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Методичні вказівки
англійською мовою
для курсового проектування і самостійної роботи студентів
з дисципліни
«Технологія обробки типових деталей та
складання машин»
для здобувачів вищої освіти з числа іноземних громадян
освітнього рівня бакалавр за спеціальністю
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INTRODUCTION

The course project on the technology of processing typical parts and assembling machines is performed by students after listening to courses in technological disciplines, laboratory work and technological practice. Course designing for the processing of typical parts and assembling machines is also based on the knowledge gained in the study of general-technical and a number of special disciplines.

During the performance of the course project students are given the opportunity to independently solve technological and design problems, learn to use reference and technical literature, standards and other materials, improve design skills, in addition, much attention is paid to the feasibility study of the design and technological decisions taken and the use of computers in solving tasks set.

The final stage of the course design is the project report, where the author must demonstrate the ability to briefly describe the essence of his work and adopted technical and economic decisions and, if necessary, to prove their correctness.

Due to the limited volume of the manual, the authors consider it advisable to highlight only the recommendations on the implementation of the sections of the course project, as well as those issues that are not sufficiently systematized set forth in the technical literature, and the work that is causing the greatest difficulty. To resolve the remaining issues, use the technical literature, the link to which is given in the manual.

1. Purpose, objectives and subject of the course project

The purpose of the course project (CP) from the technology of processing typical parts and assembling machines is to consolidate and deepen the knowledge gained during lectures, in training laboratories and during the passing of manufacturing practice, as well as the use of this knowledge in independent work to solve specific technological problems.

The main tasks of the technological course project are:

to teach students independently design a technological process of mechanical processing of a particular detail or assembly of a product with a given annual program with all necessary calculations;

to teach students to choose and design a workpiece for the given detail reasonably;

train students to design and calculate equipment (devices, cutting and measuring tools) for machining operations;

to teach students to use technical literature, catalogs, reference books, standards, norms when performing a specific technical task.

The theme of the course project is given to the students by the supervisor in due time. Topics of course projects should correspond to the curriculum and be related to the practical requirements of production. In addition, the subject of the CP can be related to the research work carried out at the department.

The classical theme of the course project is the design of a technological process of mechanical processing of a given part with a given program of release and technical specifications for the manufacture.

In addition, the task may contain, in addition to mandatory, additional sections for more detailed processing of individual issues.

2. Output data for the design, scope and structure of the project

The source data for the course project are:

working drawing of the parts (parts);

annual program of parts production;

technical specifications for manufacturing;

the basic technological process of manufacturing;

assembly drawings of technological equipment.

The course project consists of a settlement and explanatory note in the volume of 40-60 sheets of A4 text format with attachments and graphic part - 4-5 sheets of A1 format.

3. Typical content of the settlement and explanatory note

Title page

Design tasks.

Abstract.

Introduction.

1 General technical part.

1.1 Description of purpose and design of the details. Technical specifications analysis.

1.2 Technological control of the drawing of the part.

1.3 Analysis of the technological design of the details.

1.4 Analysis of the existing manufacturing process of the detail.

1.5 Conclusions and formulation of the problem of course designing.

2 Technological part.

2.1 Characteristics of the type and organizational form of production.

2.2 Feasibility study of the selection of the workpiece.

2.3 Selection of technological bases.

2.4 Choice of a mechanical machining path option.

2.5 Determination of allowances and interoperability sizes, design of the workpiece.

2.6 Development of route and operational process of processing details.

2.7. A comprehensive analysis of the technological process.

2.8. Selection of cutting and auxiliary tools, methods and means of technical control.

2.9. Calculation of cutting modes by operations.

2.10 The calculations required for the development of a setup and control program card.

2.11 Technical valuation of the developed technological process.

2.12 Choice of equipment and determination of its quantity. Building schedules for loading and used equipment.

3 Design part.

3.1 Description of purpose, structure and operation of machine tools and control devices. Justification for the feasibility of developing or upgrading devices.

3.2 Choosing the installation circuit for the device.

3.3 Calculation of the error of installing the part in the device.

3.4 Calculation of the clamping force and determination of the main parameters of the clamping mechanism.

3.5 Power calculations of the most loaded parts of devices (calculations for strength, rigidity, durability, etc.).

3.6 Calculations for accuracy.

General conclusions on the course project.

References.

Attachments

A set of technological documentation according to ГOCT 3.1404-86.
Specifications of general views of assembly drawings.

4. Contents of the graphic part

The graphic part of the course project, depending on the assignment, may include:

drawings of the object of technological development - the assembly unit, or parts, the working drawing of the parts is allowed to be placed in the settlement and explanatory note;

drawings of the workpiece;

assembly drawings of special machine tools and control devices;

schemes of technological adjustments.

The content of the graphic part of the course project is determined by the project manager and indicated in the form of the task.

5. Course project report and evaluation criteria

The course project report allowed students who provided the commission is a complete project, signed by the executor and the head. The protection of the course project takes place according to the established schedule before the commission, the composition of which is approved by the head of the department.

The Commission hear a brief (up to 10 minutes) student report. Approximate structure of the report:

1) task, brief description of the part, type of production;

2) procurement and selection of the method of its receipt;

3) the technological process of processing the part with a brief justification of the chosen methods of processing, methods of ensuring accuracy and the accepted sequence of operations;

4) a brief overview of the graphic part of the technological equipment and control devices.

The report should be accompanied by references to the graphical and explanatory note.

Upon completion of the report, the members of the commission ask the student questions related to both the protected project and the material of the course, related to the sections of the project.

After the report is over, a decision is made on the assessment of the implementation and protection of the project. The assessment is announced to the student and is entered in a credit book and a note signed by the chairman of the commission. When placing the evaluation, successful decisions, novelty, the level of application of the latest research in science and technology, the volume of independent development, independence in the design of technological equipment, the quality of work and the level of protection of the project are taken into account.

After the defense, the student must, in due course, pass the course project into an archive.

6. Recommendations on the implementation of individual parts of the course project

6.1. Cover page

The cover sheet is drawn up in form (Annex A).

The title page indicates:

full name of the university, department;

education level;

theme of the course project;

the cipher and the name of the direction of training, specialty;

the code of the academic group;

the surname and initials of the performer (performers);

the names and initials of the project manager.

The title page is included in the total number of notes and explanatory notes, but the page number is not set.

6.2. Objectives for a course project

The task for a course project must be executed according to the form (Appendix B). The front and back pages of a sheet are not numbered, but are included in the total number of sheets of the settlement and explanatory note.

For a comprehensive course project, each co-executor will complete an individual assignment.

6.3. Annotation

Abstract – a brief description of the content of the project and the results achieved. Annotation volume – up to 1 page. The abstract is made on a standard sheet of A4 format with the main inscription according to ГОСТ 2.104-2006 under the following scheme:

surname of the project executor;

the co-executor's name (in case the project is comprehensive);

data on the amount of settlement and explanatory note, the number of tables, formulas and illustrations in it, the number of sheets of applications;

number of sheets of the graphic part of the project;

the name of the project, the year of development;

annotation text.

An example of annotation is provided in Appendix B.

6.4. Content

The contents are given at the beginning of the billing and explanatory note and placed after the annotation. Make it on the header sheet, which has the main inscription according to ГOCT 2.104-2006, Form 2, and the following sheets with the main inscription according to ГOCT 2.104-2006, Form 2a.

The word "CONTENT" is written symmetrically in capital letters to the text. The contents include the introduction, the name of all sections, subdivisions, items (if they have a name), a conclusion, a list of sources used and the name of the application, indicating the pages from which these elements of the explanatory note begin.

6.5. Introduction

In the introduction, it is necessary to substantiate the relevance of the topic being developed, to present the current state of the issue, to outline the prospects and directions for the solution of the tasks. In the presence of theoretical or experimental research or original design development, it is necessary to specify the purpose of these works and their connection with the implementation of the main task of the course project.

