MECHANICAL ENGINEERING

DEGREE COURSE: Educational Program 15.03.01 (150700) Mechanical Engineering
SPECIALISATION: Technology, Equipment and Automation of Mechanical Engineering Manufacturing
QUALIFICATION (DEGREE): bachelor
YEAR OF STUDY: 4   SEMESTER: 7, 8
CREDITS: 8 (6 / 2)
PREREQUISITES: Б3.Б3 «Constructional Materials Engineering»; Б3.Б4 «Metrology, Standardisation and Certification»; Б3.Б8 «Materials Science»; Б3.В2.1 «Material Cutting and Cutting Tools».
COREQUISITES: Б3.В2.2 «Metalworking Machinery»; Б3.В2.1 «Material Cutting and Cutting Tools»; Б3. В2.3 «Engineering Metrology in Mechanical Engineering».
EDUCATION FORM: full-time

Kinds of educational activity	ALLOCATION OF CLASS HOURS		
	7-th semester	8-th semester	Total
LECTURES	40	30	70
PRACTICAL CLASSES	16	---	16
LABORATORY WORKS	24	30	54
CLASS HOURS IN TOTAL	80	60	140
SELF-STUDY TRAINING	46	50	96
TOTAL	126	110	236
ASSESSMENT FORM	examination	examination	

ASSESSMENT FORM: examination
PROVIDING DEPARTMENT: Department of Automated Mechanical Manufacturing Engineering of Institute of Cybernetics

The objective of the «Mechanical Engineering» course is to acquire knowledge, skills and experience in the field of analysis and design of the manufacturing processes with the application of universal equipments and also with the computer numerical control (CNC) system, mastering of modern electrophysical and electrochemical methods of parts (details) machining.

The discipline ensures reaching of following purposes from the General Educational Program (GEP):

- preparing of a graduate for industrial-technological activity in the field of modern engineering and construction-assembling manufacture on the base of resource effective technologies;

- preparing of a graduate for design activity with use of computer design aids of articles of machine industry and welding manufacture, master schedules of their manufactures and means of technological equipment of these processes;

- preparing of a graduate for research activity in the field of creation of innovative production technologies of machine industry articles and construction-assembling plants, means of their technological equipment;

- preparing of a graduate for self-education and mastering of new professional knowledge and abilities, to continuous professional self-improvement;

The course outcomes are in agreement with the education results described in the General Educational Program 15.03.01 (150700) «Mechanical Engineering». After completion of the «Mechanical Engineering» course the student is to:

know
    • concepts of mechanical engineering production;

- technological ensuring required machining accuracy;
- technological ensuring required properties of the part material and surface layer quality;
- principles and strategies of the manufacturing process design;
- principles of the manufacturing datum selection; methods of calculation of the machining allowances, workpiece dimensions, cutting parameters and standard time for manufacturing operations;

be able to
- calculate types of manufacturing;
- choose way of initial workpiece manufacturing;
- choose methods of workpiece production;
- assign tooling for product manufacturing;
- assign manufacturing datums, calculate machining allowances, workpiece dimensions, cutting parameters and standard time for manufacturing operations;
- carry out dimensional analysis of part machining;
- carry out statistical analysis of machining accuracy;
- analyze causes of manufacturing defects and assign ways to eliminate the defects;

apply the following methods
- tolerance analysis of the manufacturing processes;
- statistical analysis of machining accuracy;
- investigation of the surface layer quality;
- programming the CNC turning and milling machines;
- deigning of the technological processes of complex intricate parts depending on type of manufacturing.

The following competences are formed upon completion of the course:
1. Universal (cultural) -
- an ability to apply basic and special knowledge of math, natural science, humanities and economic sciences in engineering (OK-10).
2. Professional -
- an ability to apply basic laws of natural sciences, methods of mathematic analysis and simulation, basics of theoretical and experimental researches in engineering to design objects and engineering processes in mechanical engineering using standard CAD software (ПК-10);
- readiness to maintain engineering discipline during production, develop new engineering methods of production, apply methods of quality assessment of samples, parts, assemblies and products (ПК-1);
- readiness to apply state-of-the-art methods for developing low-waste, energy-saving and environmentally friendly mechanical engineering techniques, that ensure human safety and protection from potential accidents and natural disasters, readiness to apply methods of conservation of raw materials, energy and other resources (ПК-8).

7-th semester
4.1.1. Production process design (6 hours)
Input data. Analysis of part drawing specification and identification of part manufacturing objectives. Manufacturability analysis. Production methods identification. Initial workpiece selection depending on type of manufacturing. Manufacturing datums selection depending on type of manufacturing. Selection of manufacturing routes, machine tools and equipment depending on type of manufacturing. Machining operation structure. Principles and sequence of manufacturing process design. Calculation of machining allowances and manufacturing dimensions. Selection of machining parameters, means of ensuring required productivity and accuracy of products. Analysis of production cost-effectiveness.
Laboratory Works
1. Manufacturing datums selection depending on type of manufacturing (2 hours).
2. Manufacturing routes design (2 hours);
3. Measurement of time for carry out of operation (2 hours).

