Introduction to Mechanical Engineering, Lecture 1

Introduction

Computer Aided Design (CAD)

Engineering Drawings

Innopolis University

Lecturers/Instructors

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Course Goal

To understand engineers:

their problems and

their terminology

*by doing **their** job*

*using **their** tools*

Course puprose and objectives

The development of any class of robots and the use of robots in industry requires the engineer to have knowledge and skills in:

- the ability to read engineering drawings,
- the analysis and synthesis of mechanisms,
- the dynamic calculation of mechanisms and machines,
- the calculation stress and strain,
- understanding the technological production processes,
- modern CAD and CAE systems.

Course outline and organization

1	ср	05.06.2024	Lecture 1 (Introduction; Engineering Drawings)
2	чт	06.06.2024	Lab 1 CAD_DET1 (Intro to subject; History of CAD; Solid modeling)
3	чт	13.06.2024	Lecture 2 (Intro to Theory of Mechanisms and Machines; Links, Joints (Kinematic pairs); Kinematic chains, Degrees of Freedom, Mobility)
4	чт	13.06.2024	Lab 2 CAD_DET2 (Workflow, Work in groups; CAD file formats; Threads)
5	пт	14.06.2024	Lecture 3 (Types of drives: kinematics, where to find other info; Drives: friction, belts, chains, gears, universal, geneva, ballscrew)
6	пт	14.06.2024	Lab 3 CAD_ASM1 (Bottom-Up approach; Basics)
7	чт	20.06.2024	Lecture 4 (Links, Joints, Connections; Shafts, Axles, Shaft couplings; Bearings)
8	чт	20.06.2024	Lab 4 CAD_ASM2 (Top - Down approach: WAVE; Assembly Load Options; GOST Naming convection; Common Parts Library; Sequence (Assembling animation))
9	пт	21.06.2024	Lecture 5_1 (Connections: Detachable (Threaded, Keyed, ...))
10	пт	21.06.2024	Lab 5 CAE_DYN1 (Introduction to CAE; Animation Designer; Mechatronics Concept Designer; Motion; Measure; Interference; Density; Assign Materials)
11	чт	27.06.2024	Lecture 5_2 (Permanent (Riveting, Welding, ...))
12	чт	27.06.2024	Lab 6 CAD_REN1 (Render)
13	пт	28.06.2024	Lecture 6 (Design Thinking and Manufacturing)
14	пт	28.06.2024	Lecture 7 (Basics of FDM Printing)
15	чт	04.07.2024	EXAM
16	чт	05.07.2024	COMPETITION
			Quiz
			Lab
			Exams

Grading criteria

What will be evaluated on the course

- Qz: Quizzes: 2 × 5 = 10%
- CP: Competition: 20%
- FE: Final Exam: 30%
- Lbs: Lab assignments: 10%
- HWs: Homework assignments: 30%
- Extra: Slide fixes in Github: 5%

Late policy: -100% of max grade for a task

Scale:

- A: 85 — 100%
- B: 70 — 84.99%
- C: 50 — 69.99%
- D: 0 — 49.99% or less than 50% by any criterion.

Quizzes

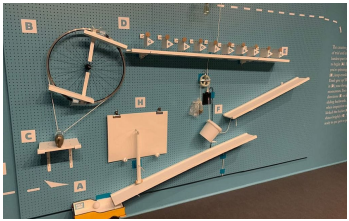
Purpose: You will have theoretical questions on final exam. Quizzes encourage you to study material more serious.

Competition (Previous year)

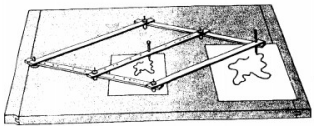
Bottle lifting mechanism

Competition: Let's vote

(a) **Throwing mechanism**
Create a stationary mechanism, which can throw the ball as far as can



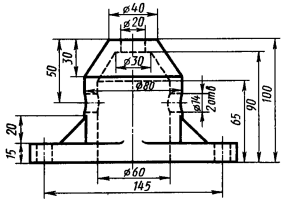
(b) **OverEngineering**
Make a mechanism for putting a teabag into the mug in most complex way



(c) **Image copier**
Create a mechanism for copying picture.

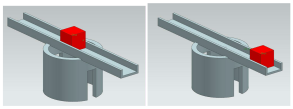
Final Exam (Previous Year)

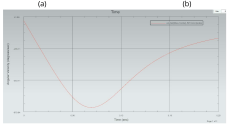
1. (10 score) Make a CAD model of the blueprint, which provided below.
2. (2 extra score) Make the same blueprints (without dimensions), based on your CAD model.
3. (3 extra score) Perform the stress analysis of the detail. All forces and fix supports are on the picture. Material — Steel. You have to show the stress and strain diagrams and explain what happens to the parts after such a load.



CAD part

The task is to determine the maximum angular velocity of the structure that will be reached and the point in time when this maximum will occur.