The introduction should be short and clear. It should not contain general phrases and indents that are not directly related to the topic of the project. The word "INTRODUCTION" is written in capital letters symmetrically to the text. Volume of entry - up to 2 sheets of format A4.data B.

6.6. General technical part

6.6.1. Service purpose and characteristics of the production facility

In this part, based on the thorough study and analysis of the assembly drawing of the node, which includes the part for which the technological process is being developed, formulate its official purpose. From the description of designation and design, the parts determine the main surfaces and dimensions that have the greatest impact on the performance of the part of the service purpose. The analysis of details is carried out on all surfaces which are processed, with consideration of the accuracy of the sizes, which are obtained and the roughness of the surfaces, their relative position. When looking at the surface of the part, it is necessary to assign to each of them the lettering, for example: plane A, end face B. These same designations should be applied to the corresponding surfaces in the drawing. If it is necessary to make partial changes to the design of the part in order to improve its machinability, they should be substantiated in the explanatory note. In this case, perform the drawing of the parts in accordance with the requirements of the ESCR and taking into account the changes that were proposed by the student in the process of analysis of service parts.

In the same section are given details of the material details: chemical composition, mechanical and other properties, which are drawn in the form of separate tables.

In addition, it should also be concluded on the correctness of the choice of material for these conditions of work of the part in the product, the expediency of its replacement with other brands of material and what exactly.

6.6.2. Analysis of technical conditions

In the analysis of specifications, perform a check of the working drawing on:
the possibility of correct understanding of the shape of the part;
availability of all necessary sizes, tolerances, deviations from normative values, landings, qualities of accuracy, etc.;

presence of instructions on the roughness of all surfaces, material details, its hardness and heat treatment;

the availability of the necessary technical specifications for the manufacture and assembly, which determine the accuracy of the geometric shape of the surfaces, the accuracy of their relative position and special conditions.

The results of the analysis are the basis for the formulation of technological tasks, determination of the scheme of the base of the workpiece, the method of processing its surfaces.

The results of the analysis are made in the form of a table for example table. 6.1.

Table 6.1 - Analysis of technical conditions

Content of the technical condition or requirement	Methods of execution	Methods of control
Admission of the radial beating of the surface of the neck relative to the axes of surfaces A, B - 0,05 mm	Treatment of a crank shaft on a circular grinding machine	Checking at the control centers using the indicator

6.6.3. Analysis of the technological design of the parts

The development of the design for machinability is a continuous process, which solves the complex task, from the receipt of the workpiece and the processing of parts to test the machine.

In this section of the explanatory note, it is necessary to give an analysis of the technological detail and measures to increase it. The sequence and maintenance of the work are regulated by ГOCT 14.201-83, which establishes the rules for ensuring the technological design of the part. Methodical recommendations for the evaluation of

the technological design details are reflected in the literature recommended for the chapter: [1, 7, 9, 16, 18].

6.6.4. Analysis of the basic manufacturing process

The analysis of the existing (basic) version of the technological process is carried out in terms of providing the desired quality of the parts and processing performance. Conducting the analysis is the basis for making proposals for its improvement and modernization. For the convenience of analysis, the basic technological process should be made in the form of a table (Table 6.2), where from the basic technological documentation to reduce the most important elements of it, available for comparison. In the "Contents of the operation" column, it is expedient to display a simplified operational sketch with the workbench baseline.

Table 6.2 - The basic technological process of the part processing

№ and the name of the operation	Contents of the operation	Machine model

In the general case, the analysis of the basic version of the technological process should include the following main issues:

- the rationality method of obtaining the workpiece for this production;

- the conformity of the actual drawing with the drawing of the part with respect to the actual allowances for the processing and performance of the technical requirements;

- correct selection of bases, observance of the principle of unity of bases;

- the correctness of establishing the sequence of operations of the process to ensure the specified accuracy of the size of the part;

- compliance of the equipment parameters with the requirements of this operation;

- conformity of modes of cutting progressive;

- the degree of equipment operations;

- application of high-performance cutting;

- the level of mechanization and process automation;

- probable lack of treatment and causes of its occurrence.

It is not allowed to replace the analysis of the technological process by describing it or rewriting information from technological cards.

Recommended literature to the chapter: [5, 6, 8, 9, 14, 17, 28].

6.6.5. Conclusions and problem statement for course design

Conclusions and formulation of the problem for course design are formulated based on the results obtained earlier. Next, it is necessary to formulate the main tasks to be solved during the course project. The content of these tasks should correspond to the theme of the course project and a list of the main issues to be considered.

6.7. Technological part

6.7.1. Characteristics of the type and organizational form of production

The organization of production processes, the choice of the most rational methods of preparation, planning and control of production are largely determined by the type of production. Therefore, in the settlement and explanatory note it is necessary to give a brief description of the given type and organizational form of production, in particular to characterize the influence of the type of production on the choice of the nature of the technological process, selection of procurement, equipment, equipment and tools.

Recommended literature to the chapter: [5, 6, 7, 9, 15, 18].

6.7.2. Choice and justification of the method of obtaining the workpiece

The choice of the method of obtaining the workpiece is influenced by: material parts; its purpose and technical requirements for manufacturing; the dimensions and shape of the surfaces of the parts; volume of production of parts. When carrying out a course project, a brief analysis of the existing method of obtaining a workpiece is given. The analysis should reflect: the cost effectiveness of the method; technological process of obtaining a workpiece; its positive and negative sides; quality of workpiece; possible reasons for the occurrence of the lack and ways to eliminate it. Bring data on the cost of the method of obtaining the workpiece, its complexity, productivity, material content. Based on the analysis carried out, the study of advanced methods for obtaining similar products, as well as the literature data and the feasibility study, it is necessary to propose a method for obtaining the workpiece, which is the most rational for the given conditions.

In the development of the technological process, the method of obtaining the workpiece can be taken analogous to the existing, choose another option without changes in the technological process of machining or with significant changes in a number of operations of mechanical processing. In the first case, it is enough to restrict the reference to reference literature, where for these conditions it is recommended that this option is optimal. Since in this case the cost of the workpiece does not change, it is not taken into account in determining the technological cost of

the part. In the second case, preference is given to the procurement, which is characterized by a higher coefficient of use of the material and a lower cost.

In the two cases considered, it is possible to make a final decision on the type of workpiece and calculate its cost to determine the technological cost of the part and the choice of the variant of the process of its machining.

In the third case, the question of the appropriateness of choosing a particular type of work can only be solved after a feasibility study based on the calculation of the technological cost of the options that are compared.

On the basis of the feasibility study, the analysis of the cost and labor intensity of the acquisition, the study of the methods of obtaining the workpiece, it is necessary to propose not less than two methods for obtaining the workpiece and choose the optimal one.

Preference is given to the procurement, which provides less technological cost of the parts. If the options being compared are equal, preference will be given to the procurement with a higher coefficient of material use.

The literature recommended for the chapter: [1, 3, 5, 8, 9, 16].

6.7.3. Selection of technological bases

The selection of technological and measuring bases is one of the most complex and fundamental stages of the design process. From the correct choice of technological bases to a large extent depend on the actual accuracy of the dimensions, the correctness of the mutual arrangement of surfaces, the complexity of devices, cutting and measuring tools, the overall productivity of workpieces processing.

The starting data for the selection of bases is the working drawing of the parts, the technical conditions for its manufacture, the type of workpiece and the quality of its surfaces, the desired degree of automation.

When selecting bases, you need to be guided by the following considerations:

the base surfaces must have sufficient length to provide a stable position of the part during machining;

rough technological bases should be used only in the first operations for the purpose of obtaining clean bases;

it is necessary to adhere to the principles of unity and combination of bases.

The explanatory note should justify the choice of technological and measurement bases adopted during the development of the technological process and presented the schemes of basing and installation in accordance with GOST3.1107-81.

Recommendations for selecting bases, as well as examples of different formulation of tasks, baselines, which they are responsible for and options for implementation are given in [5, 9, 12, 15, 17, 18].

