(faculty stamp) **COURSE DESCRIPTION**

1. Course title: ADVANCED PROGRAMMING OF INDUSTRIAL CONTROLLERS	**2. Course code: APIC**
3. Validity of course description: 2019/2020	
4. Level of studies: 2nd cycle of higher education	
5. Mode of studies: intramural studies	
6. Field of study: INFORMATICS	
7. Profile of studies: COMPUTER SCIENCE	
8. Specialty: INDUSTRIAL INFORMATICS SYSTEMS	
9. Semester: 2 and 3	
10. Faculty teaching the course: Institute of Informatics (RAu2)	
11. Course instructor: Piotr Gaj PhD, DSc Eng.	
12. Course classification: common courses	
13. Course status: obligatory	
14. Language of instruction: English	
15. Pre-requisite qualifications: • Fundamentals of Computer Science • Fundamentals of Computer Networks • Fundamentals of Programming	
16. Course objectives: The aim of the course is to introduce students into advanced topics of industrial programmable controllers used in control and industrial IT systems as well as to highlight the theoretical and practical issues of their programming. We discuss many advanced issues and specificity of industrial controllers programming and application. Students after this course should be able to configure programmable logic controllers (PLC), to design and create their software as well as to design distributed systems where the main nodes are programmable industrial controllers.	

17. Description of learning outcomes:

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1	Student possesses knowledge on programming tools, methods, languages, functional analysis and design of algorithms that can be used with programmable controllers in industrial facilities.	Written exam, Laboratory reports	Lectures, Laboratory classes, online stuffs	K2A_W09 K2A_W11
2	Student possesses knowledge on physical phenomena related to the interaction between information systems and the industrial environment.	Written exam, Laboratory reports	Lectures, Laboratory classes, online stuffs	K2A_W10
3	Student possesses knowledge on methods for evaluating the correctness, security and reliability of industrial controllers software.	Written exam, Laboratory reports	Lectures, Laboratory classes, online stuffs	K2A_W06

4	Student is able to accomplish the engineering and science challenges and propose improvements or alternatives to existing solutions in industrial computer systems.	Written exam, Laboratory reports	Laboratory classes, online stuffs	K2A_U01 K2A_U08 K2A_U09
5	Student is able, in accordance to the given specification, taking into account technical and non-technical aspects to design a complex system or IT process for industrial applications, and implement this project, at least in part, using appropriate methods, techniques, technologies and tools, by either adapting an existing or developing the new ones.	Written exam, Discussion, Laboratory reports	Laboratory classes, online stuffs	K2A_U10 K2A_U12 K2A_U13
6	Student is able to assess the usefulness of methods and tools for solving the engineering and science tasks in the field of computer science within the industrial systems domain, including the limitations of these methods and tools.	Written exam, Discussion, Laboratory reports	Laboratory classes	K2A_U11
7	Student is able to make an interaction and work in interdisciplinary group as a PLC system designer and programmer.	Discussion, Laboratory reports	Laboratory classes	K2A_U02
8	Student is aware of the social and educational role of an engineer and scientist.	Discussion, Laboratory reports	Lectures, Laboratory classes	K2A_K06

18. **Teaching modes and hours**
Lecture / BA / MA Seminar / Class / Project / Laboratory
30/0/0/0/0/45

19. Syllabus description:

Lecture:

- Industrial Programmable Controller:
  - classification, operation principles, hardware definition, review of contemporary solutions,
  - idea of operation, purpose of existence, and examples.
- Hardware description of devices:
  - modern hardware constructions, processors, memories, central units, racks and cassettes, io circuits, coprocessors, modules, power supply.
- Controller in work:
  - program execution, cycle definition, elements of the cycle, types of cycles, discussion of individual stages of the cycle, duration of the cycle, restart modes, persistence & retentiveness, interrupts, and examples.
  - discussion about PLC vs. DCS stations and other types of controllers.
- Hardware and software configuration of controllers:
  - concept of configuration, preparing a configuration according to the system requirements.
  - memory organization, data types, variables, system zones, variable allocation, block instances, types of addressing and types of memory access, retentive memory.
- Discussion of programming languages:
  - discussion of text and graphic languages including: STL, IL, LD, FBD, ST, SFC, GRAPH, CFC, C,
  - discussion about automatic code generation,
  - language conversion.
- Discussion of the standardization:
  - discussion of IEC 61131 Parts 1-9 with particular reference to Part 3.
  - discussion of IEC 61499.
- Programming elements:
  - common elements shared between different languages,
  - addressing and inter-module communication.
- Overview of the commands list:

- discussion of the advanced instructions for the Simatic/GE IP PACSystems, and other platforms with examples.
- Discussing examples of programs for various platforms:
  - examples of code that performs specific tasks, discussion of a practical problem being solved, discussion of the method of the presented solution and alternative solutions.
- Description of phenomena occurring in each of the controller elements:
  - discussion of phenomena at the interface between the central unit and the coprocessor,
  - cooperation with the computer network, cooperation and other drivers.
- Good practices while programming

Laboratory:

- Discussion of advanced functions of programming tools
  - presentation of contemporary development environments for various hardware platforms together with a discussion of the most important functions and showing examples of the real projects,
  - block interfaces, instances, global and local variables,
  - work with time oriented tasks,
  - programming sequential machines.
- Implementation of practical tasks in real devices including:
  - configuring the devices and projects,
  - the students work in the groups and with laboratory systems,
  - PLC cooperation in many logical subsystems and one physical system.
- Practical comparison:
  - Dedicated programming languages with the universal ones.
  - Logic languages with the sequential description languages.
  - Programming the models of real machines.
- The tasks being made during the classes are usually a part of the real solutions. To highlight the important problems of programming industrial controllers the tasks might be either elements of real applications or specially prepared ones.