CAE part

«Mechanics And Machines»
Final Exam
Theory part
Variant: 4

1. What the key aspects should we consider during the motor chosing? The general guide-line of the motor selection.
2. Screw types. Multisided screws, prof and cons. Type of drills. Type of holes. How to distinguish them on a blueprints?

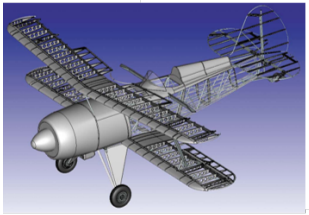
Theory part

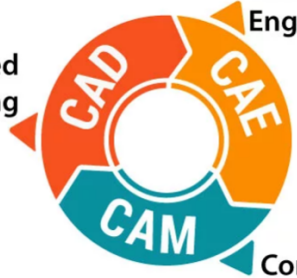
Lab Goals

To obtain the needed tools for solving the design part of the competition

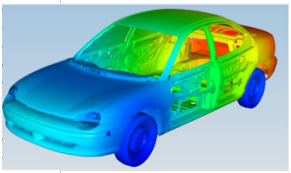
Computer Aided Design

Computer-Aided Drafting

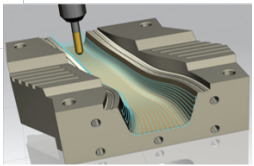




Computer-Aided Engineering

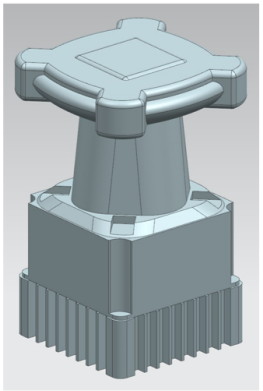


Computer-Aided Manufacturing



Computer Aided Design

Types of modeling



Solid Modeling

Surface Modeling

History of CAD

60th — Theoretical studies of the possibility of solving design problems on the computer were carried out.

70th — Methods, algorithms and programs for solving individual tasks for different design stages were developed.

80th — CAD is being developed and improved. 3D modeling became more popular.

90th — Developers had finished formation of base concepts of CAD and unified data transfer between systems.

CAD benefits

Cheaper

Safer

Faster

Popular CAD systems in Russia

CAD

Inventor

CAD/CAM/CAE/PDM

SolidWorks

CAD

Компас 3D

CAD/CAM/CAE/PDM

Siemens NX

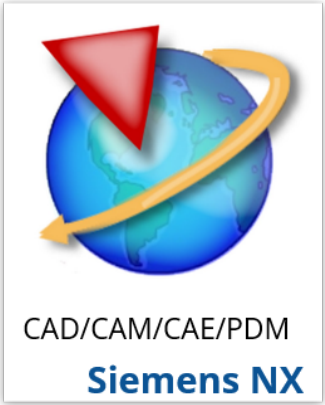
CAD

AutoCAD

Siemens NX

Prof

- All in one system (CAD,CAM,CAE,PDM)
- Free for students
- Can create a real aircraft in it



Cons

- Complex system
- Not popular in small companies

Common usage of other systems for our tasks

- If you need a good drawings. Make CAD anywhere, afterwards import to Kompas-3D.
- If you need Standard Component Library (SCL), use either Kompas, or Solid Edge, or mcmaster. Insert needed stuff in NX.

Common Labs Workflow

Lab 1

1. Oleg explains some new concepts.
2. Oleg provides HW, which should be done after the lab.
3. You start to watch prerecorded videos and make class tasks. You can do it at home.

Between lab 1 and lab 2

1. You should finish lab tasks and solve HW.
2. Submit only HW in Moodle.

Lab 2

1. Oleg explains some new concepts.
2. Oleg provides new HW, which should be done after the lab.
3. If you had self-study lectures — Oleg conducts quiz.
4. You defend previous lab task solutions and HW results.
5. You start to watch prerecorded videos and make class tasks. You can do it at home.

Engineering Drawings

Projections

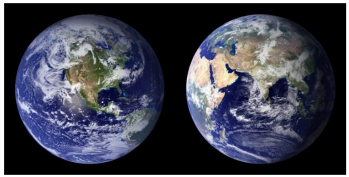
Video

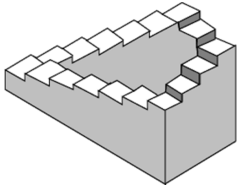
We work with 3D-objects which must be shown in a flat drawing. This is a problem.

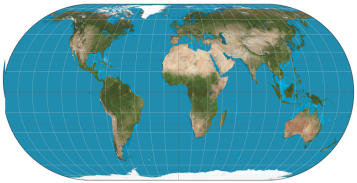
Projections

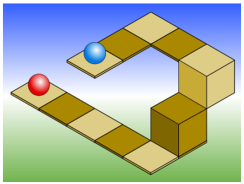
On the one hand, we cannot accurately show curved surfaces.

On the other hand, we can draw something absolutely impossible or something possible but unclear.