6.7.4. Choice of the variant of the mechanical machining path

The route of processing the workpiece parts is an enlarged workpiece processing plan that establishes the sequence of machining operations (machining), as well as the content and location of the treatment of thermal, electroplating, metallurgical and control operations.

The route must necessarily meet the given type of production and provide the necessary quality of the parts. Thus, the construction of the treatment route should be subject to one of the main principles - to ensure fulfillment of the detail of its official purpose.

The choice of a variant of the technological route for the treatment of individual surfaces is carried out on the basis of the requirements of the working drawing and the accepted workpiece. According to the parameters of accuracy and cleanliness of the surfaces of the part, and also taking into account its size, mass and configuration, choose one or several methods of final treatment and the type of equipment. For example, if the precision of the workpiece is low, then the surface treatment begins with the previous (rough) method. With precise preparation you can begin immediately clean, and in some cases, final processing.

The construction of the route is based on the fact that each sequential method should be more precise than the previous one. Technological tolerance to the intermediate size and surface quality according to the previous method should be within the limits allowing the normal use of the consistent method of treatment that is planned.

Choosing a treatment route is a challenging task with a large number of solution options. To do this, you should use the following guidelines. When determining the overall processing sequence, the surfaces first taken for the installation bases are first processed, and then the rest in sequence, reversed to the degree of their accuracy, that is, the more accurate the surface to be processed, the later it is to be processed. At the final stage, the most accurate surface is treated, which in turn has the greatest value for the part. In addition, the end of the route undergoes the treatment of surfaces that are easily damaged (for example, external grooves).

In order to timely identify the defect, first perform roughing and finishing of surfaces in which the presence of these defects is not allowed. In the case of their detection, the workpiece is missing or missing without further labor costs, or take measures, if any, to correct them.

In the manufacture of precise responsible machines, the route of processing is mainly divided into three consecutive stages: rough, clean and final.

At the first stage, they take off the bulk of the material in the form of allowances and deductions, the second has an intermediate value, and the latter provides the given precision and roughness of the surfaces of the part. In favor of such a distribution of the route indicated by such considerations. In the routing stage of the treatment there are relatively large errors caused by deformations of the

technological system from the forces of cutting and fastening of the workpiece, as well as its intense heating. In these conditions, alternating roughing and finishing does not provide the required precision. In addition, after roughing the largest deformations of the workpiece are observed as a result of the redistribution of residual stresses in it. In this plan, the implementation of the above steps contributes to increasing the gap in time between the draft and final processing and allows you to more fully identify the deformations before they are eliminated at the last stage. Final finishing at the end of the route reduces the risk of accidental damage to the finished surfaces during processing and transportation.

To some extent, the processing sequence depends on the size distribution system. In particular, in the first place, the surface to be treated, in relation to which a greater number of other parts of the surface are coordinated in the drawing.

Operations of auxiliary or secondary character (drilling of small holes, removal of chamfers, cutting of grooves, rubbing burrs) are performed at the stage of finishing with often changing sequence, because it does not affect the quality indicators and the economy of the process as a whole.

Conduct technical control after the stages of processing, where the likelihood of a shortage grows, before complicated and expensive operations, as well as at the end of the process.

The route of the technological process, after approval by its head of the course project, can serve as the basis for designing the operations of the technological process and registration of technological documentation. In the calculation and explanatory note it is necessary to give a succinct statement of the choice of methods of surface treatment of parts and the development of the route of the technological process of machining the part.

Route of processing are drawn in the form of table 6.3.

The route of machining should be divided into operations, operations - on transitions. Formulation of the content of transitions must comply with ГОСТ 3.1702-79. Locksmith's operations, washing, heat treatment, intermediate control must be written with text without sketches.

Each operation must be accompanied by a sketch of the workpiece shown in the position it will occupy in the working area of the machine tool. On each of the thumbnails show the scheme of basing and thickened lines (twice as wide as the main ones) - processed on this surface operation.

All constructive elements, formed on previous operations, show on the sketch of this operation the main lines.

Quantitative values of dimensions, surface roughness and other precision requirements do not need to be shown on the sketches of the underlying and processing schemes. For clarity, the treated surfaces can be numbered.

Table 6.3 - Route of machining the part

Number, title and contents of the operation	Sketch of processing with the scheme of the base	Type and model of equipment

6.7.5. Determination of allowances for the processing and size of the workpiece

In this chapter, it is necessary to calculate allowances for machining and interoperability sizes.

The starting data for the determination of interim allowances are:

route of machining parts;

the method of manufacturing the initial workpiece and indicators of its accuracy;

the number of steps (transitions) and methods of machining the surface.

For one-two surfaces, the assumptions are determined by the calculation-analytical method. The linear technological dimensions connecting the surfaces processed from different technological bases are calculated based on the method of using dimensional chains theory and data on the smallest admissions. The results of the calculation are drawn in the form of table 6.4.

Table 6.4 - Estimated tolerances for machining

Technological transition	Elements of allowance, MKM				$2Z_{min}$, MKM	δ , MKM	Limit size		Limit allowance	
	R_z	T	ρ	ε			l_{min}	l_{max}	Z_{min}	Z_{max}
1										
...										
n										

For the rest of the surfaces, the required allowance are determined by the tabular method using state and industry standards, departmental and factory normatives, and are drawn up in the form of Table 6.5.

Table 6.5 - Table values of allowances

Surface	Size, mm	Allowance, mm	Tolerance, mm	Size of the workpiece, mm

After determining the size of the workpiece, as well as the purpose of the casting or punching slopes, perform drawings of the workpiece, which are resulted in the graphic part or plated in the explanatory note.

6.7.6. Development of the technological process of manufacturing parts with the choice of equipment

When developing the technological process of manufacturing parts, one should strive to achieve the greatest technical and economic effect, high productivity and quality of products and low cost.

The technological process of processing is based on the projected workpiece and taking into account the type and organizational form of production. The surfaces to be treated are determined, then possible methods of processing for each surface are determined for each surface, which ensure fulfillment of the requirements for these surfaces. From these operations and the route of processing is drawn up.

The design of the manufacturing process involves the selection of methods for assembling and sequencing operations on the basis of analysis of output data, the development of assembly schemes, the development of operational technology and the rationing of assembly processes, the distribution of assembly works for each workplace in accordance with the rate of release, the definition of control tools and the mapping of control.

The methodology for the development of operations of the technological process is discussed in detail in [6, 15, 18].

During the developing the chosen version of the technological process, it is necessary to take into account the changes based on the list of measures for the improvement of the factory technological process and the choice of the route of treatment. The content of transitions of operations and thumbnails to them in the sequence of their execution is given. To make the technological process expedient in the form of table 6.6 in order to reduce the scope of the explanatory note. If the item is large, many surfaces, sizes, then you can apply a textual design.

The choice of machine tools for the technological process that is being designed is performed after each operation is pre-designed, that is, certain methods of surface treatment, the accuracy and surface roughness, the assumptions for machining, the type of production chosen, the calculations of the release timing or the batch of parts. When choosing equipment, it is necessary to consider the following:

- the selected machine tool must ensure the implementation of the technical requirements, which are advanced to the part;

- the size of the working zone of the machine should correspond to the overall dimensions of the machined parts;

- the productivity of the machine should correspond to the given program of release of parts;

- the power, stiffness and kinematic capabilities of the machine should allow machining at optimal cutting modes with the least time and with the least cost;

- the use of special, aggregate and other high-performance machines should be economically justified.

The choice of technological equipment is carried out depending on the type of processing, type of machine tool and type of production. For large-scale and mass

production, the use of high-performance special devices is characteristic. In the conditions of serial production it is necessary to choose universal devices: cartridges, machine grips, rotary tables, conductor devices, quick-adjusting devices. Selected devices for installing and fixing parts should contribute to increased productivity and accuracy of machining and improving working conditions. In single and small-scale production, the processing is widely used without devices or with devices of a universal type, which are usually accessories for machines (cartridges, grips, dividing heads, turntables, etc.). In serial production, universal and versatile-assembly devices are used. Applications and special devices cannot be excluded, but it requires a preliminary feasibility study. In large-scale and mass production, along with universal devices, special devices are widely used, which reduce the auxiliary time significantly more than universal, and provide higher accuracy of the installation. In order to increase productivity and reduce labor pressure, pneumatic and hydraulic actuators of the clamp should be used as widely as possible.