Practical Classes
1. Analysis of parts drawing specification (2 hours);
2. Manufacturability analysis, determination of initial workpiece type and shape (2 hours);
3. Calculation of machining allowances and manufacturing dimensions (2 hours);

4.1.2. Ensuring efficiency of production process (6 hours)

Production time. Production time resource and expenditure. Structure of the time required for machining operation. Machining time rating and work measurement. Technological methods of productivity boosting and manufacturing cost reduction. Improving technical-economic efficiency of manufacturing. Technological ways of increasing machining productivity. Reduction of materials removal. Multiple-machine machining. Typification of manufacturing processes. Prime cost minimization.

Laboratory Works
1. Increasing of machining productivity (2 hours).

4.1.3. Manufacturing technology of standard parts (details). Manufacturing technology of step shafts (6 hours)

Assignment of shafts. Specifications and norms of accuracy. Materials and ways of initial workpiece manufacture. Principles of manufacturing datums selection for rough and finish operations. Accuracy within an operation and through the whole production process. Components of surface layer quality and their performance characteristics. Technological heredity. Standard master schedules of step shafts manufacture depending on type of manufacturing.

Laboratory Works
1. Machining of step shaft and measurement of it accuracy (2 hours);
2. Measurement of shaft technological heredity (2 hours).

Practical Classes
1. Step shaft master schedule design (2 hours).

4.1.4. Manufacturing technology of parts of type a sleeve and a flange (4 hours).

Assignment of sleeves. Specifications and norms of accuracy. Materials and ways of initial workpiece manufacture. Standard master schedules of sleeves manufacture depending on type of manufacturing. Assignment of flanges. Specifications and norms of accuracy. Materials and ways of initial workpiece manufacture. Standard master schedules of flanges manufacture depending on type of manufacturing.

Laboratory Works
1. Machining of sleeve and measurement of it accuracy (2 hours);
2. Machining of flange and measurement of it accuracy (2 hours)

Practical Classes
1. Sleeve master schedule design (2 hours).

4.1.5. Manufacturing technology of gear wheels (4 hours).

Assignment and classification of gear wheels. Specifications and norms of accuracy. Materials and ways of initial workpiece manufacture. Machining of teeth and methods of their finish machining. Standard master schedules of gear wheels manufacture depending on type of manufacturing.

Laboratory Works
1. Machining of gear wheel and measurement of it accuracy (2 hours).

4.1.6. Manufacturing technology of body-case parts (4 hours).

Assignment and classification of body-case parts. Specifications and norms of accuracy. Materials and ways of initial workpiece manufacture. Methods of control of surfaces arrangement accuracy of body-case parts. Standard master schedules of body-case parts manufacture depending on type of manufacturing.

Laboratory Works
1. Machining of body and measurement of it accuracy (2 hours).

Practical Classes
2. Body master schedule design (2 hours).

4.1.7. Methods of finishing abrasive machining (4 hours).

Honing, super finishing abrasive machining, lapping, polishing (buffing). Technological possibilities, advantages and disadvantages (merits and demerits).

4.1.8. Electro-physical and electro-chemical methods of parts processing. Surface plastic deformation (4 hours).

Electrical discharge machining (EDM). Chemical milling and electrochemical machining (ECM). Ultrasonic machining (USM). Laser machining (LM). Electron beam machining (EBM). Plasma flame processing (PFP). Abrasive jet machining (AJM), hydro-abrasive machining (HAM). Recovering (restoration) of parts by gas-flame spraying. Processing by surface plastic deformation. A running by balls and rollers. A diamond burnishing. Calibrating. The shot peening. Technological possibilities, merits and demerits.

Laboratory Works
1. Machining of part on EDM machine tool (2 hours).
2. Abrasive jet machining of workpiece (8 hours)

8-th semester
4.1.9. Design features of CNC machine tools (2 hours)..

Machining of workpieces on machine tools with computer numerical control (CNC) system.

Laboratory Works
1. The control panel of the CNC machine tool, the software (4 hours);
2. Base principles of programming in system Fanuc (8 hours);
3. Systems of coordinates, linear interpolation, creation of the cutting tools and the table of instruments (4 hours);
4. Installation of a workpiece and its binding, assembly of the instrument with a mandrel, its installation and a binding (4 hours);
5. Creation and editing of steering programs and their fine-tune in a simulation condition on the simulator EMCO Win NC (4 hours);
6. Correction for the cutting tool, conditions of limitation of correction application (2 hours);
7. Fine-tune and editing of the steering program by shots (2 hours);
8. Fine-tune of the steering program in an automatic mode (2 hours);
9. Fillet and rounding off, circular interpolation (2 hours);

4.1.10. Technological attachment (20 hours).

Classification of technological attachment. Types of self-centering chucks. Types of drives for mechanized chucks. Types of drives for mechanized chucks. Independent 4-jaws chuck. Locating, adjustment and clamping of workpiece. Colette chuck. Calculation of clamping and axial forces. Mandrels. Calculation of clamping and axial forces of self-centering mandrel. Faceplate. Locating and clamping of workpiece. Drilling attachments. Hand and air operated jig conducter. . Milling attachments. Calculation of clamping force for key slot milling. Analysis of the attachment application cost-effectiveness.

4.1.11. **Fundamentals of product assembling processes** (8 hours).

General concepts. Classification of joining methods. Types of assembly. Forms of assembly organization. Principles of assembling process design. Input data and sequence of assembling process design. Analysis of assembly drawings for manufacturability. Design of assembly sequence. Assembling process design. Scheme of an assembly. Calculation of a timing period (time rating) of issue; calculation of assembly type; a choice of the form of assembly organization.