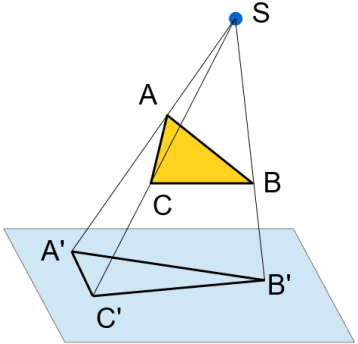






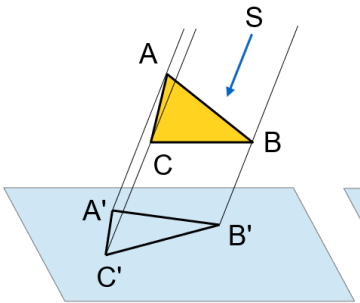
Parallel and perspective projections

Central (perspective) projection

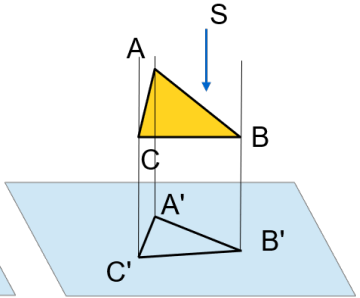


Parallel projections

General (oblique) case

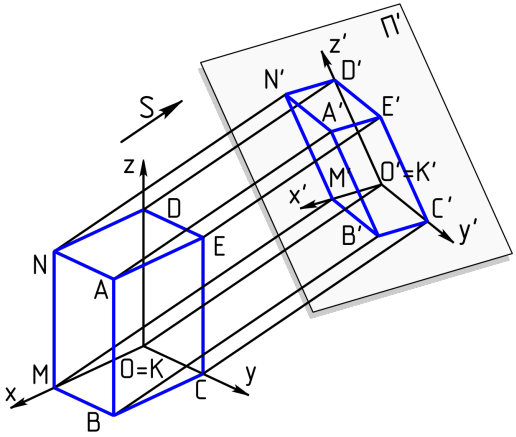


Orthografic projection

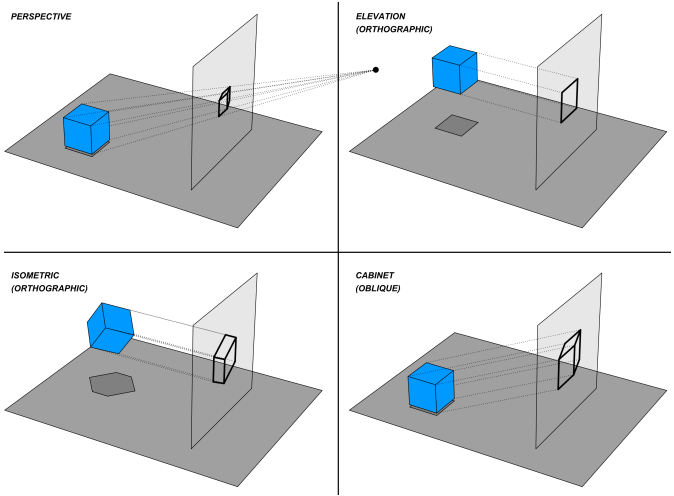


Axonometric projections

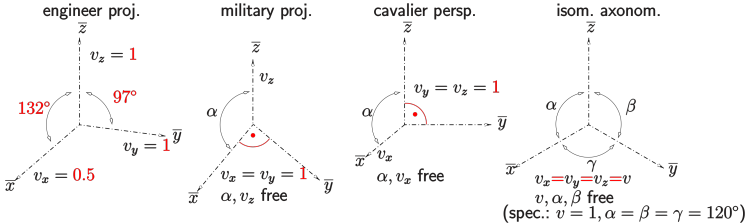
General

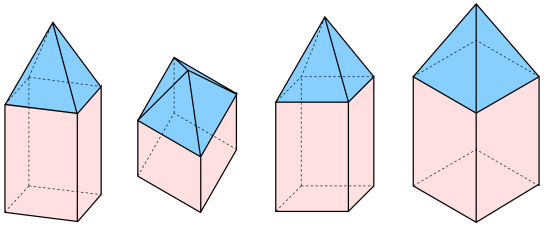


