THE FIRST HIGHER TECHNICAL UNIVERSITY IN RUSSIA

MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
Federal State Budgetary Educational Institution of Higher Education
"Saint-Petersburg Mining University"

IOM3 PD APPROVED

The Institute of Materials, Minerals and Mining

Approved by
Vice-Rector for Educational Activity
Prof. V.A. SHPENST

01/12/2016

Professional training program

"Modern methods of technological preparation for the automated production of mining, metallurgical and petroleum equipment with the use of CNC machines"

Professional standard:
"Specialist in development of technologies and programmable equipment with numerical control";
"Specialist in computer aided design of technological processes"

Major: ***"Mechanical Engineering"***
"Technological machines and equipment"
"Technology of mechanical engineering"

Attendance: full-time

Course leader: _____ **Professor, Head of Mechanical Engineering Department**
V. V. Maksarov

Course developer: _____ **Associate Professor of Mechanical Engineering Department**
E. G. Zlotnikov

ST. PETERSBURG
2016

1. General Provisions

1.1. The purpose of the program:

The purpose of training – improvement of the qualification level in accordance with professional standards in developing technologies and programs for equipment with programmed numerical control, computer aided design of technological processes in the field of technological preparation of automated manufacturing based on machine tools with numerical control and the acquisition of practical skills of development of control programs for CNC machines.

1.2 Competences to be formed

The basic professional competences to be formed following the results of training are presented in the table.

No. competence	Target groups	Description of the competences gained/ availability for occupational activities as part of occupational performance types
1.	Chief Technologist, Heads of departments and sections of CNC machines	The ability to provide technical equipment of workplaces with the placement of technological equipment, the ability to master the introduced equipment
2.	Chief Technologist, Heads of departments and sections of CNC machines	The ability to make requests for equipment and spare parts, to prepare technical documentation for equipment repairs
3.	Chief Technologist, Heads of departments and sections of CNC machines Engineer of automated systems of production management Engineer of automation and mechanization of production processes	The ability to receive and process information from various sources, using modern information technologies, the ability to use software tools for solving practical problems with the use of personal computers with software for general and special purposes, including remote access
4.	Engineer of automated systems of production management Engineer of automation and mechanization of production processes	The ability to select and evaluate the methods and means of automation of manufacturing processes, products
5.	Technologist Technologists programmers Engineer for CNC machine tools Software Engineer for CNC machine tools	The ability to use new modern methods of development of technological processes of manufacturing of products and objects in the field of professional work with the definition of rational technological modes of special equipment
6.	Technologist Technologists programmers Engineer for CNC machine tools Software Engineer for CNC machine tools	The ability to use CAD advanced technological processes by means of automatic processing and assembly operations

7.	Technologists Technologists programmers Engineer for CNC machine tools Software Engineer for CNC machine tools	The ability to provide the modeling of technical objects and technological processes using standard packages and computer-aided design, to conduct experiments by the specific methods with the processing and analysis of results
8.	CNC Commissioning Engineer CNC Operator Operator-adjuster of CNC machine tools	The ability to participate in the preparation of control programs for CNC machine tools, including the use of automated design tools
9.	Technologist Engineer for CNC machine tools	The ability to choose the appropriate means of technological support and equipment for the calculations according to their constructions justification
10.	Technologist Engineer for CNC machine tools CNC Commissioning Engineer CNC Operator Operator-Adjuster CNC machines	The ability to select the main and auxiliary materials and methods of implementation of the main technological processes and to apply advanced methods of operation of technological equipment in the manufacture of engineering products
11.	Mechanical Engineer Design Engineer	The ability to choose the analytical and numerical methods in the development of mathematical models of machines, drives, equipment, systems and technological processes in mechanical engineering
12.	Mechanical Engineer Design Engineer	Ability to apply modern methods for the development of low-waste, energy-saving and environmentally friendly engineering technologies to ensure the safety of life of people and protect them from the possible consequences of accidents, catastrophes and natural disasters, the ability to apply the methods of rational use of raw materials, energy and other resources in engineering

