

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
VINNYTSIA NATIONAL TECHNICAL UNIVERSITY

SCIENTIFIC WORKS OF VINNYTSIA NATIONAL TECHNICAL UNIVERSITY

Scientific journal

Founder and publisher: Vinnytsia National Technical University

Frequency: 4 times a year

Founded in October 2006

№ 3 2017

Founded according to the
decision of the Rector's Office of Vinnytsia National
Technical University
Minutes №6 of 02.10.2006

©Vinnytsia National Technical University, 2017

Vinnytsia VNTU 2017

Scientific Journal «Scientific Works of Vinnytsia National Technical University» is the edition, included in the List of scientific professional periodicals in Ukraine in the sphere of engineering sciences (it is assigned the B category) on specialties: 01.05.00, 05.02.02, 05.02.10, 05.03.05, 05.09.03, 05.11.00, 05.13.05, 05.13.06, 05.12.13, 05.12.20, 05.14.02, 05.14.06, 05.22.20, 05.23.02, 05.23.05 (Order of the Ministry of Education and Science of Ukraine № 893 of 04.07.2013, appendix 6).

Journal is included for indexing in the international scientometric base PIHLI.

The aim of the edition is publication of new scientific information, obtained as a result of the research activity of leading scientists of Ukraine, other countries and its communication in Ukraine and a broad. The content of the edition comprises the original scientific articles or articles of the survey character which have not been published before. The journal is bilingual, it is published in Ukrainian, Russian and English languages, «Scientific works of Vinnytsia National Technical University» is a quarterly journal.

Sections of the Journal:

- ☐ automation and information measuring equipment;
- ☐ construction;
- ☐ research results application;
- ☐ power generation, electrical engineering, electromechanics;
- ☐ information technologies and computer engineering;
- ☐ machine-building and transport;
- ☐ radioelectronics and radioelectronic equipment design;
- ☐ anniversaries and jubiliates.

Website of the Journal: <https://praci.vntu.edu.ua>

Address of the Editorial Board :

VNTU, office 110, 95
Khmelnyske Shose Str.,
Vinnytsia, Ukraine, 21021

Contacts:

E-mail: praci_vntu@vntu.edu.ua

Editorial Board

Editor-in-Chief

Lezhniuk P. D., Doctor of Science (Eng.), Professor (VNTU).

Deputy Editor-in-Chief

Grabko V. V., Doctor of Science (Eng.), Professor (VNTU).

Executive Editor

Netrebbskyi V. V., Candidate of Science (Eng.) Associate Professor (VNTU).

Charged with English translation

Veremienko S. Ya., Managing Editor (VNTU), **Yablonska S. Z.**, Editor (VNTU).

Charged with Editing

Pyast N. Y., Technical Editor, Candidate of Science (Philology) (VNTU).

Members of the Editorial Board

Engineering Sciences:

Azarov O. D., Doctor of Science (Eng.), Professor (VNTU); **Bilynskyi Y. Y.**, Doctor of Science (Eng.), Professor (VNTU); **Burbelo M. Y.**, Doctor of Science (Eng.), Professor (VNTU); **Varetskiy Y. O.**, Doctor of Science (Eng.), Professor (NU «Lvivska Polytehnika»); **Vasylenko V. V.**, DPh, Professor (New University of Lisbon, Portugal); **Voitsek V.**, Doctor of Science (Eng.), Professor (State University «Lublińska Polytehnika», Poland); **Grabko V. V.**, Doctor of Science (Eng.), Professor (VNTU); **Graboviy P. G.**, Doctor of Science (Eng.), Professor (MSCU, Russia); **Gotra Z. Y.**, Doctor of Science (Eng.), Professor (NU «Lvivska Polytehnika»); **Divak M. P.**, Doctor of Science (Eng.), Professor (TNEU); **Drukovaniy M. F.**, Doctor of Science (Eng.), Professor (VNTU); **Dubovoi V. M.**, Doctor of Science (Eng.), Professor (VNTU); **Dudar I. N.**, Doctor of Science (Eng.), Professor (VNTU); **Zlepko S. M.**, Doctor of Science (Eng.), Professor (VNTU); **Iskovych-Lototskyi R. D.**, Doctor of Science (Eng.), Professor (VNTU); **Karpov Y. O.**, Doctor of Science (Eng.), Professor (VNTU); **Kvietnyi R. N.**, Associate Member of National Academy of Pedagogical Sciences of Ukraine (NAPSU), Doctor of Science (Eng.), Professor (VNTU); **Kychak V. M.**, Doctor of Science (Eng.), Professor (VNTU); **Kuzmin I. V.**, Doctor of Science (Eng.), Professor (VNTU); **Kulyk A. I.**, Doctor of Science (Eng.), Professor (VNTU); **Kutin V. M.**, Doctor of Science (Eng.), Associate Professor (VNTU); **Kucheruk V. Y.**, Doctor of Science (Eng.), Professor (VNTU); **Kukharchuk V. V.**, Doctor of Science (Eng.), Professor (VNTU); **Livinskiy O. M.**, Doctor of Science (Eng.), Professor (O. Dovzhenko GSPU); **Mykhalevych V. M.**, Doctor of Science (Eng.), Professor (VNTU); **Mokin B. I.**, Academician of National Academy of Pedagogical Sciences of Ukraine (NAPSU), Doctor of Science (Eng.), Professor (VNTU); **Mokin V. B.**, Doctor of Science (Eng.), Professor (VNTU); **Mokin O. B.**, Doctor of Science (Eng.), Professor (VNTU); **Morgun A. S.**, Doctor of Science (Eng.), Professor (VNTU); **Ogorodnikov V. A.**, Doctor of Science (Eng.), Professor (VNTU); **Osadchuk V. S.**, Doctor of Science (Eng.), Professor (VNTU); **Osadchuk O. V.**, Doctor of Science (Eng.), Professor (VNTU); **Pavlov S. V.**, Doctor of Science (Eng.), Professor (VNTU); **Perevoznikov S. I.**, Doctor of Science (Eng.), Professor (VNTU); **Petukh A. M.**, Doctor of Science (Eng.), Professor (VNTU); **Petruk V. G.**, Doctor of Science (Eng.), Professor (VNTU); **Politanskiy L. F.**, Doctor of Science (Eng.), Professor, (Yu. Fedkovych ChNU); **Ranskyi A. P.**, Doctor of Chemistry, Professor (VNTU); **Roik O. M.**, Doctor of Science (Eng.), Professor (VNTU); **Romaniuk O. N.**, Doctor of Science (Eng.), Professor (VNTU); **Rusu Ioan**, Doctorate in Engineering, Professor (Gheorghe Asachi Technical University, City of Iasi, Romania); **Savuliak V. I.**, Doctor of Science (Eng.), Professor (VNTU); **Sakhno V. P.**, Doctor of Science (Eng.), Professor (National Transport University); **Sivak I. O.**, Doctor of Science (Eng.), Professor (VNTU); **Serdiuk V. R.**, Doctor of Science (Eng.), Professor (VNTU); **Stratan Ion**, Doctor of Science (Eng.), Professor (Technical University of Moldova, Moldova); **Tkachenko S. Y.**, Doctor of Science (Eng.), Professor (VNTU); **Khos Khim Triu**, Doctor of Science (Eng.), Professor (Technical University of Hamburg-Hamburg, Germany); **Filyniuk M. A.**, Doctor of Science (Eng.), Professor (VNTU); **Chystiakov V. V.**, Doctor of Science (Eng.), Professor (KNUCA); **Shynkaruk O. M.**, Doctor of Science (Eng.), Professor (KhNU).

List of Abbreviations:

VNTU – Vinnytsia National Technical University, Ukraine.

O. Dovzhenko GSPU – O. Dovzhenko Glukhiv State Pedagogical University, Ukraine.

Yu. Fedkovych ChNU – Yu. Fedkovych Chernivtsi National University, Ukraine.

MSUCE – Moscow State University of Construction, Russia.

KNUCA – Kyiv National University of Construction and Architecture, Ukraine.

TNEU – Ternopil National Economic University, Ukraine.

NU «Lvivska Polytechnica» – National University «Lvivska Polytechnica», Ukraine.

KhNU – Khmelnytskyi National University, Ukraine.

Responsible to sign-off Netrebbskyi V. V.