Axonometric projections



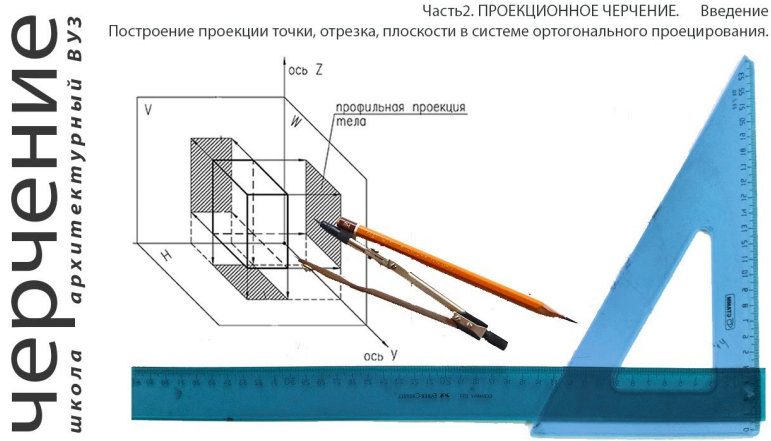
Axonometric projections



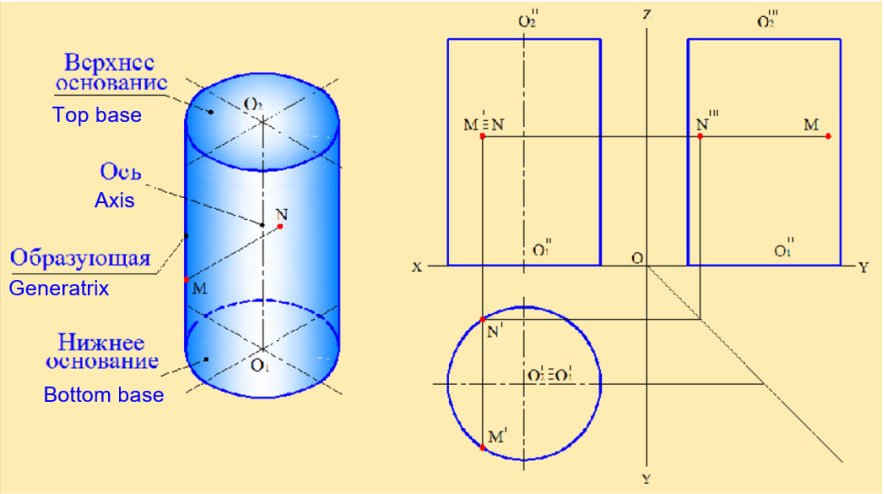


Make a line projection

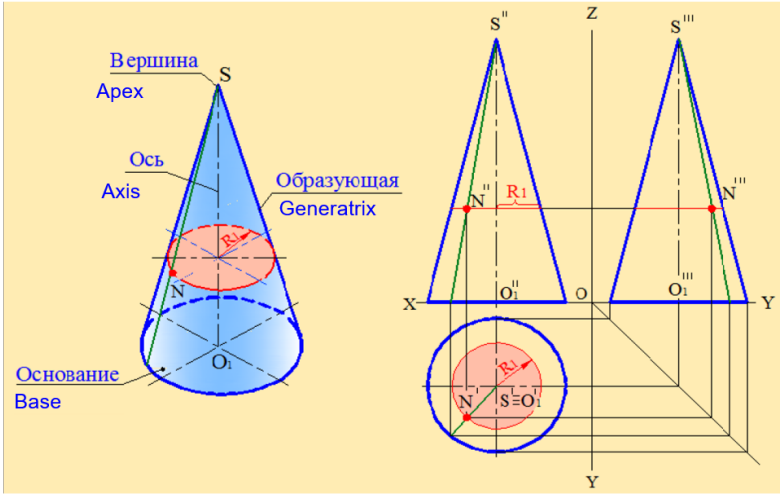
Video



Orthographic Multiview projections



Orthographic Multiview projections



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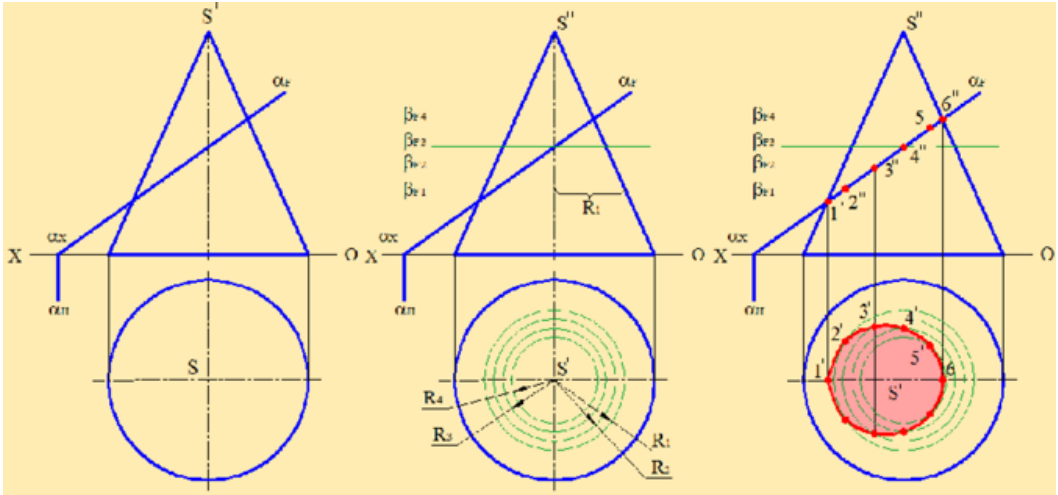
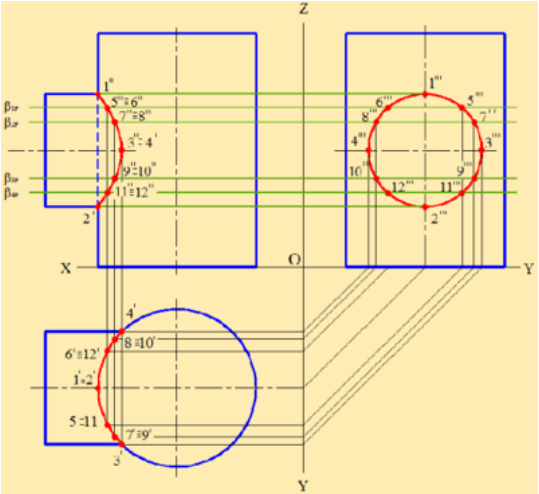
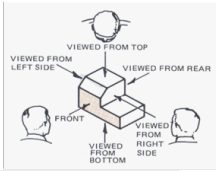