Table 6.6 - Technological process of machining the part

№ operation	The name of the operation, the content of the transition	The name and model of the machine	Equipment

The literature recommended for the chapter: [5, 9, 15, 18].

6.7.7. Selection of cutting and measuring tools

The choice of a cutting tool for a particular technological operation means the definition for each of the transitions of the type and size of the tool, as well as the material and geometric parameters of its cutting part.

When choosing the type and design of the cutting tool, the nature of production, the method of machining, the type of machine, the size, configuration and material of the workpiece, the required surface quality, and the accuracy of the machining should be taken into account.

Cutting tools use standard and special, which are advanced requirements for accuracy, stiffness, speed of change and adjustment to the size, stable removal of chips, reliability. The dimensional stability of the tool should ensure the complete processing of one or a batch of parts within the specified tolerance field. The most suitable is the use of a standard tool. A special tool is used only when it is not possible to process the part by standard. The auxiliary tool is used mainly in a prefabricated, which although has a lower stiffness compared to solid, but well suppresses the vibrations that arise during processing.

The choice of methods and means of technical control is based on providing the specified indicators of the control process and analysis of the costs of its

implementation in the prescribed time period for a given quality of products. Mandatory indicators are accuracy, reliability, complexity and cost of control.

The recommendations for choosing a cutting, auxiliary and measuring instrument are given in [5, 6, 8, 9, 10, 15]. The results are drawn in table 6.7.

Table 6.7 - Choice of cutting and measuring instrument

№ з/п	Operation name (transition)	Tool	
		Cutting	Measuring

6.7.8. Systematic analysis of the technological process

The objectives of the dimensional analysis of the technological process are:

definition of the technological sizes and sizes of the initial workpiece, which connect flat surfaces, flat surfaces with axes of apertures and the axis of openings with each other;

check the correctness of the construction of the route of machining and the correctness of the allocation of technological dimensions.

determination of maximum allowances for the treatment of flat surfaces.

Typically, tolerances and limit deviations on the size of parts are determined based on the calculation of assembly dimensional chains. This affects the sequence of processing individual surfaces, which can not always be performed in the processing of workpieces on well-adjusted machines, since the technological bases may not coincide with the design ones. There is a need to set the technological dimensions for performing individual operations and conversions based on the detection and calculation of dimensional chains. However, it may turn out that the selected processing sequence is unacceptable, since it is difficult to provide tolerances on the technological dimensions. In this case, it is necessary to review the sequence of workpiece surface processing.

Detailed recommendations for dimensional chains calculation and examples of implementation are given in [5, 9, 15].

6.7.9. Definition of processing regimes and technical standards of time

The initial data for determining the cutting modes are:

route of machining;

material of workpiece and indicators of its physical and mechanical properties;

the type of cutting tool;

the material of the cutting part of the tool and its geometric parameters;

the type and model of the machine tool.

Cutting modes are defined in the following order:

depth of cutting;

filing;

cutting speed;

spindle speed;

power of cutting;

the estimated length of the work of the tool;

the main time of execution of each work move.

Determination of cutting modes for 1-2 diverse operations are carried out by calculation and analytical method, and for others - tabular. When determining the cutting modes for tables, one should pay attention to the following:

the conditions for which recommendations are given in the tables do not always entirely correspond to the specific conditions of the processing, for the correct choice of cutting modes it is necessary to use the coefficients for the changed working conditions;

adjust the cutting modes of the equipment necessary both in the calculation and analytical, and in tabular methods.

In determining the modes of cutting should use not only reference, but also special literature, as well as appropriate software for the computer. Recommended literature to the chapter: [5, 11, 13, 17].

The results of calculating the cutting modes are drawn in the form of a tab. 6.8.

Table 6.8 - Cutting modes for operations

Transition operation name	t, mm	L, mm	i	$T_m, \text{min.}$	$S_p, \text{mm/rev.}$	$n, \text{min.}^{-1}$	$V, \text{mm/min.}$	$S_M, \text{mm/min.}$	$T_o, \text{min.}$	N, kW

Also, the project performs the normalization of all technological operations of mechanical processing or assembly. The explanatory note describes in detail the normalization procedure of one operation. The results of the calculation are drawn in the form of a tab 6.9.

Table 6.9 - Calculation of time standards for operations of the technological process

№ and the name of the operation n	T_o, min	$T_d, \text{min.}$			T_{on}, min	$T_{ob}, \text{min.}$		T_n, min	T_{um}, min	T_{n3}, min	n, pcs	T_{us}, min
		T_ϵ з	T κ	T_ϵ м		T_{me} x	T_{op} z					

When performing calculations should use the reference literature, as well as the recommendations set out in [5, 6, 8, 10, 17].

6.7.10. Determining the amount of equipment, plotting the loading and use of equipment

The preliminary selection of equipment is carried out when designating the surface treatment method, and the general rules of its choice are regulated by ГОСТ 14.404-73.

The final choice of equipment is carried out in accordance with the recommendations, taking into account the following factors:

- the type of processing for which the machine tool is assigned;
- the dimensions of the working zone of the machine, which determine the largest dimensions of the workpiece being processed;
- accuracy of machining provided by the machine;
- conformity of the machine to the performance of the given program of release of parts;
- conformity of the machine according to power;
- the ability to work on optimal cutting modes;
- the possibility of mechanization and automation of both the main and auxiliary processes of mechanical processing.

The required amount of equipment can be determined in two ways: according to the technological process and techno-economic indicators.

After determining the number of equipment, determine the load factor and equipment usage. According to the calculations performed, the corresponding graphs are constructed [5].

6.8. Design part

In the design part of the work, make a choice of design of machine tools, assembly or control devices.

The starting data for the choice of devices is the basic information from the developed technological process of manufacturing a given detail or assembly of the product.

The choice of the design of the device should be made taking into account the following requirements:

- ensuring the necessary accuracy of processing;
- achieve the necessary performance;
- ensuring convenience and safety of work;
- minimum cost and high cost-effectiveness of the device;
- maximum use of standard and normalized parts and units of the device.

Particular attention should be paid to ensuring the accuracy of the device, based on the required precision of the machining, which is determined by the

conditions of installing the part in the device, the accuracy of its basic and installation elements, the conditions of the clamping of the part and the rigidity of the machine system - the device - the tool - the part.

Then in the text of the settlement and explanatory note it is necessary to describe the structure and principle of the selected devices.

In the course project it is also desirable to choose the design of measuring devices for which to choose the methods and control schemes of the product parameters.

In the case where the component can not be manufactured using a standard cutting and auxiliary tool, the design part of the design of the design of the cutting, auxiliary and control tool is performed.

In addition, in order to increase the efficiency of the technological process, increase the level of product quality, the level of equipment use, improve individual indicators of the technological process and working conditions, in the design part, perform a selection of mechanization and automation tools.

The assembly drawings of the selected means of technological equipment, tools, means of mechanization and mechanization point in the graphic part of the work.

The literature recommended for the chapter: [1, 2, 4, 8, 10, 17].

6.9. General conclusions regarding the course project

In this section, the conclusions drawn from the results of the course project are presented.

It should be stated:

a brief description of the technical decisions and organizational and technical measures adopted in the project, which ensure the fulfillment of the task;

the benefits of the decisions taken, their technical, scientific, economic and social significance;

assessment of the completeness of the solution of the tasks;

recommendations on possible use of project results;

other information (in agreement with the project manager).

conclusions should be correlated with the task of the course project.

6.10. Technological documentation

To the settlement and explanatory note should be added a set of technological documentation, which includes:

title page;

route map - forms 1, 1a, 1b, 3, 3a, 3b, 5;

map of sketches - forms 6, 6a, 7, 7a, 8, 8a;

map of the technological process - forms 1, 1a;

operational card - forms 2, 2a, 3;

instrument setup card - forms 4, 4a.