1.3. Results to be achieved:

In order to achieve the professional competencies mentioned in Table 1.2, the student should:

Gain the practical experience of:

- Development of advanced automated production technology and its implementation in the enterprise;
- Technical equipment of workplaces on the basis of CNC machine tools;
- Preparation of control programs using the most common modern systems of CNC (Sinumerik 810D/840D, EMCO WinNC for Sinumerik Operate, Sinumerik 802S baseline; FanucOM / 21M, EMCO WinNC Fanuc 0-TC, EMCO WinNC Fanuc 0-MC; EMCO WinNC Heidenhein TNC 426 Conversational).

Get skills of :

- Selection of means of technological processes automation;
- Development of technological parts manufacturing operations on CNC machines using modern automated control systems (CAM-systems);

- Preparation of control programs in manual mode in a variety of CNC systems (for turning and milling machines);

- Automated preparation of control programs for CNC machine tools using SAMConcept software environment;

- A three-dimensional simulation of the turning and milling operations using Win3D-View program;

- Mining cycle preparation of turning and milling operations: a computer modelled parts, control program simulation, visualization processing, adjustment of equipment and tools, machining on CNC machines with EMCOConcept.

Get knowledge of:

- Main types of manufacturing equipment with CNC and how it works;
- Technological design of CNC machine tools;
- Modern cutting CNC machine tools;
- Methods of setting up CNC machines in the preparation of technical operations;
- The main CAD/CAM System used in the process of technological preparation of automated production;
- Methods and tools for post-processing programs;
- Methods and means of control and editing control programs.

1.4. Course length

Type of study	Total hours
Total	**144**
Lectures	32
Laboratory and practical classes	112
Individual work, including preparations for the final test	**34**
Final test	**12**

1.5. Course structure

No. s/p	Name of module	Total hours	Including			The list of competencies (according to Table 1.2)
			Lectures	Practical classes and rooms	Laboratory works and training centers	
1.	Module 1: Automation of production and technological processes	30	8	10 (interactive class Rm. 7204)	12 (Laboratory CNC machines Rm. 5404)	1,2,3,4,11,12
2.	Module 2: Technological and tool maintenance of CNC machine tools	42	10		24 (Laboratory CNC machines Rm. 5404	1,2,9,10
3.	Module 3: processing CNC programming in a variety of systems	42	8	8 (interactive class Rm. 7204)	24 (Laboratory CNC machines Rm. 5404	6,7,8
4.	Module 4: Preparation of control programs in CAD / CAM systems	30	6	10 (interactive class Rm. 7204)	12 (Laboratory CNC machines Rm. 5404	5,6,7,8

1.6. Final assessment

The form of the final assessment of the program - the development of a control program.

1.7. Certificates

After training program has been successfully accomplished, the trainees get certificates of advanced training

1.8. Academic staff involved in educational process

No.	Full Name	Education (school, year of graduation, specialty),	Position, academic degree. Experience in this or a similar field, years	A list of major scientific and educational publications
Course leader				
	Maksarov Vyacheslav Viktorovich	Kuzbass Polytechnic Institute -Leningradsky Polytechnic Institute, 1976, "Technology of mechanical engineering, machine tools and instruments"	Head. the Department of Mechanical Engineering, Dr. Sc. Sciences, professor, 37 years	Author of over 262 scientific papers, 13 monographs
Lecturers				
	Zlotnikov Eugene Glebovich	Leningrad Institute of aviation instrument engineering, 1983, "Designing and manufacturing of radio equipment"	Associate Professor of Department. Engineering, Ph.D., associate professor, 20 years	Author of more than 39 scientific and educational works
	Timofeev Dmitry Yurievich	North-West Polytechnic Institute, 1989, "Technology of mechanical engineering, machine tools and instruments"	Associate Professor of Department. Engineering, Ph.D., 17 years	Author of more than 33 scientific and educational works
	Khalimonenko Aleksey Dmitrievich	North-West State Technical University, 2003, "Mechanical Engineering"	Associate Professor of Department. Engineering, Ph.D., associate professor, 10 years	Author of more than 31 scientific and educational works