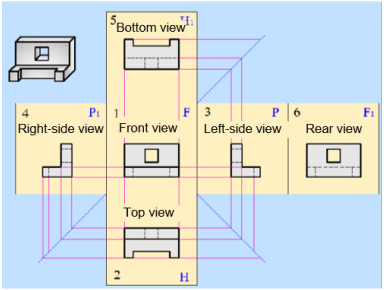
Orthographic Multiview projections

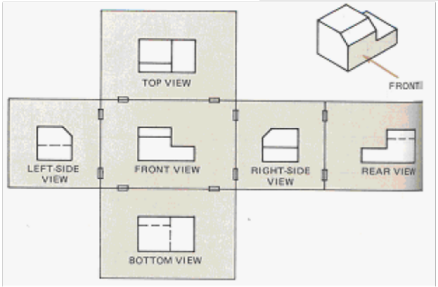


Orthographic Multiview projections

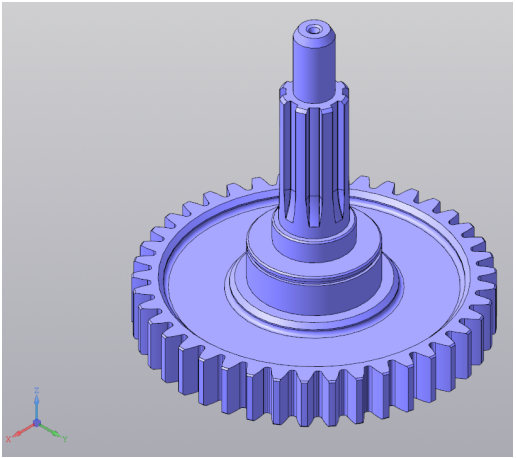
The difference between European and American standards



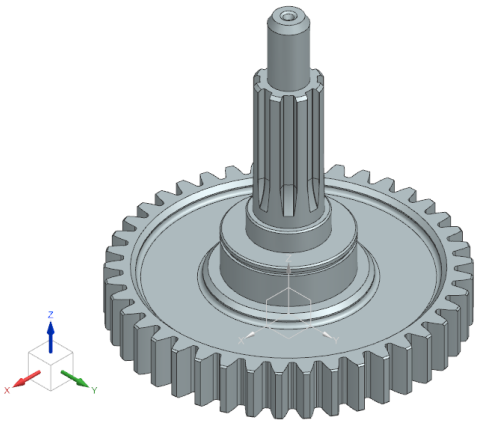




Orthographic Multiview projections

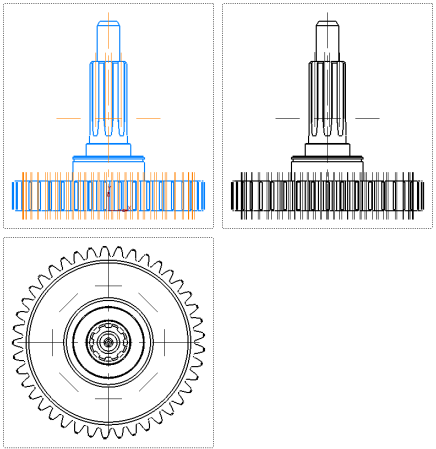


Kompas 3D

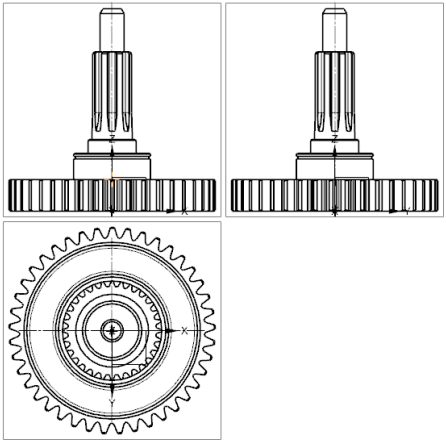


Siemens NX

Orthographic Multiview projections

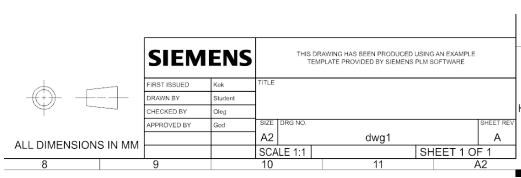


Kompas 3D (European system)



