of the discipline is to develop the following general competencies (GC) in students:

GC 1 Ability to think abstractly, analyze, and synthesize;
GC 2 Ability to apply knowledge in practical situations.
GC 4 Knowledge and understanding of the subject area and understanding of professional activity.
GC 7 Ability to communicate in the official language, both orally and in writing.
GC 8 Ability to identify, pose, and solve problems.

The discipline also develops the following professional competencies (PC):

- PC 1 Ability to understand the essence and significance of information in the development of a modern information society
- PC 5 Ability to use regulatory and legal documentation related to information and telecommunications networks, telecommunications and radio engineering systems (laws of Ukraine, technical regulations, international and national standards, recommendations of the International Telecommunication Union, etc.) to solve professional tasks.
- PC 11 Ability to draft regulatory documentation (instructions) for the operational and technical maintenance of information and telecommunications networks, telecommunications and radio engineering systems, as well as for testing programs.
- PC 14 Willingness to study scientific and technical information, domestic and foreign experience on the subject of investment (or other) projects in telecommunications and radio engineering.
- PC 17 Ability to participate in design and technological preparation, implementation in production, and support of radio-electronic equipment production
- PC 21 Ability to take a comprehensive approach to the development of radio-electronic equipment.
- PC 23 Ability to select and apply specialized software tools for simulation modeling and design of radio-electronic equipment
- PC 25 Ability to make informed choices of CAD systems for analysis, calculation, optimization of the output characteristics of mathematical and circuit models of analog and digital devices depending on the frequency range, taking into account external factors, ability to use Internet information resources to obtain mathematical and design models of radio components from manufacturers based on an assessment of the characteristics of information transmission in radio networks

Program learning outcomes:

- PLO 1 Analyze and make informed decisions when solving specialized tasks and practical problems in telecommunications and radio engineering, which are characterized by complexity and incomplete certainty of conditions;
- PLO 2 Apply the results of personal search and analysis of information to solve qualitative and quantitative problems of a similar nature in information and communication networks, telecommunications and radio engineering systems;
- PLO 6 Adapt to changes in information and communication networks, telecommunications, and radio engineering systems technologies.
- PLO 14 Application of understanding of the basic properties of the component base to ensure the quality and reliability of telecommunications, radio engineering systems and devices.
- PLO 15 Application of understanding of means of automation of design and technical operation of

telecommunications and radio engineering systems in professional activity

- PLO 21 Ensuring the reliable and high-quality operation of information and communication networks, telecommunications and radio engineering systems.
- PLO 26 Design and implement elements of intelligent technologies using software-configurable equipment
- PLO 29 Select the configuration, structure, main components, and elements of radio-electronic equipment depending on its purpose
- PLO 30 Apply a comprehensive approach to the design of telecommunications and radio-electronic equipment
- PLO 31 Apply the basics of designing radio-electronic equipment for intelligent systems and the latest component base and materials when designing radio-electronic equipment for intelligent systems

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

The discipline is based on knowledge gained from the discipline "Design of Intelligent Radio-Electronic System Components." It is the basis for studying the discipline "Design and Production Technologies of Intelligent Radio-Electronic Equipment."

## 3. Content of the discipline

Sections of the discipline

| ***Section*** | *Content* |
|---|---|
| ***1. Basic concepts and definitions*** | **1.** *History of the emergence of DP*<br>**2.** *DP, basic definitions*<br>**3.** *Types of DP*<br>**4.** *Elements of printed circuit board assembly*<br>**5.** *Sequence of DP design* |
| ***2. Materials for manufacturing printed circuit boards*** | **1.** *Base materials. Foil (manufacturing methods, thicknesses)*<br>**2.** *Basic materials. Prepreg (manufacturing methods, weaving methods, binding agent)*<br>**3.** *Basic materials. Laminate (designations, parameters)*<br>**4.** *Basic materials. Copper foil coated with resin*<br>**5.** *Base materials. Metal-based* |
| ***3. Printed circuit board manufacturing technologies*** | **1.** *PCB manufacturing technologies*<br>**2.** *Manufacturing single-sided PCBs. Dielectric base. Home technologies. Metal base.*<br>**3.** *Manufacturing double-sided PCBs. Combined negative. Combined positive. Tenting method.*<br>**4.** *Manufacturing of multilayer PCBs. Pair pressing. Open CM. Protruding leads. Through-hole metallization. Layer-by-layer build-up*<br>**5.** *Manufacturing of flexible PCBs*<br>**6.** *Manufacturing of flexible-rigid PCBs* |
| ***4. Technologies for manufacturing electronic modules*** | **1.** *Assembly depends on: ...*<br>**2.** *Lead assembly.*<br>**3.** *Soldering. Solder. Traditional and lead-free solder. Wave soldering. Double wave soldering. Selective soldering.*<br>**4.** *Surface mount technology (SMT). Installation of SMT components. Soldering* |
| ***5. Defects in the manufacture of DP*** | **1.** *Typical screen printing defects*<br>**2.** *Soldering defects. Solder balls. Lack of wetting. Lack of soldered connection. Bridges, voids. Damage to components and soldered connections.* |