1.9 Curriculum

The content of training programs

Training modules	Content of training material, laboratory works and practical classes	Hours
Module 1. Automation of production and technological processes		
Topic 1: Introduction to automated production	The concept of automation and automated production. Automation levels. Automatic control of metalworking equipment	2
	Exercise: Calculation of technological systems automation level	2

Theme 2. CNC machine as the basis of modern computer-aided manufacturing	Complex "CNC machine": Features of turning and CNC milling machines. Functional components (subsystems) NC: Control subsystem, drives, subsystem feedback. CNC system control functions (CNC): input and storage system software; input and storage of UE; interpretation of the frames; interpolation; Motor control innings and main drive; logic control; Correction of tool dimensions; implementation cycles; tool change; correction of errors and mechanical measuring devices; Adaptive control of machining; Accumulation of statistical information; Automatic built-in control.	2
	Exercise: Design study of lathe EMCOConceptTurn55	4
	Exercise: Design study of milling machine EMCOConceptMill55	4
	Laboratory work: Design study of the lathe EMCOConceptTurn250	6
	Laboratory work: Design study of the milling machine EMCOConceptMill250	6
Theme 3. The technological capabilities of CNC machine tools	The technological capabilities of CNC lathes. The technological capabilities of CNC milling machines. Technological capabilities of drilling and boring machines with CNC. Technological capabilities of multioperational CNC machines Resolution of mining movements. The accuracy of CNC machine tools. The rigidity of technological system. The reliability of CNC machine tools. Performance of CNC. Scope and efficiency of CNC machine tools.	2
Theme 4. Flexible automated production	Flexible manufacturing cells (FMC) Robotized technological complex Flexible manufacturing systems (FMS) and flexible automated lines (FAL)	2
Module 2: Technological and tool maintenance of CNC machines		
Theme 1. Industrial tools for CNC machines	Features of fixtures for CNC machines. Classification of fixtures for CNC machines.	2

Theme 2. Cutting tools for CNC machines	General features of the cutting tool for CNC machine tools. Tool materials. Cutting tools for machine tools of the turning group. Encoding tools. Tool systems for CNC lathes. Complete tool system. Modular tool system. Cutting tools for milling machines. End mills. Mechanical and disc cutters. Cutting tools for drilling and boring machines. Drill. Vertical drills, reamers, taps. Boring tool.	4
Theme 3. The auxiliary tool for CNC machines	Classification of auxiliary tools for CNC machine tools. Systems support tool for turning machines. Systems of auxiliary tools for milling, drilling and boring machines.	2
Theme 4. Methods of setting, measuring and control	Installation and alignment of technological devices. Determination of the workpiece coordinate system. Measuring tool options. Dimensional adjustment of the cutting tool. Setting tool outside the machine. Measurement tool data by touching. Tool length compensation. Pass test method. Setting up a test batch of parts.	2
	Exercise: Setting up and configuring the instrument to perform the turning operation of the machine EMCOConceptTurn55	4
	Exercise: Setting up and configuring the instrument to perform milling operations on the machine EMCOConceptMill55	4
	Laboratory work: Setting up and configuring the instrument to perform the turning operation of the machine EMCOConceptTurn250	12
	Laboratory work: Setting up and configuring the instrument to perform milling operations on the machine EMCOConceptMill250	12
Module 3. Program machining in various CNC systems		
Theme 1. Introduction to handling programming	CNC machine coordinate system. Machine zero point and the direction of movement Zero point of the program and the work coordinate system. Compensation of the tool length. Absolute and relative coordinates Comments to the UE, and setting up the card.	2