Siemens NX (American system)

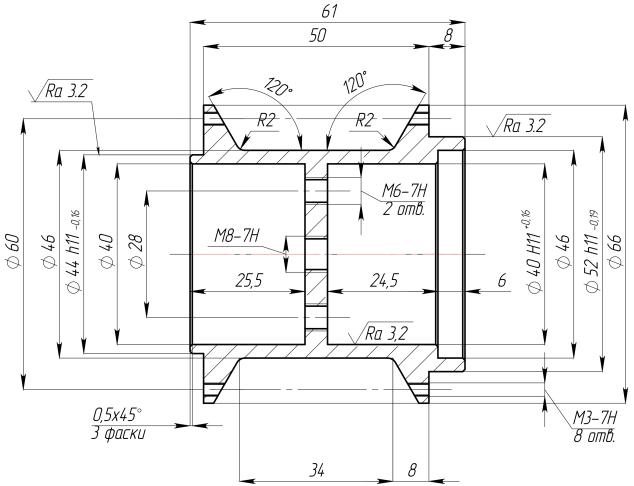
Drawing standards



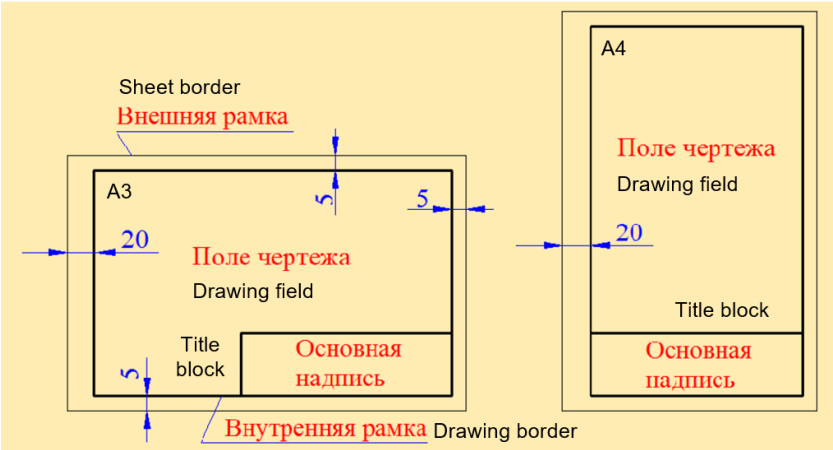
ANSI standard Title Block

GOST standard Title Block

GOST Drawing Example



GOST Drawings



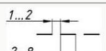
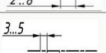
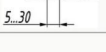
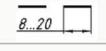
GOST Drawing Title Block

Scale

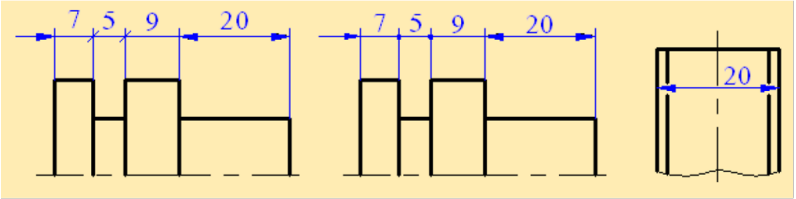
Drawings may be made actual size, or they may be made smaller or larger than the actual size of the object. A drawing that is twice the actual size of the part would show a scale of 2 = 1 or 2:1. A drawing made half the actual size of a part would be in a scale of 1/2 = 1 or simply 1:2.

Type of Scales	Scale Values
Enlargement Scale	50:1 25:1 10:1 5:1 2:1
Full Scale	1:1
Reduction Scale	1:2 1:3 1:5 1:10 1:100