General requirements for forms and their style are regulated by ГOCT 3.1404-86 (for machining) and ГOCT 3.1404-87 (for assembly).

An example of a complete set of technological documentation is provided in Appendix E and [8, 9, 15].

6.11. Specifications

The form and rules for filling the specifications of products of all industries are regulated by ГOCT 2.106-96.

Specifications are made on separate sheets for each product by the forms 1 and 1a. The specification shall include the component parts of the product, as well as the design documents relating to this product and its parts.

Specifications in the general case consist of sections that are in the following order:

documentation;

complexes;

assembly units;

details;

standard products;

other products;

materials;

sets

The presence of certain sections is determined by the composition of the product. The name of each product is indicated in the form of a heading in the column "Name" and underline.

To the section "Documentation" insert documents that constitute the main set of design documents of the product, in addition to its specifications, information operational documents and information for repair documents.

The sections "Complexes", "Assembly units" and "Details" add complexes, assembly units and parts that directly form the product. The record of these products is carried out in alphabetical sequence of the combination of initial letters (letters) of the indexes, the organizations-developers and further in the sequence of growth of the digits that are included in the designations.

The section "Standard Products" records products that are manufactured according to state and industry standards, as well as enterprise standards.

Within each category of standards, the record is recommended for groups of products that are grouped according to their function (eg, bearings, fasteners, electrical products, etc.), within each group, in alphabetical order, the names of products, within each name - in the sequence of growth of designations of standards, and within each designation of standards - in the order of growth of the main parameters or size of the product.

The section "Other products" records products that are not used in the main design documents (according to technical requirements), except standard products. Records of products are carried out in homogeneous groups; within each group - in alphabetical order of names of products, and within each name - in the sequence of growth of the main parameters or sizes of the product.

The section "Materials" records all materials included in the product. Materials are recorded by type in the following order:

- metals are black;
- metals are magnetoelectric and ferromagnetic;
- metals are colored, noble and rare;
- cables, wires and cords;
- plastics and press materials;
- paper and textile materials;
- mineral, ceramic and glass materials;
- varnishes, paints, petroleum products and chemicals;
- other materials.

Within each type of material are written in alphabetical order of names, and within each name - in increasing sizes or other technical parameters.

To the Materials section does not record materials, the required number of which can not install the designer by the size of the product elements and therefore sets the technologist. These materials include, for example, varnishes, paints, glues, soldering, electrodes, and the like. Guidance on the use of such materials is indicated in the technical requirements in the drawing field.

To the section "Sets" insert a statement of operating documents, a record of repair documents and the kits that are part of the product, as well as the packaging, and record them in the following order:

- a statement of operational documents;
- a record of documents for repair;
- a set of mounting parts;
- a set of variable parts;
- a set of spare parts;
- a set of tools and accessories;
- a set of tools for investing;
- other kits;
- packing.

The graphs of the specification are filled in this way.

1 In the "Format" column, specify the format of documents whose designations are written in the "Designation" column. If the document is executed on several sheets of different formats, then the column is marked with an asterisk (*), and in the column "Notes" list all the formats in order of magnification. For documents recorded in the sections "Standard Products", "Other Products" and "Materials" the column is

not filled. For documents issued by printing or other similar method on the formats provided by the state standards, in the column put a dash.

2 In the "Zone" column, indicate the area in which the position number of the component part of the product is recorded (provided that the area of the drawing of the zone is split).

3 In the "Pos." Column, indicate the order numbers of the component parts that are part of the product. In the section "Documentation" and "Sets" the column is not filled in.

4 In the "Designation" column indicate: in the "Documentation" section - the designation of the documents to be recorded; in the sections "Complexes", "Assembly units", "Details" and "Sets" - the designation of the main design documents that are not written in these sections. For details on which drawings are not issued, the designation that they have been assigned to. In the "Standard Products", "Other Products" and "Materials" sections, the columns are not filled in. If the design documentation is issued for the manufacture of standard products, the designation of the issued basic design document shall be indicated in the column "Designation".

5 In the "Name" box indicate: in the "Documentation" section for documents included in the basic set of documents for products and products for this product - only the name of the documents, for example: "Assembly drawing", "Technical requirements", etc.; in the sections of the specification "Complexes", "Assembly units", "Details", "Sets" - the names of the products in accordance with the main inscription on the main design documents of these products, and for details on which the drawings are not given, indicate the name and the material, and also the sizes necessary for manufacturing; in the section "Standard Products" - the name and designation of products in accordance with the standards for these products; in the section "Other products" - the name and conditional designation of the products in accordance with the documents for their delivery, indicating the designations of these documents; in the "Materials" section - the designation of the material, set in the standards or specifications for these materials.

For the recording of products and materials that differ in size and other data and are applied to the same document, the general part of the name of these products or materials with the designation of the specified document is allowed to be written on each sheet of the specification once in the form of the general name (header). Under the generic name, for each of these products and materials, only their parameters and sizes are recorded.

6 In the column "Quantity" specify: for the components of products, which are written down to the specifications, their number per product; in the "Materials" section - the total number of materials per product with indication of units of measurement. In the "Documentation" section the columns are not filled in.

7 The "Note" column specifies additional information for the planning and organization of production, as well as other information relating to the products, materials and documents recorded in the specification.

For documents issued on two or more sheets of different formats, indicate the designation of formats, before listing which put an asterisk, for example: *) A1, A2.

After each section of the specification, you need to leave a few free lines for additional records.

It is allowed to combine the specification with the assembly drawing provided they are placed on a sheet of A4 format project project

7. Requirements for the course project

7.1. Payment and explanatory note

7.1.1. General requirements

The main document of the course project is a settlement and explanatory note (SEN) in which information about the technical and research developments performed, as well as economic substantiation, should be provided. The statement of the explanatory note should be short and clear, with obligatory graphic illustrations (drawings, diagrams, graphs). It is not recommended to rewrite the well-known provisions from textbooks or other printed publications. The information provided in the above mentioned sources can be used only for the choice or substantiation of the decisions taken in the work with the indication of the source of information.

The settlement and explanatory note should be executed in accordance with the requirements of DSTU 3008-95. It is executed either by handwriting or by machine (using computer technology) in a way on one side of a sheet of white paper of A4 format with a frame and the main inscription in accordance with ГОСТ 2.104-2006. It is allowed to perform separate parts of a note in different ways - machine or manual. You can also submit illustrations, tables and computer printouts on sheets of A3 format.

The distance from the border of the form to the text borders at the beginning and end of the lines should be not less than 3 mm.

When writing text using a computer, you should observe the following general formatting recommendations:

main font - Times New Roman, 14 points, normal (without bold, italic and underscore), color - black only;

the main line spacing is 1.5 (without applying any intervals before and after paragraphs and spaces of lines in the text);

in multi-line names of clauses / sub-clauses, subheading inscriptions and table headings, within them - line spacing - 1,0;

within the tables, the line spacing is 1.0; font - of any size (but not less than 7 p.);

inside the drawings (illustrations) the line spacing - 1,0; font - of any size, but not less than 7 p.);

paragraph indent ("new line") - 1.27 cm

In addition, some common rules should be kept in mind. The Latin letters that explain the physical and mathematical values should be written in italics, and the Greek ones are always in direct line. Figures are written in italics only when they mean something (from point 1 to point 2), but are not numbers in the direct sense of the word. Functions (sin, cos, tg, lg, etc.) are always presented in a straight line so they are clearly different from the arguments. Brackets and mathematical signs are always straightforward.

You should also pay attention to the correctness of debugging the Microsoft Equation formula editor. In the Style menu, select Define, for Greek letters and characters, the Symbol font must be set, for the rest the main font, for example, is Times New Roman. The inclined character format (italics) should be noted only for the style "Variable", while the bold one is "Matrix - Vector". When writing indexes, there are two possible options.