	Base M and G codes, program structure Data word and address number. Modal and non-modal codes. The format of the program	
	Practical lesson: study of the interface of the EMCO training module, entry panel information management system, the control panel of the machine	2
Theme 2. Processing Programming for CNC lathes among the Sinumerik 810D/ 840D and WinNC for Sinumerik Operate	Basics: the basic point, zero offset, the coordinate system, programming in absolute and relative size (in increments). The tool data. Interface elements, review the most important functions of the keys. Turning and moving the origin. Basic modes of operation of CNC system. Jog Mode. MDA mode. Auto mode. Programming. G and M-commands. Cycles. Linear and circular interpolation. Positioning. Contouring mode. Selection of the working plane. Tapping. Drilling cycles, turning cycles. Frames. Subroutines. Processing modes programming. Correction tool. Dimensional binding instrument. Testing program. Terms, program selection, start, stop. Messages during program run, program control, block search.	2
	Exercise: Commissioning a lathe EMCOConceptTurn 55 in the system WinNCforSinumerikOperate	2
	Exercise: Computer simulation of turning in the program of Win 3D-Vier	2
	Laboratory work: Programming turning from the counter machine EMCOConceptTurn250	12
Theme 3. Processing Programming for CNC milling machines in the environment of Sinumerik 810D / 840D and WinNC for Sinumerik Operate	Basics: the basic point, zero offset, the coordinate system, programming in absolute and relative size (in increments). The tool data. Interface elements, review the most important functions of the keys. Turning and moving the origin. Basic modes of operation of CNC system. Jog Mode. MDA mode. Auto mode. Programming. G and M-commands. Cycles. Linear and circular interpolation. Positioning. Contouring mode. Selection of the working plane. Tapping. supply programming. Drilling cycles, chamfering, rigid tapping, boring. Milling cycles: mechanical, contour milling, thread milling, milling slots, pockets. Frames. Routines. processing modes Programming. Correction tool. Programming and tool change. Dimensional binding instrument. Testing program. Terms, program selection, start,	2

	stop. Messages during program run, program control, block search. Flexible programming. Alarms and messages.	
	Exercise: Setting up the milling EMCO Concept Turn 55 machine system WinNC for Sinumerik Operate	2
	Exercise: Computer simulation of milling in the program Win 3D-Vier	2
	Laboratory work: Programming milling machine from a rack EMCOConceptMill250	12
Theme 4. Processing Programming for CNC milling machines in the system Fanuc OM / 21M and WinNC Fanuc 0-MC	Basics: the basic point, zero offset, the coordinate system, programming in absolute and relative size (in increments). The tool data. Interface elements, review the most important functions of the keys. Turning and moving the origin. Basic modes of operation of CNC system. Jog Mode. MDA mode. Auto mode. Programming. G and M-commands. Cycles. Linear and circular interpolation. Positioning. Contouring mode. Selection of the working plane. Tapping. supply programming. Drilling cycles, chamfering, rigid tapping, boring. Milling cycles: mechanical, contour milling, thread milling, milling slots, pockets. Frames. Routines. processing modes Programming. Correction tool. Programming and tool change. Dimensional binding instrument. Testing program. Terms, program selection, start, stop. Messages during program run, program control, block search. Flexible programming. Alarms and messages.	2
Module 4: Preparation of control programs in the CAD/CAM systems		
Theme 1. Review of modern CAD / CAM systems	The concept of computer-aided design systems. CAD in computer - integrated manufacturing. Classification and comparative analysis of the CAD / CAM systems. Simulation and verification processing. Postprocessing.	2
Theme 2: Preparation of programs for CNC lathes in the software environment EMCO CAMConceptTurning	Basic operation in CAMConceptTurning system. The type and structure of the windows of CAD and CAM modules. Basic action and menu items. Basic commands in the CAD mode. The choice of the coordinate system, the creation of circuit elements. Entering text, dimensions, symbols, building and editing geometry in the CAD model of a part unit. Basic commands in the CAM mode. Selection of the machine, the composition and parameters of	2