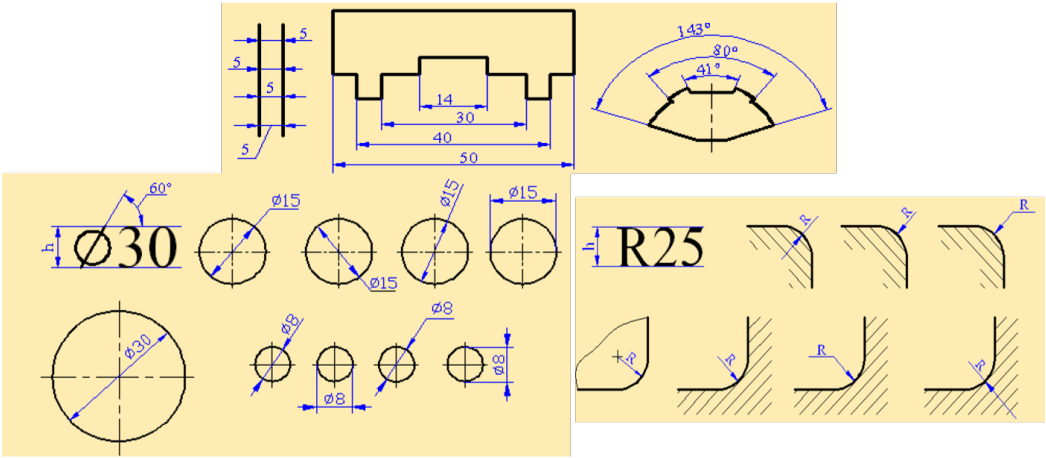
Type of lines

Наименование	Начертание	Толщина линии	Основное назначение
Сплошная толстая основная		**S**	Линии видимого контура
Сплошная тонкая		от **S/3** до **S/2**	Линии контура наложенного сечения, линии размерные и выносные, линии штриховки
Сплошная волнистая		от **S/3** до **S/2**	Линии обрыва, линии разграничения вида разреза
Штриховая		от **S/3** до **S/2**	Линии невидимого контура
Штрихпунктирная тонкая		от **S/3** до **S/2**	Линии осевые, центровые
Разомкнутая		от **S** до **1.5S**	Линии сечений
Сплошная тонкая с изломами		от **S/3** до **S/2**	Длинные линии обрыва

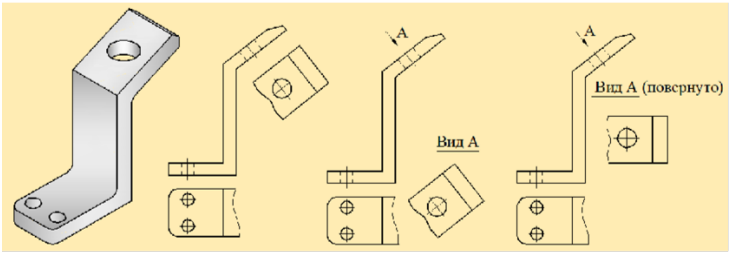
GOST Standard

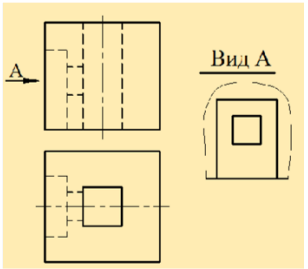


GOST Standard



GOST Standard





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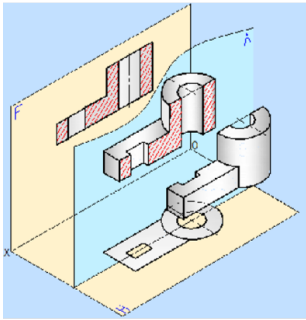

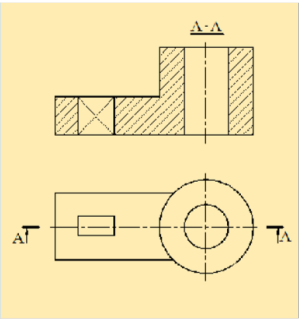

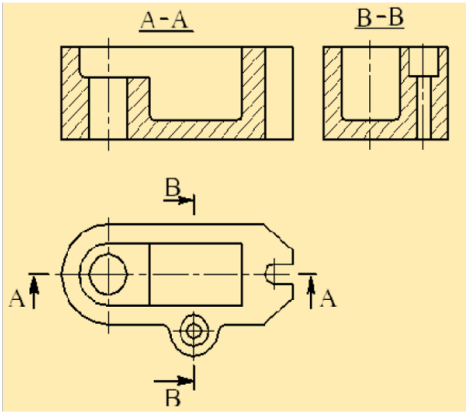

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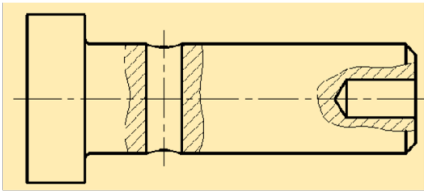