In polygraphically competently prepared texts you can find the minuses, dashes and two types of dashes - short (end-dash) and long (em-dash). The hyphen is usually used when specifying a range, for example, pages 13-32, and a short dash in contexts.

Dashes have no spaces on the one hand. The same applies to the long dash in English texts. On the contrary, when typing texts into Ukrainian, it is necessary to keep in mind the gaps from both sides of the long and short dash.

When introducing mandatory requirements, the words should be used in the text, "it follows", "necessary", "it is necessary that ..." is "allowed only", "not allowed", "prohibited", "does not follow". When presenting other provisions, it is worthwhile to use the words "maybe", "as a rule", "if necessary", "maybe", "in case", etc. It is allowed to use the narrative form of the text of the text of the RPP, for example: "apply", "indicate", etc.

Scientific and technical terms, designations and definitions, established by the relevant standards, and, in their absence, generally accepted in the scientific and technical literature, should be used in the SEN. The text of the document should be short, clear and not allow different interpretations.

If the specialist terminology is adopted in the SEN, then a list of accepted terms with the corresponding explanations should be submitted at the end of it (before the list of literature). The list is included in the content of the SEN.

The text of the SEN is not allowed:

apply for the same concept different scientific and technical terms, similar in content (synonyms), as well as foreign words and terms;

reduce the designation of units of physical quantities, if they are used without figures, except for the units of physical quantities in the heads and sides of the tables and in the decoding of the letter symbols included in the formulas and figures;

apply word abbreviations, in addition to the rules of Ukrainian spelling, punctuation, as well as relevant state standards;

use the mathematical sign minus (-) in front of the negative values of the values in the text. Instead of a mathematical sign (-) it is worthwhile to write the word minus;

apply mathematical symbols, for example, > (more), <(less), = (equals), (greater than or equal to), φ (less or equals), \neq (not equal), and also signs № (number), % (percentage);

apply indexes of standards, technical specifications (TS) and other documents without a registration number;

apply derivative word formations.

If the SEN give explanatory inscriptions which are applied directly to the manufactured product (for example, on plates, plates to controls, etc.), they are allocated in font (without quotation marks), for example, NETWORK, STOP, or in quotes - if the inscription consists of digits and (or) characters.

Name of commands, modes, signals, etc. the text should be highlighted with quotation marks, for example: "Signal +27 is on".

If the SEN adopts a special system of word or denominator reduction, then decryption is given directly in the text at the first mention. For example, "... a cutting tool (CT)", after which you can use the contractions of CT.

Conditional letter designations of values, as well as conditional graphic designations, must conform to those established by the state standard. In the text of the SEN, before the designation of the parameter, give an explanation, for example: "Feed S".

Numerical values of the values in the text should point to the degree of accuracy required to provide certain properties of the product, while in a number of quantities, the alignment of the number of characters after a comma is carried out.

Rounding of numerical values of values to the first, second, third, etc. decimal mark for different sizes, stamps, etc. products of the same name must be the same. For example, if the gradation of the thickness of the steel tape is 0.25 mm, then the whole series of tape thickness must be indicated with the same number of decimal places, for example, 1.50; 1.75; 2.00.

Fractional numbers should be given as decimal fractions, except for the sizes in inches, which should be recorded: $1 / 4^2$; $1 / 2^2$.

If it is impossible to express a numeric value in the form of a decimal fraction, then it is allowed to write it in the form of a simple fraction in a single line because of a strain of risk, for example, "5/32; 50A - 4C / (40V + 20)".

The standard also sets out a number of requirements for the execution of certain elements of the settlement and explanatory note.

Structural elements of the SEN "CONTENTS", "LIST OF CONDITIONS, SYMBOLS, UNITS, SHORT TERMS AND TERMS", "INTRODUCTION", "CONCLUSIONS", "LIST OF LINKS" are not numbered, and their names are headings of structural elements.

The sections and subdivisions of the SEN should have headers. Items and sub-items may have headers. The headings of the structural elements of the SEN and the headings of the sections should be placed in the middle of the line and printed in capital letters without a dot at the end, not emphasizing. The headings of subdivisions, paragraphs and sub-paragraphs should begin with a paragraph and print

in bold, in small letters, except for the first one, without emphasizing, without a dot at the end. The indent should be the same throughout the text of the SEN. If the title consists of two or more sentences, they are separated by a dot. The words in the title of the section are not allowed. It is not allowed to place the title of a section, a subdivision, and also a paragraph and sub-item at the bottom of the page, if only one line of text is placed after it.

The distance between the name of the structural part and the name of the unit should be one line. The distance between the title and the text should be one line, the previous text and the next heading - two lines.

Each structural part of the course project should begin with a new page on a sheet, which has the main inscription in accordance with ГОСТ 2.104-2006, Form 2.

The pages of the SEN should be numbered in Arabic numerals, following through-the-line numbering throughout the text. The title page includes the total numbering of the pages. The page number on the title page is not posted. Illustrations and spreadsheets on separate pages are included in the total numbering of pages. The contents are included in the total number of sheets of explanatory note.

The sections, subdivisions, paragraphs, and sub-paragraphs of the SEN should be numbered in Arabic numerals. The sections should have an ordinal numbering and denoted Arabic numerals without a dot, for example, 1, 2, 3, etc. Each section of the SEN must start with a new sheet (page). Unit number consists of section number and unit serial number, separated by a dot. After the unit number does not put a point, for example 1.1, 1.2 etc.

Items must have ordinal numbers within each section or subdivision. The item number consists of the section number and the serial number of the item, or from the section number, the unit serial number and the item's serial number, separated by a dot. After point number point is not put, for example, 1.1.1, 1.1.2, etc. The subitem number consists of the section number, serial number of the unit, the serial number of the item and the serial number of the subpoint, separated by a dot, for example, 1.1.1.1, 1.1.1.2, 1.1.1.3, etc.

Typical mistakes, abnormalities and graphic inaccuracies found during the execution of the work can be corrected by purifying or painting with white paint and applying the corrected text or drawing at the same place.

7.1.2. Illustrations

The number of illustrations (drawings, drawings, graphs, diagrams, photographs) should be sufficient to explain the above text. Illustrations should be placed directly after the text, where they are mentioned for the first time, or on the next page. All illustrations should contain references in the text of the SEN.

Illustrations may have a name that is placed under the illustration. If necessary, under the illustration, place explanatory data (sub-text text). The illustration is indicated by the word "Figure", which, along with the name of the illustration, is placed after the explanatory data, for example: "Figure 3.1 - Scheme of placement."

The name of the picture should be placed in the middle of the line. Before and after the name of the drawing you need to skip one blank line.

Illustrations, with the exception of the illustrations in the annexes, should be numbered with Arabic numerals through the sequential numbering. If the figure is one, then it is labeled as "Figure 1". It is allowed to number the illustrations within the section. In this case, the number of the illustration consists of the section number and the sequence number of the illustration, separated by a dot, for example: "Figure 1.1".

When referring to the illustration, it should be written "... in accordance with Figure 2" with the sequential numbering and "... according to Figure 1.2" for the numbering within the section.

If there is an illustration in the text of the SEN, in which the component parts of the product are shown, then these figures in the illustration should indicate the positions of these components within the limits of this illustration, which are arranged in the order of growth, with the exception of repetitive items.

When reference is made to individual elements of the details (openings, grooves, grooves, etc.) in the text, they are indicated by the uppercase letters of the Ukrainian or English alphabet.

If the illustration does not fit on a single page, it can be moved to other pages, including the name of the illustration on the first page, explanatory data - on each page, and under it: "Figure __, sheet __".

7.1.3. Tables

Digital material, as a rule, is drawn up in the form of tables in accordance with Fig. 1

Table _____ - _____

number table name

Figure 1 - An example of drawing a table

Horizontal and vertical lines that delimit the rows of the table, as well as the left, right and bottom lines that restrict the table, can not be performed if their absence does not hinder the use of the table.