	the cutting tool, dimensions of input untreated blank. Input processing circuit. Definition of processing cycles. 2D-simulation cycles. Enter the geometry data in a cycle of technological modes, sequence roughing and finishing passes, tool changer. Turning cycle (boring), threading, grooving, cutting, turning on the contour, drilling. Setting tool movement (positioning), enter the necessary technological data (tool number, direction of rotation, feed rate, spindle speed). editing software cycle DIN / ISO code. Review of M, G-commands for turning. The cycle of coordinate transformations. 3D-modeling mode (simulation) processing program. controls, error signals, configure 3D-modeling. Modeling tools in the program 3D-ToolGenerator. Tool sort function (by type of instrument) Working in the program execution mode NC (NC). NC screen layout, the program CNC control elements	
	Practical exercise: Building a geometric model of the part for turning operation.	2
	Practical exercise: Determination of cycles of machining and edit the control program	2
	Practical exercise: Verification processing program in 3D simulation (simulation processing). The mode of execution of the NC program	2
	Laboratory work: Development pack turning operation in the system CAMConceptTurning with debugging and machining EMCOConceptTurn 250	6
Theme 3. Preparation of control programs for CNC milling machines in a software environment EMCO CAMConceptMilling	The type and structure of the windows of CAD and CAM modules. Basic action and menu items. Basic commands in the CAD mode. The choice of the coordinate system, the creation of circuit elements. Entering text, dimensions, symbols, building and editing geometry in the CAD model of a part unit. Basic commands in the CAM mode. Selection of the machine, the composition and parameters of the cutting tool, dimensions of input untreated blank. Input processing circuit. Select (change) the starting point and the working current direction. Setting form and holes system. Definition of processing cycles. Work cycles 2D-simulation mode.	2

	Enter the geometry data for milling operations. Imports coordinates from the drawing elements and points (CAD module). Input process data for milling cycle (tool direction of rotation, feed rate, spindle speed for the roughing and finishing transitions). Specifying the positioning and movement of the tool. Drilling cycles, centering, boring, reaming, tapping, thread milling, face milling, slot milling, pockets, studs Islands, contour milling, engraving, milling text. editing software cycle DIN / ISO code. Review of M, G-Team for milling. The cycle of coordinate transformations. 3D-modeling mode (simulation) milling program. controls, error signals, configure 3D-modeling. Modeling tools in the program 3D-ToolGenerator (to create a new or modify existing tools, 3D-visualization tool). Tool sort function (by type of instrument) Working in the program execution mode NC (NC). NC screen layout, control elements of the program the CNC. The use of peripheral functions (control auxiliaries NC).	
	Practical exercise: Building a geometric model of a part for milling operations.	2
	Practical exercise: Determination of the part cycles and NC editing for milling operations	2
	Practical exercise: Checking milling programs 3D-modeling mode (machining simulation). Working in the NC program execution	2
	Laboratory work: Development of NC milling operations CAMConceptMilling system debugging and machined EMCOConceptMill 250	6

1.10 An exemplary theme of the program assessment

1. Development of a control program for turning operations.
2. The development of the control program of the milling operation.

1.10.1. Assessment questions

1. What are the advantages of automated production based on CNC machines?
2. Describe the purpose of the CNC machine functional subsystems.
3. What are the main functions of the CNC control system?
4. How are drives and CNC machine operated?
5. Describe the structure and operation of the stepper motor.

6. Why do the modern machines mainly use servo motors instead of stepper motors?

7. How does the feedback subsystem of the machine relate to the control program?

8. What are the main types of sensors used in the feedback subsystem?

9. What kind of programming language for processing CNC machines today is the most common?

10. What is the interpretation and interpolation frame?

11. How is the change and correction of tool dimensions done?

12. Is the processing of the exact details provided by the correction of errors and mechanical measuring devices CNC machine?

13. What is the adaptive control of machining?

14. What are the technological capabilities of various types of CNC machine tools?

15. What causes the displacement discontinuity of mining executive bodies of the CNC machine?

16. What determines the accuracy of CNC machine tools?

17. Determine the area of the effective application of CNC machine tools in the conditions of modern production.

18. What is the flexible production module?

19. How are flexible manufacturing systems and flexible automated lines operated?

20. What tooling is used for CNC machines?

21. What are the common features of cutting tools for CNC machines?

22. What coding system for tool materials and tools for CNC machine is used?

23. What is an auxiliary tool?

24. Give an auxiliary tool for the classification of CNC machine tools.

25. How are technological devices installed and aligned on CNC machines?

26. Which of the coordinate systems is considered when processing CNC machines?

27. How are the parameters of the cutting tool and dimensional adjustment of the instrument measured?

28. What is the length offset and tool radius?

29. How is the tool data measured by touching?

30. How does the machine setting method CNC test pass and test batch of parts?

31. Where in the coordinate system of the lathe (milling) CNC machine is zero and how are the directions of movement determined?