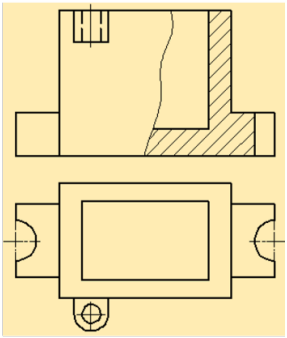

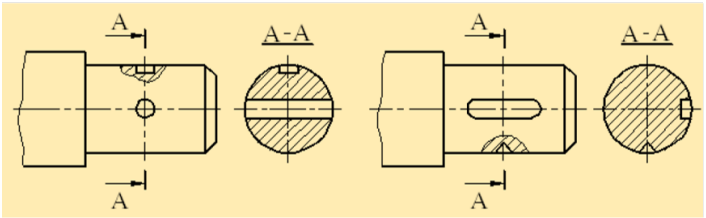

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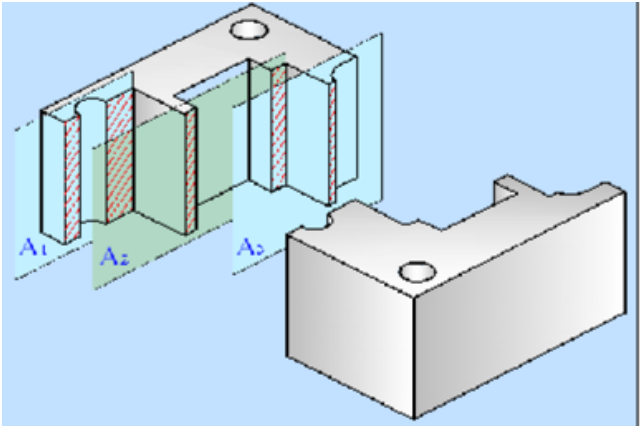

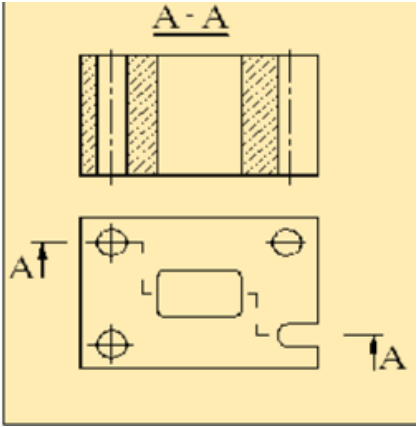

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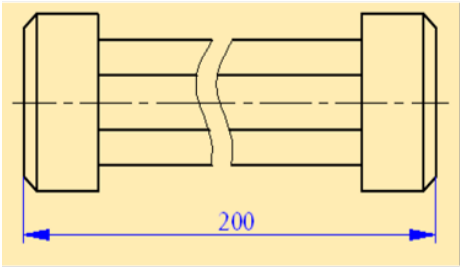

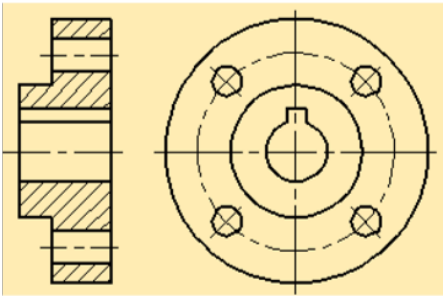

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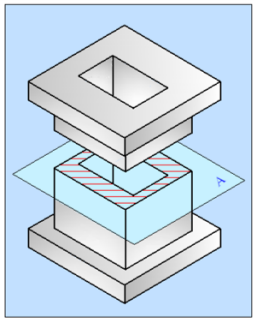
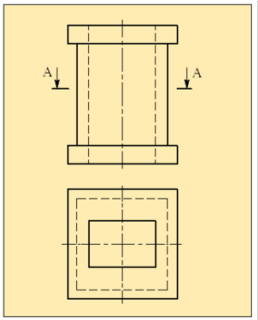
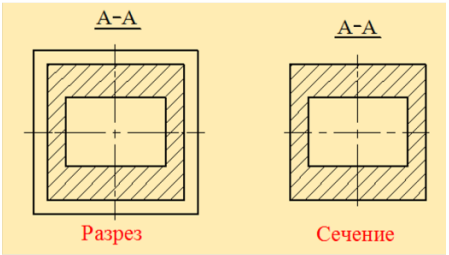
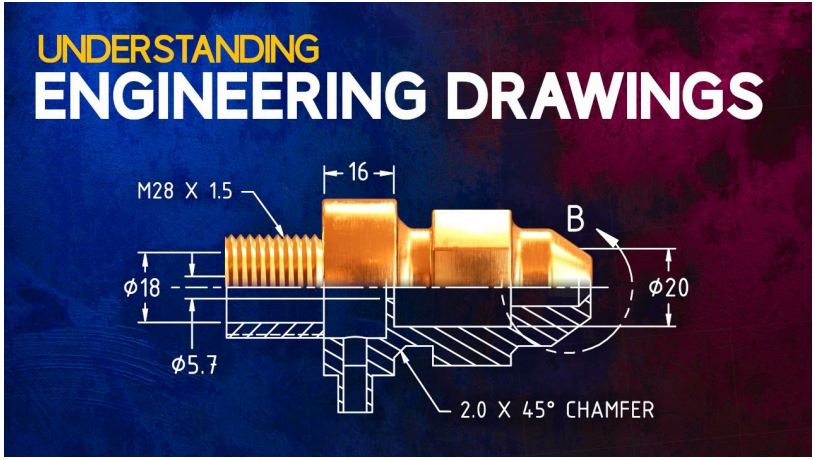






Understanding Engineering Drawings

Video



Reference Materials

1. Title Block
2. Методы проецирования (RUS)
3. Инженерная графика (RUS)

Deserve “A” grade!

– Oleg Bulichev

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Room 105 (Underground robotics lab)