If at the end of the page the table is interrupted and its continuation will be on the next page, in the first part of the table the bottom horizontal line that does not limit the table does not.

The table should be placed directly after the text in which it is mentioned for the first time or on the next page. The table is separated from the rest of the text by a free line. All tables should contain references in the text of the SEN. It is allowed to place the table along the long side of the SEN sheet.

If the rows or graphs of the table are beyond the format of the page, they are divided into parts, placing one part under another or adjacent, with each part of the table repeating its head and sidewall. When dividing the table into parts it is allowed to replace its head or side by side with the number of graphs and rows. In this case, Arabic numerals are numbered graphs and (or) rows of the first part of the table.

The tables should be numbered with Arabic numerals with order numbers within the section, except for the tables in the annexes. The table number consists of the section number and the sequence number of the table, separated by a dot, for example: "Table 2.1 - The first table of the second chapter".

A table may have a name that is typed in lower case letters (except for the first large one) and placed above the table. The name should be compressed and display the contents of the table. You must skip one blank line before the table name.

The word "Table ___" indicates once to the left above the first part of the table, over other parts write: "Continuation of the table ___" indicating the table number without its title.

The headings of the chart count start with a capitalization, and the subheadings are from the small one if they form one sentence with the title. Sub-headers that have an independent meaning are written in capital letters. At the end of the headings and sub-headings of the tables do not put the dot. The headings and subheadings of the graph are indicated in the singular.

If in the majority of the graph of the table indicators are given, expressed in the same units of physical quantities, but there are graphs with the indicators expressed in other units of physical quantities, then over the table should write the name of the prevailing index and the designation of its physical value, for example, "Dimensions in millimeters", and in the subheadings of other graphs give the name of the indicators and (or) the designation of other units of physical quantities.

To shorten the text of the headings and subheadings, the graph substitutes certain notions for letter symbols, established by standards or other symbols if they are explained in the text or illustrated, for example, D is diameter, H is height, L is length. Indicators with the same lettering group are grouped sequentially in the order of growth of the indices.

Restrictive words "more", "no more", "less", "no less", etc. must be placed in a single row or column of the table with the name of the corresponding indicator after denoting its unit of physical value, if they belong to the whole row or graphs. At the same time, after the name of the indicator, a comma is placed before the restrictive words.

A repeating text in the lines of the same graph and consisting of single words alternating with digits, are replaced by paws. If the repeating text consists of two or more words, at the first repetition it is replaced by the words "Same", and then - the quotes. Replace the digits, mathematical signs, symbols and numbers, marking marks, materials and standard sizes of products, signs of repeating normative documents, are not allowed. In the absence of individual data in the table put a dash (dash).

The interval of numbers in the text is written with the words "from" and "to" (meaning "from ... to ... inclusive"), if after the numbers the indicated unit of physical quantity or number representing dimensionless coefficients, or through the hyphen, if the numbers represent the ordinal numbers.

The numbers in the tables of the tables should be placed so that the digits of the numbers throughout the graph are arranged one by one, if they relate to one indicator. In one column, as a rule, the same number of decimal places for all values of values should be observed.

If it is necessary to specify in the table the advantages of using certain numerical values of quantities or types (marks, etc.) of products, it is allowed to use symbols with explanations in the text of the document.

For the selection of a better nomenclature or restriction of numerical values or types (marks, etc.) of the products used, it is allowed to take in brackets the values that are not recommended for use or have a limited application, indicating in the note the value of the brackets.

If there is a small amount of digital material in a document, it is impractical to draw up a table, and submit it with text, with digital data in the form of columns, for example:

Limit deviations in profile sizes for all rooms:
at a height of 2.5 %%;
at a width of 1.5 %%;
at a thickness of 0.3 %%.

7.1.4. Formulas

When using formulas, it is necessary to adhere to certain technical and spelling rules. The largest, as well as long and cumbersome formulas containing the signs of sum, product, differentiation, integration, are placed on separate lines. This also applies to all numbered formulas. To save space, several short uniform formulas separated from the text can be submitted in one line, not one by one. Small and simple formulas that do not have an independent meaning are written inside the lines of the text.

The explanation of the values of symbols and numerical coefficients must be submitted directly under the formula in the sequence in which they are presented in the formula. The values of each character and numeric coefficient are written from a

new line. The first line of explanation begins with the word "where" without a colon and a paragraph indentation.

Equations and formulas should be separated from the text by free lines. Above and below each formula leave at least one free line. If the equation does not fit in one line, it is transferred to another after the equals sign (=), plus (+), minus (-), multiplication (\times) and division (/).

Formulas and equations (except formulas and equations in the annexes) should be numbered by ordinal numbering within the section. The number of the formula or equation is given at the level of the formula or the equation in brackets at the far right position on the line.

Ordinal numbers are indicated by Arabic numerals in round brackets on the right side of the page without points from the formula to its number. The number that does not fit into the line with the formula is transferred to the following formula. The number of the formula when it is carried is put at the level of the last line. If the formula is in the frame, then the number of this formula is written outside the frame on the right side opposite the main line of the formula. The number of the formula is given at the level of the main horizontal risk of the formula.

The number of a group of formulas placed on separate lines and combined by a curly bracket (paranthesis) is placed to the right of the paranthesis, which is in the middle of the group of formulas and facing the number.

It is also necessary to know the rules of punctuation in the text with the formulas. The general rule here is as follows: the formula is included in the sentence as its equal element. Therefore, at the end of the formulas and in the text before them, the punctuation marks are put in accordance with the rules of punctuation.

A two-column before the formula is put only in cases provided for by the rules of punctuation:

- a) in the text before the formula is a generalizing word;
- b) this requires the construction of the text preceding the formula.

Separate signs between formulas that follow one another and not separated by text may be comma or semicolon, directly by the formula to its number. Partitioning between the formulas when paantage is placed inside the paranthesis. After such bulky mathematical expressions as determinants and matrices, punctuation marks can not be put.

7.1.5. Units of physical quantities

In the text of the settlement and explanatory note, standardized units of physical quantities and their designations should be used. Along with units SI, if necessary, in parentheses indicate units of physical quantities, other systems, allowed for use. The use of SENs in different systems of designation of physical quantities is not allowed.

In order to describe the values of values, units should be used in letters or special characters (... °, ... ', ... ²). There are two types of letter designations:

international (using letters of the Latin and Greek alphabet) and Ukrainian (using the letters of the Ukrainian alphabet).

The letters of the units must be printed in plain text. In the notation of units, the dot is not a sign of reduction.

The notation of units should be used after the numerical values of the value and placed in a row with them (without transferring to the next line), except for the units of physical quantities placed in the tables, which are executed in a typewritten way. Between the last digit of the number and the designation of the units, leave an indissoluble space.

True: 80 %%

Wrong: 80 %%

When indicating values of values with marginal deviations, numerical values with marginal deviations in brackets should be placed, and the designation of the unit should be placed after the brackets or put the designation of units after the numerical value of value and after its limit value.

True:

$(100,0 \pm 0,1) \text{ кг}$

$50 \text{ г} \pm 1 \text{ г}$

Wrong:

$100,0 \pm 0,1 \text{ кг}$

$50 \pm 1 \text{ г}$

You can apply the notation of units in the headings of the graph and in the names of the rows (side panels) of the tables.

It is allowed to use the notation of units in explanations of the designations of values to the formulas. Placing the notation of units in a single line with the formulas expressing the dependencies between the values or between their numerical values represented in an alphabetical form is not allowed.

The letters of the designation of units included in the product should be separated by dots on the middle line, as multiplication signs.

In literal notation of the relation of units, as a sign of division, only one oblique or horizontal risk should be used. It is allowed to denote units in the form of a product of the notation of units constituted in power (positive and negative).

When applying the oblique risk, the designation of units in the numerator and denominator should be placed in a row, the product of the notation of units in the denominator should be taken in brackets.

When using a derivative unit consisting of two or more units, it is not allowed to combine the letters and denominations of the units, that is, for some units to indicate the designation, and for others, the name.

