TOMSK POLYTECHNIC UNIVERSITY
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

Director of *Institute of Cybernetics*
_______________ / *Dmitriy M. Sonkin*

**Parallel computing**

**Field of Study:** 09.03.04 Software Engineering

**Programme name:** Big Data Solutions

**Level of Study:** Master Degree Programme

**Year of admission:** 2019

**Semester, year:** 3

**ECTS:** 6
**Total Hours:** 216
**Contact Hours:** 64

- **Lectures:** 32
- **Labs:** 16
- **Practical experience:** 16

**Assessment:** exam

**Department: Software Engineering**

**Head of Department** _________________________ V.S. Sherstnev

**Instructor(s)** _______________________ S.V. Axyonov

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**Parallel computing**

**Course Overview**

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| **Course Objectives** | Parallel computing focuses on the application of programming and problem-solving skills using parallel computation techniques to solve computationally intensive problems in a variety of disciplines. Parallel computation invites new ways of thinking about problems, and is an increasingly important skill in corporate and research environments.<br>Students will learn about programming paradigms used in parallel computation, about the organization of parallel systems, and about the application of programs and systems to solve interesting problems. Parallel computation is done on a variety of hardware platforms and requires a wide range of software tools to accomplish. As part of this class students will work with SMP (multi-core) machines, clusters, message passing interfaces, cluster management tools, and a variety of other high performance computing software and gear. |
| **Learning Outcomes** | As a result of mastering the discipline, the student must achieve the following results:<br>- Ability to use hardware supports parallel processing.<br>- Ability to design algorithms for high-performance computing.<br>- Ability to estimate performance of parallel and distributed algorithms.<br>Understanding the basics of the following technologies: GRID computing, GPU processing, multithreading. |
| **Course Outline** | *1.Organization of computing in multiprocessor systems*<br>*2.Worksharing in parallel and distributed software*<br>*3.Multithreading*<br>*4.High-performance GPU computing*<br>*5.Distributed computing in cluster systems*<br>*6.GRID computing*<br>*7.Effectiveness of parallel and distributed computing*<br>*8.Cloud services for high-performance computing* |
| **Prerequisites (if available)** | *Software Engineering, Operating systems* |
| **Course Structure** | *1.Organization of computing in multiprocessor systems*<br>*Basic terms and definitions.*<br>*2.Worksharing in parallel and distributed software*<br>*Work distribution. Basic algorithms.*<br>*3.Multithreading*<br>*Control multiple threads in SMP programs.*<br>*4.High-performance GPU computing*<br>*GPU memory and execution model. Optimizing of GPU-based solutions.*<br>*5.Distributed computing in cluster systems*<br>*Message passing interface. Multi process computing.*<br>*6.GRID computing*<br>*Basics of GRID data processing.*<br>*7.Effectiveness of parallel and distributed computing*<br>*Assessment of performance in high-performance computing.* |

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| | *8.Cloud services for high-performance computing*<br>*Modern cloud implementations for high-performance computing. IaaS, PaaS* |
| **Facilities and Equipment** | *Computer lab equipped by the following software: Microsoft Azure Machine Learning Workbench, Microsoft Visual Studio, Eclipse, R and Python compilers. Hardware supports CPU multithreading and GPU processing* |
| **Grading Policy** | *In accordance with TPU rating system we use:*<br><br>*Current assessment which is performed on a regular basis during the semester by scoring the quality of mastering of theoretical material and the results of practical activities (performance tests, perform tasks, problem solving). Max score for current assessment is 60 points, min – 40 points.*<br>*Course final assessment (exam/ credit test) is performed at the end of the semester. Max score for course final assessment is 40 points, min – 22 points.*<br>*The final rating is determined by summing the points of the current assessment during the semester and exam (credit test) scores at the end of the semester. Maximum overall rating corresponds to 100 points, min pass score is 80.* |
| **Course Policy** | *Class attendance will be taken into consideration when evaluating students' participation in the course / Students are expected to actively engage in class discussions about the assigned readings. / Attendance is strictly controlled. All classes is obligatory to presence.* |
| **Teaching Aids and Resources** | *Compulsory Readings:*<br><br>1. V. Rajaraman and C. Siva Ram Murthy Parallel Computers: Architecture and Programming. Prentice-Hall of India Pvt.Ltd - 2016, 492 pages. ISBN: 8120352629<br>2. Raja Malleswara Rao Pattamsetti Distributed Computing in Java 9 Packt Publishing, - 2017, 304 pages. ISBN: 9781787126992<br>3. Julian Shun Shared-Memory Parallelism Can Be Simple, Fast, and Scalable ACM Books - 2017, 444 pages. ISBN: 978-1970001914<br>4. Jaydip Sen Cloud Computing: Architecture and Applications. PE Press – 2017, 138 pages. ISBN 9789535132431<br>5. Duane Storti, Mete Yurtoglu CUDA for Engineers: An Introduction to High-Performance Parallel Computing Addison-Wesley Professional - 2015, 352 pages. ISBN: 978-0134177410<br>6. Jose M. Garrido Introduction to Computational Models with Python. CRC 2015, 496 pages. ISBN: 978-1498712033<br><br>*Additional Readings:*<br><br>1. Sabri Pllana, Fatos Xhafa Programming multicore and many-core computing systems. Wiley - 2017, 528 pages. ISBN: 978-0470936900<br>2. Zbigniew J. Czech Introduction to Parallel Computing. Cambridge University Press - 2017. 378 pages. ISBN: 978-1107174399<br>*3.* Eric Aubanel Elements of Parallel Computing Chapman and Hall/CRC - 2016, 222 pages. ISBN: 9781498727891<br>*4.* Jeffrey Aven Apache Spark in 24 Hours, Sams Teach Yourself. Sams Publishing - 2016, 592 pages. ISBN: 978-0672338519<br><br>Internet resources: |

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| | 1. NVIDIA SDK. The Essential Resource for GPU developers. https://developer.nvidia.com/<br>2. OpenCL overview – The Khronos Group Inc. https://www.khronos.org/opencl/<br>3. Parallel Python http://www.parallelpython.com/<br>4. MPI Forum http://mpi-forum.org<br>5. Apache Hadoop http://hadoop.apache.org/<br>6. Apache Spark – Lightning-Fast Cluster Computing. http://spark.apache.org/ |
| **Instructor (-s)** | *Axyonov Sergey Vladimirovich, PhD, Assistant professor, E-mail: axyonov@tpu.ru, Skype: axoenow.sergej, Mob. +79138874790* |