20. Examination: yes

21. Primary sources:

[1]. Rabiee Max, Programmable Logic Controllers: Hardware and Programming 4th Edition, ISBN-13: 978-1631269325, Goodheart-Willcox Publisher, 2017

[2]. Green Curtis, Learn How To Program And Troubleshoot Ladder Logic, ISBN-13: 978-1508474920, CreateSpace Independent Publishing Platform, 2015

[3]. Petruzella Frank D., Programmable Logic Controllers 5th Edition, ISBN-13: 978-0073373843, Mc Graw Hill, 2017

[4]. Kevin Collins, PLC Programming for Industrial Automation, November 14, 2006, ISBN-10: 1846854962, ISBN-13: 978-1846854965

[5]. Gary Dunning, Introduction to Programmable Logic Controllers, 3rd edition, 2006, Delmar ISBN 0-7668-1768-7

[6]. William Bolton, Programmable Logic Controllers, Newnes, 2006

[7]. Wilamowski, B.M. and Irwin, J.D. The Industrial Electronics Handbook, Second Edition - Five Volume Set, Taylor & Francis 2011, USA

[8]. Wilamowski, B.M. and Irwin, J.D. Fundamentals of Industrial Electronics, CRC Press 2011, USA

[9]. Wilamowski, B.M. and Irwin, J.D. Industrial Communication Systems, CRC Press 2011, USA

[10]. Piotr Gaj, "Wybrane zagadnienia projektowania informatycznych systemów przemysłowych", Studia Informatica, Gliwice 2016

[11]. Online: Relevant papers published by IEEE Transactions on Industrial Informatics (ieeexplore.ieee.org)

[12]. Online: Relevant papers published by LNCS, CCIS (link.springer.com)

[13]. Online Wikibooks: Introductory PLC Programming

[14]. Online: Nebojsa Matic, Introduction to PLC controllers, microE

22. Secondary sources:

[1]. Kasprzyk Jerzy, Programowanie sterowników przemysłowych, ISBN 9788363623241, WNT, Warszawa 2014

[2]. Roman Mielcarek „Programowanie Sterowników PLC – przewodnik do ćwiczeń laboratoryjnych" Wydawnictwo Politechniki Poznańskiej, 2012

[3]. Kacprzak S.: Programowanie sterowników PLC zgodnie z normą IEC61131-3 w praktyce. BTC 2011.

[4]. Król Artur, Moczko-Król Joanna "S5/S7 Windows. Programowanie i symulacja sterowników PLC firmy Siemens", Nakom

[5]. Dworak Paweł, Pietrusewicz Krzysztof, „Programowalne Sterowniki Automatyki PAC", Nakom

[6]. Sałat Robert, Korpysz Krzysztof, Obstawski Paweł „Wstęp do programowania sterowników PLC", WKIŁ 2010

[7]. Kwaśniewski Janusz.: Sterowniki PLC w praktyce inżynierskiej. BTC 2008.

[8]. Kwaśniewski Janusz „Programowalny sterownik SIMATIC S7-300 w praktyce inżynierskiej", BTC

[9]. Kwaśniewski Janusz, „Programowalne sterowniki przemysłowe w systemach sterowania" Wydawnictwo AGH 1999.

[10]. Kwiecień Roman „Komputerowe systemy automatyki przemysłowej" Helion 2012

[11]. Bogdan Broel-Plater, „Układy wykorzystujące sterowniki PLC – projektowanie algorytmów sterowania", PWN 2008

[12]. „Programowalne sterowniki PLC w systemach sterowania przemysłowego", Politechnika Radomska 2001

[13]. Jerzy Pasierbiński, T. Jegierski, „Programowanie sterowników PLC"

[14]. Andrzej Maczyński, „Sterowniki programowalne PLC. Budowa systemu i podstawy programowania"

[15]. Zbigniew Seta, „Wprowadzenie do zagadnień sterowania. Wykorzystanie programowalnych sterowników logicznych PLC."

[16]. Włodzimierz Solnik, Zbigniew Zajda "Sieci przemysłowe Profibus DP i MPI w automatyce", Wyd. Politechniki Wrocławskiej

[17]. Mystkowski Arkadiusz, „Sieci przemysłowe PROFIBUS DP i PROFINET IO"

[18]. Science scripts Politechniki Śląskiej seria „Studia Informatica" ISSN 0208-7286

[19]. Archives of Control Sciences ISSN 1230-2384

[20]. Science scripts AGH seria Automatyka ISSN 1429-3447

[21]. Science scripts AGH seria Computer Science ISSN 1508-2806

23. Total workload required to achieve learning outcomes

No.	Teaching mode:	Contact hours / Student workload hours
1	Lecture	30/30
2	Classes	
3	Laboratory	45/45
4	Project	
5	BA/ MA Seminar	
6	Other (exam)	0/30
	Total number of hours	75/105

24. Total hours: 180

25. Number of ECTS credits: 5

26. Number of ECTS credits allocated for contact hours: 2

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 3

28. Comments:

Approved:

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(date, Instructor's signature) (date, the Director of the Faculty Unit signature)