32. What are the zero point of the program and the operating system of coordinates?

33. What software is used to set a UP code on a PC?

34. List the most important items of basic safety rules in the operation of CNC machine tools.

35. What is the programming in absolute and relative coordinates?

36. What is the structure of the control program?

37. What is the set-up card and who is in charge of control program preparation?

38. What are the G and M codes? Give examples of the base G and M codes.

39. What are the comments in control program?

40. What is the modal and non-modal codes?

41. How is the accuracy of control program on your computer checked?

42. What is DNC mode?

43. What is the sequence of a complete check of the control program?

44. What is the rule of "right hand" to determine the direction of the axes of the coordinate system of the machine?

45. What is the base point for the spindle?

46. What should I do first after turning the machine?

47. What codes are used to determine the operating system of coordinates?

48. What is tool length compensation?

49. What is the control program block?
50. What is the word data?
51. List the functional groups of codes.
52. What is needed in the NC security line?
53. What is the format of NC?
54. Appointment of G00 and G01 codes.
55. Why should you exercise extreme caution when working with the G00?
56. What is the difference between the codes G02 and G03?
57. What is in the frame circular interpolation point I-, J-, data K-word?
58. How is the NC block movement in an arc using the data R-word described?
59. List the main M-codes.
60. What are the commands for the automatic tool change. Describe the typical behavior of the machine during tool change.
61. What is the difference between the codes M03 and M04, M30 and M02, M00 and M01?
62. List the main modes of the CNC system.
63. How is the Jog Mode used?
64. What is the mode of the MDA operation? What is the difference from the automatic mode?
65. What is called a constant cycle?
66. List the main drilling cycles.
67. What is the plane of the discharge? What is the difference from the initial plane?
68. Why do we need to specify the code G80 in the NC?
69. Why is intermittent drilling cycle used?
70. What are Q- and R-word?
71. What is the difference between G98 and G99 in regular cycles?
72. Why is the automatic correction function on the tool radius used?
73. List the G-codes for automatic tool radius compensation.
74. What needs to be specified in the NC before - tool length compensation or an automatic tool radius compensation?
75. What is a subroutine?
76. What is the difference of the internal routines external routines?
77. Why are codes M98 and M99 used?
78. Can a single subroutine call another subroutine?
79. What are the features of the programming of the 4th axis (rotary table).
80. What is a Macro?
81. How are treatment regimes programmed?
82. How is the program worked out?
83. What is meant by flexible programming?
84. What is CAD / CAM systems?
85. What is the advantage of UP preparation using CAD / CAM systems?
86. What is the difference between simulation and verification of NC?
87. Basic principles of operation in CAMConcept system.
88. Purpose and basic steps in the CAD module.
89. Appointment of CAM module and core team in the CAD mode.
90. What is the 2D-modeling of processing cycles CAMConcept system?
91. How is in CAMConcept system cycles of software DIN / ISO code implemented?
92. How to enable and configure 3D-modeling mode (simulation) processing program?
93. How is the tool in the program 3D-ToolGenerator modelled?
94. Describe the work of CAMConcept system runtime NC (NC operation).
95. How is the transfer prepared in CAD / CAM NC system on the machine CNC stand?

1.11 Material and technical conditions of implementation of the program

For the implementation of the program students will use interactive classrooms of the Department of engineering, there will be personal computers with special software with simulators of the company Arinstein for programming various CNC systems equipped with lathes and milling machines with CNC of the company EMCOMaierGmbH (Austria) ConceptTurn 55, 55 ConceptMill, ConceptTurn 250, 250 ConceptMill and machines company KnuthWerkzeugmaschinenGmbH (Germany) Ratih ATP PicoMill CNC (audience 7204, 5405).