| | |
|---|---|
| ***6. Features of PCB design*** | **1.** *Accuracy classes of DP*<br>**2.** *Design characteristics of DP. Body not specified. Body specified.*<br>**3.** *Calculation of printed pattern elements*<br>**4.** *Scribing. Reference marks.*<br>**5.** *Placement of elements. Algorithm.* |
| ***7. Design Design documentation*** | **1.** *General provisions*<br>**2.** *Schemes*<br>**3.** *List of elements.*<br>**4.** *DP drawing (detail drawing)*<br>**5.** *Printed assembly/EM drawing*<br>**6.** *Device drawing*<br>**7.** *Specifications for EM and device* |

### **4.** *Training materials and resources*


1. Vanin V.V., Bliook A.V., Gnitetskaya G.O. Design documentation preparation: Tutorial. 4th edition, revised and supplemented. – Kyiv: Karavela, 2012. – 200 p.
2. DSTU 3008:2015 Reports in the field of science and technology.
3. DSTU 3321:2003 Design documentation system. Terms and definitions of basic concepts.
4. DSTU 3974 2000 System for the development and delivery of products to production. Rules for performing experimental design work. General provisions.
5. DSTU 3973 2000 System for product development and delivery to production. Rules for performing research work. General provisions.
6. DSTU 2646-94. Printed circuit boards. Terms and definitions
7. Prepreg. Development of a stack of complex multilayer printed circuit boards. Features of stack formation taking into account conductor impedance control. Part 3 – Access mode: http://ictech.com.ua/ publication.html#prepreg
8. Printed circuit board materials – Access mode: http://surl.li/hubig
9. IPC-6011. Generic Performance Specification for Printed Boards
10. IPC-6012. Qualification and Performance Specification for Rigid Printed Boards
11. IPC-2221. Generic Standard on Printed Board Design
12. IPC-2152. Standard for Determining Current-Carrying Capacity In Printed Board Design
13. PCB Trace Width Calculator [Electronic resource] // PCBway – Access mode: https://www.pcbway.com/pcb_prototype/trace-width-calculator.html
14. PCBway [Electronic resource] – Access to the resource: https://www.pcbway.com/
15. JLCPCB [Electronic resource] – Access mode: https://jlcpcb.com/
16. Tutorial - A Complete Design Walkthrough with Altium Designer [Electronic resource] – Access mode: Tutorial - A Complete Design Walkthrough with Altium Designer | Altium Designer 22 User Manual | Documentation
17. Altium Academy [Electronic resource] – Access mode: https://www.youtube.com/@AltiumAcademy


## Educational content

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

At the beginning of the semester, each student receives a personal assignment in the form of a project, which they work on throughout the semester

### 6. *Independent work by students*

Throughout the semester, students must independently complete their project as part of their practical assignments. Each new assignment builds on the previous one.

## Policy and control

### 7. *Academic discipline (educational component) policy*

- For quick communication with students, a Telegram chat for the discipline created for part 1 of the discipline in the previous semester is used. All students in the group must be present in the chat.
- Attendance at practical classes and lectures is mandatory.
- All assignments must be submitted to the instructor for review by the specified deadlines. Late submissions will result in a deduction of 1 point for each assignment and the loss of the right to redo the work to improve the score.
- If the instructor has questions about the authorship of the work submitted by the student, the instructor has the right to conduct an additional defense of the work.
- Incentive points are awarded for student activity in practical classes.

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

During the semester, a student can earn up to 60 points.

If a student scores between 40 and 60 points, they are exempt from taking the exam, and their points are multiplied by a factor of 1.67.

To be admitted to the exam, a student must score 20 points during the

semester. A student can score up to 40 points on the exam.

What can students earn points for during the semester?
Calculation and graphical work - up to 10 points.
Module control work - up to 5 points.
Practical work — up to 3 points for each of the 15 assignments.

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 about the discipline (educational component)*

Computer classroom with 12 Intel Celeron G540 computers, 2.5 GHz, RAM: 4 GB, HDD: 500 GB Software: Altium Designer (license for educational institutions), Microsoft Office. Projector: Vivitek D551

Design laboratory
Siemens laboratory tables, breadboards, HoldPeak HP-36K multimeters,Siglent SDS1104X-E digital oscilloscopes, Siglent SDS1202CNL+ digital oscilloscopes (or equivalents), Siglent

SDG1062x signal generators (or equivalents), components (capacitors, resistors, microchips, etc.). Soldering stations, solder, flux.

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

Work program for the academic discipline (syllabus):

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**Compiled by** Y. L. Zinger;
**Approved by** the PRE Department (Minutes No. 06/2025 dated 06/25/2025)
**Approved by** the methodological commission of the faculty/research institute (protocol No. 06/2025 dated 26.06.2025)