**CURRICULUM**

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CS 208

# COMPUTER GRAPHICS

Adopted: Protocol No 7/30.01.2019

Lecturer: Associate Prof. Yanislav Zhelev, PhD

## ANNOTATION

Computer graphics (CG) is the science that studies the methods of digital synthesis and manipulation of visual content. It is a sub-field of computer science. CG also studies the mathematical apparatus for creating and processing digital images. CG tools develop computer applications (programs) for creating and processing graphic information.

Subject of training in the discipline are the main tasks of computer graphics related to the introduction, presentation and transformation of graphic primitives, curves, sections, surfaces and other two-dimensional and three-dimensional objects. The geometric shapes and methods of geometric transformation are consistently introduced. Basic models and algorithms for analysis of geometric shapes and objects are considered.

The discipline addresses the general principles: on the graphic systems, illustrating them with the totality of a limited number of graphic functions; to organise user interaction with a graphic program; to represent real-world objects and the connections between them in the graphic system; to create, edit and save raster and vector images.

As more general topics, the discipline covers: Basic techniques in computer graphics; Geometric modelling; Visualisation; Graphic systems.

## MAIN OBJECTIVES

The course aims to introduce students to KG by examining the methods of digital synthesis and manipulation of visual content, the mathematical apparatus for creating and processing digital images, and giving the principles and techniques for creating graphic applications.

Upon successful completion of the course in the discipline, students should know the basic principles and techniques in computer graphics, geometric modeling, visualisation methods, graphic transformations, as well as be able to design, analyse, develop and maintain graphic applications and systems.

## PREREQUISITES

Students should have knowledge about: Programming C++ or JavaScript.

## STATUS AND STRUCTURE

| specialty | status | ECTS | full-time training | | | | part-time training | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | C | t | total | L | C | t | total |
| Informatics and Computer Science | Mandatory | 6 | 20 | 40 | | 60 | 10 | 20 | | 30 |
| Software Engineering | Mandatory | 6 | 20 | 40 | | 60 | 10 | 20 | | 30 |

## COURSE CONTENT

1. Introduction to KG. Color patterns
    a. RGB
    b. CMYK.
    c. CIELAB.
    d. HSV.
    e. Conversion formulas
2. Discreet drawing of basic primitives – section, circle.
    a. It's rasters.
    b. Section – Bresenham's algorithm.
    c. Circle – Brezenham's algorithm.
3. Coordinates and coordinate transformations..
    a. Consumer, Model and Screen CP.
    b. Pyramid projection.
    c. A prismatic projection.
    d. Main interactive image transformations – Translation, Rotation, Scaleing/Zooming/.
    e. Derivative transformations: Axis stretching or shrinkage, Mirror transformation, tip or contour stretching
4. Construction of paintings directly on the visualisation surface. Elementary 2D transformations.
    a. Common matrix record of elementary two-dimensional transformation.
    b. Elementary two-dimensional transformations – Translation, Rotation, Scale, Central and Axial Symmetries
    c. Combined conversions.
5. Representation of different types of lines. It's a template. Stroke on the contour area.
    a. Algorithm for drawing a line according to a template.
    b. Contour area stroke algorithm.
6. 3D graphics. Coordinate space. It's a scene. Coordinate systems. An observer.
    a. User Space, Model Space, Observer Space
    b. Edge Presentation, Realistic Presentation.
7. 3D coordinate transformations. It's a translation. It's rotation.
    a. Matrix of Transformation
    b. Basic coordinate transformations in the 3D graph: Translation, Axis Rotation, Scale by Axis, Mirror relative to plane, Projection.
    c. Combined conversions.
8. 3D coordinate transformations. Scaling. Mirror.
    a. Elementary 3D transformations – Scale, Mirror Transformation.
    b. Combined transformations.

9. 3D coordinate transformations. Projections. Parallel and central projection.
    a. Projections
    b. Parallel projection
    c. Central projection.
10. Patterns of curved lines.
    a. Basic form of presentation of curves.
    b. Bezier's curves.
    c. B-sleep curves.
    d. NURBS curves.
11. Models of surfaces.
    a. A basic form of surface presentation.
    b. Surfaces of Bezzier.
    c. B-Spain Surfaces.
    d. NURBS surfaces.
12. Stereoscopic images.
    a. Technology.
    b. Methods of creation.

## SEMINAR EXERCISES

1. Color converter.
2. Drawing a section with Bresenham's algorithm.
3. Drawing a circle with Bresenham's algorithm.
4. Translating a drawn section with a specified vector.
5. Translating a drawn circle with a specified vector.
6. Rotate a drawn section with a set angle.
7. Scaling a section.
8. Implementation of Bresenham's algorithm for drawing a section, according to a specified drawing template.
9. Stroke of contour area with lines.
10. Cohen Sutherland's algorithm.
11. Loading a raster image.
12. Implementation of a three-dimensional cube.
13. Projections.
14. Stereoscopic images.

## COURSE ASSIGNMENT

Each student receives a course assignment that he develops at the end of the semester. The defense takes place in the last week of the semester.

## PLANNED LEARNING ACTIVITIES AND TRAINING METHODS

All sections of the course, whether theoretical or practical, are presented and/or taught to students in a computer laboratory. Students actively use the University's e-learning platform, where a variety of

resources are published to support, enrich, expand and facilitate the implementation of the training, such as: presentations of the sections described in the content, texts on the topics of the content, texts of lessons.

The training covers the following practical activities: a lesson, a practical assignment. The outputs of these activities are presented and/or discussed during the exercises. Each activity is accompanied by an instruction (what the student has to do, how to present a final decision/product of the activity, and when is the deadline for submission). During the discussion, the teacher provides assistance in the form of advice, recommendations and practical guidance.

The basis for the implementation of the training in this discipline are the recommendations and principles of blended learning constructive training in an interactive educational environment. The learning process is carried out on the basis of training with an active role of the learner, training through examples, training through practice, training through research and teamwork.

## ASSESSMENT METHODS

Each student's work during the semester is assessed with an ongoing assessment. It is the result of the development and protection of the course task. The final score is formed as a result of the current evaluation and the grade from the semester exam.

## RECOMMENDED LITERATURE


1. Marijn Haverbeke, Eloquent JavaScript
2. Lukipudis E., Computer Graphics and Geometric Modeling, Part I – in the Plain, Pazardzhik, 1996.
3. Rachev B., M. Stoeva, D. Ilieva. Computer graphics. Varna, 2006.
4. Hill F.S. Jr., Stephen M. Kelley, Computer Graphics Using OpenGL – third edition. Pearson Education, Inc. Upper saddle river, NJ 07458, USA, 2007.
5. Agoston Max K. Computer Graphics and Geometric Modeling – Implementation and Algorithms. Springer, USA, 2005.
6. Salomon David. Transformations and Projections in Computer Graphics. Springer, USA, 2006.
7. Gichev D. Computer graphics, textbook, BSU, Burgas, 2006