1.12 Information Support program

The list of recommended textbooks, online resources for further reading.

Main sources:

1. Serebrenitsky P.P. Programming automation equipment: a textbook for high schools; Part 1 / P.P.Serebrenitsky, A.G. Skhirtladze. M .: Bustard, 2008. - 576 p.

2. Lovygin A.A., Teverovsky L.V. Sovremenny CNC and CAD / CAM-sistema. Moskva: DMK Press, 2015.- 278 p.

3. Automation of production processes in mechanical engineering: a textbook for technical colleges / N.M. Kapustin, P.M. Kuznetsov, A.G. Skhirtladze etc .; Ed. N.M. Kapustin. - M .: Higher. wk. 2004. - 415 p.

4. Gzhirov R.I., Serebrenitskiy P.P. Programming processing on CNC machines: A Handbook. - L .: Mechanical engineering. Leningrad dep-set, 1990. - 588 p.

Additional Resources:

1. EmcoConceptTurn 55.Lathe with slant bed: description of the machine EmcoConceptTurn 55. Room EN 1055. Version A2003-04. – 39 S.

2. EmcoConceptMill 55. Milling machine with PC-based control for training purposes: description of the machine EmcoConceptMill 55. Room EN 2055. ВерсияA2003-09. – 51 S.

3.EmcoConceptTurn 250. Two-axis lathe with a computer numerical

program management for the processing of cartridges and support:a description of the machine ConceptTurn 250. The original room DE 1250. Edition A2007-12.-98 C.

4. EmcoConceptMill 250. Vertical machining center CNC: description of the machine EmcoConceptMill 250. Edition Specifier A2009-09.– 80.

5. EmcoConceptMill 250. Vertical machining center CNC. Programming/Management. Replaceable CNC system PLC ConceptMill 250 V1.01. A2009-07. – 24 p.

6. T. EMCO CAMConcept Software description - software version 2.0 or higher Software description EMCO CAMConcept Turning. Ref. no.EN 1829. Edition C 2009-10. – 186 p.

7. M. EMCO CAMConcept Software description - software version 2.0 or higher Software description EMCO CAMConceptMilllling. Ref.No. EN 1828. Edition C 2009-10. – 194 p.

8. Programming manual CNC SimensSinumerik 802 baseline.

9. Software description Milling machine with EMCOWinNC for SinumerikOperate. Ex. No. EN 1848. Revision B 2013-06.

10. Software description Lathe with WinNC for SinumerikOperate. Ex. No. EN 1849. Revision B 2013-06.

11. Guide installation, operating and maintenance obsluzhivayuschuyu for the preset tool E236N. Ed. 1.1 – 03/11.

12. The professional standard "Specialist in computer aided design technological processes". The Ministry of labour and social protection of the Russian Federation. Order No. 1158n from December 26, 2014

13. The professional standard "Specialist in the development of technologies and programs for equipment with numerical control". The Ministry of labour and social protection of the Russian Federation. Order 229n April 11, 2014

14. The professional standard "Specialist commissioning and testing of technological equipment of mechanical Assembly production". The Ministry of labour and social protection of the Russian Federation. Order No. 1025n from 11 December 2014

15. Professional standard "Operator-Adjuster machining centers with numerical control". The Ministry of labour and social protection of the Russian Federation. Order No. 530n from August 4, 2014.

Internet resources:

1. ЧПУ-станки.РФ
2. www.emco.at
3. www.arinstein.com
4. planetacam.ru
5. www.adem.ru/

1.13 The electronic version of the teaching kit program

The content of the electronic version of the teaching kit program:

- Training program in electronic format;
- Demo presentation showing the structure and content of the lecture material in electronic format;
- Handouts used during lectures, laboratory and practical works, in electronic format;
- A list of exemplary subjects of certification for the program, in electronic format;
- Guidelines for students for laboratory and practical works.