7.1.6. Notes

Notes are provided in the text of the explanatory note if explanations are required for the content of the text, tables or graphic material. They should not contain requirements.

The notes should be placed immediately after the text, graphic material, or in the table to which these notes relate, and to print from the capitalization of the paragraph. If the note is one, then after the word "Note" put a dash and the note is also printed with capital letters. One note is not numbered. Several notes are numbered sequentially in Arabic numerals. A note to the table is placed at the end of the table under the line indicating the end of the table.

7.1.7. List of links

The reference to the source should be the serial number allocated by the square brackets according to the list of references.

The list of references is based on the choice of the author of the work in alphabetical order or in the order of their mention in the text of the SEN. The list is in the language of the original text, with some information (for example, in terms of quantitative characteristics) allowed to be written in the language of the main text of the document.

The maximum number of bibliographic sources in the list of links is not limited. It is not recommended to include in the list of sources for which there were no references in the text of the explanatory note. In addition, it is not recommended to include encyclopedic dictionaries, newspapers and popular science publications.

The list of references is made in accordance with the requirements of the national standard, identical to ГОСТ 7.1-2003 "System of standards for information, library and publishing. Bibliographic record. Bibliographic description. General requirements and rules of drafting ", introduced in Ukraine from 01.07.2007.

7.1.8. Annexes

The annexes are issued as an extension of the SEN on the following sheets. They are usually performed on sheets of A4 format. It is allowed to make applications on sheets of A3, A4 × 3, A4 × 4, A2 and A1.

Examples may include, for example, graphic material, large-scale spreadsheets, calculations, hardware and instrumentation descriptions, algorithm descriptions and program texts, etc.

Attachments may be required and informational. Information can be advisory or reference.

If the applications are executed on the next pages of the RPP, each such application should begin with a new page.

The attachment must have a headline printed on the top with small letters from the first large symmetrically relative to the text of the page. In the middle of the line above the headline in small letters from the first one, the word "Attachment ___" and the capital letter indicating the application must be printed. The attachments should be indicated consistently in uppercase letters of the English alphabet, for example, Annex A, Annex B, etc.

One application is indicated as Annex A.

Attachments must have a page numbered with the rest of the document.

7.2. Graphic part

7.2.1. General provisions

All drawings of the graphic part of the work should be performed on standard sheets of A1 size writing paper pencil, ink or using machine graphics with the mandatory compliance with requirements of higher education.

7.2.2. Drawing of the detail

Work drawing of a part is a document that contains the details of the image and other data necessary for its manufacture and control. The working drawing, as a rule, is developed for every part that is part of the product. The number of types, cuts, sections should be sufficient to give a complete picture of the interior and exterior surfaces of the parts.

The workpiece drawing should be done on a separate sheet in all necessary projections with all the necessary cuts and sections to reveal the complete configuration of the part and all sizes. Scale 1: 1 if possible.

The work drawing should show: all dimensions, size tolerances, tolerances on the mutual arrangement of surfaces, surface cleanliness, material details, heat treatment and hardness, the magnitude of permissible surface defects on untreated surfaces, type of coating, specifications and other instructions.

7.2.2. Drawing of the workpiece

Drawings of the workpiece are executed on a separate sheet or combined with the drawing of the details. In the joint drawing, the contour of the details are depicted by continuous, thin lines, and the parts are added to the image by a continuous main line of tolerances of the corresponding magnitude (on those surfaces where mechanical processing is foreseen). The drawing should show all the necessary projections, sections and sections, sizes, tolerances and nominal values of allowances.

The technical conditions for the workpiece should be placed in the lower right corner of the sheet within the width of the main inscription and write without a title.

In the case where the workpiece has a standard bar or profile, the drawing of the workpiece can not be executed or drawn as a sketch in the SEN.

7.2.3. Assembly drawings of technological equipment

The assembly drawing must be executed in all necessary projections and with all cuts and sections, which show the configuration of the conjugated surfaces, details and operating principle of the device.

In addition to the assembly drawing of the device, it is recommended to develop its kinematic, hydraulic or electric circuits. They can also be cited in the settlement and explanatory note.

The assembly drawing must include: overall dimensions, dimensions of parts that stand for dimensions, fitting dimensions, dimensions and alignment in responsible conjugations, dimensions and parameters calculated by the author in the payment note and other instructions for the manufacture, adjustment, operation and maintenance this device. It is allowed on the assembly drawings of technological equipment in the upper right corner to place an operational sketch.

In the assembly drawing, the device must be represented by a continuous thin line of the contour of the part in a fixed position and a continuous thick double-thickness line or a line of red-colored surface of the parts that are processed in this operation. The device name must contain information about its destination

7.2.4. Technological thumbnails and adjustments

Drawings of technological sketches and adjustments are performed after the development of the technological process of mechanical processing of a given detail. Typically, they are depicted by sketches of not all operations of the developed technological process, but only typical, most characteristic of this technological process, associated with a significant change in the shape of the workpiece, or those that are most interesting from the educational and technical point of view.

The number and the list of transactions, which perform adjustments, is determined by the author in agreement with the supervisor.

In the drawings, sketches of parts obtained after this machining operation, in the required number of projections, and, if necessary, with sections and sections, should be depicted.

The drawings of technological sketches and adjustments should be depicted:

- elements of devices that provide the installation of the workpiece in the required position and its fixation;
- the tool in the final position of processing;
- cyclogram of the motion of the instrument;
- devices for installing a cutting tool to the dimensions that are maintained and the limitation of their stroke with indication of adjusting sizes;
- dimensions with tolerances obtained in this operation;
- basic debugging size;

requirements for the accuracy of the shape and location of the surfaces of the processed part;
roughness of treated surfaces;
directions of main movements and innings.

The bold contour lines or red lines depict the surfaces that are processed in this operation.

For operations performed on multi-operation machines, they represent sequence diagrams of positions or their layout schemes. The sketch shows the numbers and names of operations, transitions or positions, the name and type of the machine.

In the lower right corner of the field all drawings should be placed the main inscription in accordance with ГOCT 2.104-2006, Form 1. Requirements for filling in the main inscriptions are given in Annex G.

Requirements for the design of technological thumbnails and adjustments are basically similar to those that apply to drawings and schemes. In addition, in the lower right corner of the sheet, above the main inscription, an angle plate according to Appendix D must be made, in which the name and model of the machine, cutting modes and time rules for this operation should be indicated.

7.2.5. Charts of dependencies, tables, diagrams, diagrams

This material is used to illustrate the results of the project, as well as to reflect its main technical and economic indicators. The design of this part should be done taking into account that there should be placed so many graphs, tables or diagrams on a single sheet of A1 format so that the sheet space can be used rationally and that they are well read from a distance of 6 + 8 m. The same principle should be followed when choosing the thickness of the lines and the size of the inscriptions. On each sheet of charts, diagrams, tables, circuits should be the frame and the main inscription.

7.2.6. Technical requirements in the drawing

The technical requirements should be placed on the drawing field above the main paragraph of the paragraphs, the size of which does not exceed the width of the main inscription. If all the technical requirements do not fit the main inscription, then at least one requirement is placed over it, and the rest - on the free sheet of the field.

The technical requirements in the drawing are presented in groups, grouping together homogeneous and close in character.

The sequence of submission of technical requirements is as follows:

- a) the requirements relating to the material of the workpiece and substitute materials;
- b) the dimensions, the limits of the deviations of the sizes, forms and the mutual arrangement of surfaces;

- c) requirements to the quality of surfaces, their coverage;
- g) gaps, placement of individual elements of the structure;
- e) requirements for the regulation and adjustment of the product;
- e) other requirements, such as low noise, vibration resistance, etc.;
- g) conditions and methods of testing;
- c) instructions for marking and marking;
- i) transport and storage rules.

Навчально-методична література

**Дячун А. Є., Паливода Ю. Є., Ткаченко І. Г.,
Паньків В. Р., Паньків М. Р.**

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з дисципліни**

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