

REVIEW

on a dissertation work for the acquisition of an educational and scientific degree "PhD"
field of higher education - 5. Technical sciences
professional direction - 5.1. Mechanical Engineering
specialty - Engineering Technology

Author of the dissertation: M.Sc. Eng. Nikolaj Penkov Kolev

Dissertation topic: "Optimization of technological processes for part processing on CNC machines with robotic feeding"

Member of the jury: Prof. PhD. Eng. Galina Ivanova Nikolcheva

1. Relevance and novelty of the problem developed in the dissertation in scientific and scientific-applied terms.

Modern mechanical engineering is entirely implemented on CNC machines. In recent years, to unleash the full potential of these machines, robotization systems have been implemented for processes. Robots for servicing CNC machines provide reliable, fast and safe manipulation of blanks and finished parts, eliminating or significantly reducing downtime. The basis of the dissertation is the optimization of technological processes in turning on CNC machines with robotic power supply. The topic is strategic for the development of the Bulgarian industry in the context of its integration into the European production network and achieving the goals of Industry 4.0 and the expectations for Industry 5.0. It follows that the dissertation work is relevant and reflects the innovations in the research area.

2. Degree of knowledge of the state of the problem and creative interpretation of the literary material.

The literature used contains a total of 126 sources, of which 7 are in Cyrillic, distributed as follows: 1) in Cyrillic: textbooks – 6 issues, conference reports – 1 issue; the remaining 119 are in Latin, with 32 being Internet addresses and catalogs. The literature review examined developments in the research area, which shows that the dissertation candidate is familiar with the technological processes for machining parts on CNC machines and on this basis the goal of the dissertation work and the tasks for its achievement were formulated. I give a high score in terms of the degree of knowledge of the state of the problem and the creative interpretation of the literary material.

3. Research method

The main research method is experimental research and the optimization models derived from them.

The chosen methodology for experimental research fully corresponds to the set goal and tasks. The application of the created methodology has made it possible to obtain theoretical and

experimental dependencies taking into account the influence of the technological parameters of the process of CNC turning with robotic feeding.

4. Brief description of the material on which the contributions of the dissertation are built.

The dissertation consists of 113 pages and is divided into 4 chapters and a conclusion. There are 3 appendices to the dissertation in a volume of 40 pages.

Chapter 1 analyzes the problem of robotization of CNC production, uniting the technological, economic and organizational aspects of the topic. This in turn determines the need for research aimed at optimizing CNC processes through robotic feeding, based on both a theoretical model and experimental data. On this basis, the goal of the dissertation and the tasks for its achievement are formulated.

Chapter 2 contains research and modeling of the technological parameters of the turning process on CNC machines with robotic feed. The chapter contains information about the materials, equipment and supplies. Here, an experimental study of the influence of cutting conditions on the main technological parameters of the CNC turning process with robotic feed - productivity, durability of cutting tools and roughness of the machined surfaces, and obtaining corresponding theoretical and experimental models have been carried out. Two robotic stations have been studied: Fanuc LR Mate 200iD/7L and Mitsubishi RV-8CRL. The experimental study was implemented through a planned experiment. The results of the studies have been processed with QstatLab and theoretical and experimental models have been obtained. To determine the influence of the controlling factors on the roughness and to determine the influence of the controlling factors on the studied parameters, an analysis of variance using ANOVA was conducted.

In Chapter 3, a multi-objective optimization of the turning process is performed, with the aim of the study being to determine the cutting mode that provides the best combination of the technological parameters of the CNC turning process with the two robotic feeding stations (maximum productivity; maximum durability of the cutting tools and minimum roughness of the machined surfaces). A methodology for multi-objective compromise optimization of the conditions of the turning process is proposed: determination of a compromise optimal area; optimization by the generalized arithmetic mean utility function with weighting coefficients. The optimal cutting modes are determined by the two optimization methods using the Fanuc LR Mate 200iD/7L and Mitsubishi RV-8CRL robotic stations. A comparative analysis of the technological parameters of the process for the cutting modes determined by the two optimization methods is performed.

Chapter 4 determines the number of cutting tools that ensure a continuous work cycle on CNC lathes with robotic feeding. A methodology has been developed to determine the required number of cutting tools for operations performed on CNC lathes with robotic feeding, depending on their durability under a certain cutting mode, the capacities of the tool magazine and the feeding mechanism, and the volume of the production batch. The methodology allows for predicting the number of processed parts at which a given tool becomes unusable, which necessitates the activation of additional tools.

The last chapter is a conclusion, which provides general conclusions and findings. Based on the results of the conducted research, the main conclusions of the work are formulated and the contributions of the dissertation are presented.

5. Contributions of the dissertation

In the development of the dissertation, scientific and applied contributions have been achieved. I accept all contributions.

Scientific and applied contributions are:

- Experimental models of the parameter Ra of roughness, productivity and durability of cutting tools when machining on CNC turning machines with two types of robotic feeding stations.
- Methodology for multi-objective compromise optimization of the CNC turning process with robotic feeding.
- Methodology for determining the number of cutting tools to ensure a continuous work process depending on the durability of the tools, the capacity of the tool magazine and the feeding mechanism and the volume of the production program.

Applied contributions are:

- Optimal cutting modes when turning improved steel 42CrMo4 on CNC lathes with robotic stations.
- Algorithm for a software product for controlling the operation of CNC lathes with robotic feeding, ensuring a continuous production process for a given batch of parts.

6. Assessment of publications on the dissertation work

7 publications have been made on the content of the dissertation work as follows: 5 reports at scientific conferences in Bulgaria; 2 reports at a scientific conference abroad (Rezekne, Latvia), which are on Scopus. In two of the reports, the doctoral student is in first place. All are in English. The publications sufficiently reflect the nature of the dissertation work, the formulated contributions, and fully cover the content of the dissertation work. I believe that the main contribution in carrying out the experimental and statistical processing of the results is the personal work of the doctoral student. There is a lack of data on the citations of the scientific publications and the practical implementation of the obtained results.

7. Notes on the dissertation Using the results of the dissertation in scientific and social practice

I highly appreciate the presented dissertation. I am particularly impressed by the graphic design of the work. I have no comments of a principled nature. I highly appreciate the two appendices, which provide all the data from the experimental studies. The appendix also contains a review from the renowned company "Iskar", which confirms the usefulness of this dissertation for the industry.

8. Conclusion with a clear positive or negative assessment of the dissertation work.

Based on my familiarization with the presented dissertation work and the related publications and contributions, I believe that the dissertation work meets the requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria. The achieved results give me reason to propose to the esteemed scientific jury to award the educational and scientific degree "Doctor" to M. Eng. Nikolay Penkov Kolev in the field of higher education - 5. Technical sciences, professional field - 5.1. Mechanical engineering, doctoral program "Technology of mechanical engineering".

Sofia

Date: 07.05. 2026

Reviewer:

(Prof. PhD Eng. G. Nikolcheva)