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| For Academic Affairs and Research Use Only |
| CIP Code:  |  |
| Degree Code: |  |

**New Emphasis, Concentration or Option Proposal Form**

**[ ] Undergraduate Curriculum Council**

**[X] Graduate Council**

Signed paper copies of proposals submitted for consideration are no longer required. Please type approver name and enter date of approval.

Email completed proposals to curriculum@astate.edu for inclusion in curriculum committee agenda.

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| Edward Hammerand | 9/27/2017 |

**Department Curriculum Committee Chair** |

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**COPE Chair (if applicable)** |
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| Hung-Chi Su | 9/27/2017 |

**Department Chair:**  |

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**Head of Unitb (If applicable)**   |
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| David F. Gilmore | 10/6/2017 |

**College Curriculum Committee Chair** |

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**Undergraduate Curriculum Council Chair** |
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| Anne A. Grippo  | 10/6/2017 |

**College Dean** |

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**Graduate Curriculum Committee Chair** |
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**General Education Committee Chair (If applicable)**   |

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**Vice Chancellor for Academic Affairs** |

**i. Proposed Program Title**

Master of Science in Computer Science with Emphasis in High Performance Computing

**ii. Contact Person** (Name, Email Address, Phone Number)

Dr. Hung-Chi Su, suh@astate.edu, 870-680-8119

**iii. Proposed Starting Date**

Spring 2018

**Bulletin Changes**

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| **Instructions**  |
| **Please visit** [**http://www.astate.edu/a/registrar/students/bulletins/index.dot**](http://www.astate.edu/a/registrar/students/bulletins/index.dot) **and select the most recent version of the bulletin. Copy and paste all bulletin pages this proposal affects below. Follow the following guidelines for indicating necessary changes.** **\*Please note: Courses are often listed in multiple sections of the bulletin. To ensure that all affected sections have been located, please search the bulletin (ctrl+F) for the appropriate courses before submission of this form.** - Deleted courses/credit hours should be marked with a red strike-through (~~red strikethrough~~)- New credit hours and text changes should be listed in blue using enlarged font (blue using enlarged font). - Any new courses should be listed in blue bold italics using enlarged font (***blue bold italics using enlarged font***)*You can easily apply any of these changes by selecting the example text in the instructions above, double-clicking the ‘format painter’ icon 🡪 , and selecting the text you would like to apply the change to.* *Please visit* [*https://youtu.be/yjdL2n4lZm4*](https://youtu.be/yjdL2n4lZm4) *for more detailed instructions.* |

Insert between page 262 and page 263262 of 2017-18 Graduate Bulletin:

Computer Science

Master of Science

Emphasis in High Performance Computing

University Requirements:

See Graduate School Degree Policies for additional information (p. 35)

Program Requirements:

Minimum of eighteen hours of 6000 level Computer Science and approved Mathematics and/or

Statistics coursework inclusive of thesis.

Sem. Hrs.

Theory: 3

CS 5133, Compiler

OR

CS 5723, Automata Theory

Systems: 3

CS 5313, Computer Networks

Algorithms: 3

CS 5713, Analysis of Algorithms

Emphasis Area (High Performance Computing):

CS 6213, Parallel Processing 3

CS 6243, Distributed Systems 3

CS 6253, Heterogeneous Computing 3

Emphasis Electives (select one of the following): 3

CS 5223, Unix Systems Programming

CS 6223, Advanced Computer Architecture

CS 6233, Operating System Design

CS 6263, Cloud Computing

CS Electives 6

CS, MATH, and/or STAT Electives, 6

Subject to the prior approval of the Computer Science Curriculum Committee.

Sub-total 33

Total Required Hours: 33

**EMPHASIS ASSESSMENT**

**University Goals**

1. Please indicate the university-level student learning outcomes for which this new emphasis will contribute. Check all that apply.

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| * 1. **[ ]** Global Awareness
 | * 1. **[X]** Thinking Critically
 | * 1. **[X]** Information Literacy
 |

**Emphasis Goals**

2. Justification for the introduction of the new emphasis. Must include:

1. Academic rationale (how will this emphasis fit into the mission established by the department for the curriculum?)
The emphasis addresses the department’s ongoing need to constantly revise the curriculum to reflect new concepts and technologies in computer science. The rapid growth in the high performance computing area in recent years is bringing great attention and challenges to computer science academia, industry and government, placing high demands on professionals in this field.
2. List emphasis goals (faculty or curricular goals, specific to the emphasis.)
* Students will possess a strong foundational knowledge of the theory and application of high performance computing algorithms and processes.
* Students will have the ability to identify and analyze high performance computing problems and to implement solutions for them.

d. Student population served.

Graduate students

**Emphasis Student Learning Outcomes**

3. Please fill out the following table to develop a continuous improvement assessment process for this emphasis.

*For further assistance, please see the ‘Expanded Instructions’ document available on the UCC - Forms website for guidance, or contact the Office of Assessment at 870-972-2989.*

***Note: Best practices suggest an emphasis would have 1 to 3 outcomes.***

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| **Outcome 1** | A deeper understanding of the theory and application of high performance computing algorithms and processes. |
| Assessment Procedure Criterion | Comprehensive examinations and employer surveys  |
| Which courses are responsible for this outcome? | CS 5223, Unix Systems ProgrammingCS 5313, Computer NetworksCS 6213, Parallel Processing CS 6223, Advanced Computer ArchitectureCS 6233, Operating System DesignCS 6243, Distributed Systems CS 6253, Heterogeneous Computing CS 6263, Cloud Computing |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |

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| **Outcome 2** | The ability to apply high performance analysis techniques to problem identification. |
| Assessment Procedure Criterion | Comprehensive examinations and employer surveys  |
| Which courses are responsible for this outcome? | CS 6213, Parallel Processing CS 6223, Advanced Computer ArchitectureCS 6233, Operating System DesignCS 6243, Distributed Systems CS 6253, Heterogeneous Computing CS 6263, Cloud Computing |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |

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| **Outcome 3** | The ability to apply high performance computing implementation techniques to problem solution. |
| Assessment Procedure Criterion | Comprehensive examinations and employer surveys  |
| Which courses are responsible for this outcome? | CS 6213, Parallel Processing CS 6223, Advanced Computer ArchitectureCS 6233, Operating System DesignCS 6243, Distributed Systems CS 6253, Heterogeneous Computing CS 6263, Cloud Computing |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |

*Please repeat as necessary.*

**LETTER OF NOTIFICATION – 3
NEW OPTION, CONCENTRATION, EMPHASIS**(Maximum 18 semester credit hours of new theory courses and 6 credit hours of new practicum courses)

1. Institution submitting request:

Arkansas State University

2. Contact person/title:

 Dr. Hung-Chi Su, Chair of the Department of Computer Science

3. Phone number/e-mail address:

 870-680-8119, suh@astate.edu

4. Proposed effective date:

Spring 2018

5. Title of degree program: (Indicate if the degree listed above is approved for distance delivery)

Master of Science in Computer Science

6. CIP Code:

11.0101

7. Degree Code:

6180

8. Proposed name of new option/concentration/emphasis:

High Performance Computing

9. Reason for proposed action:

There is a rising demand for students who have expertise in High Performance Computing from corporations, nonprofit companies, and agencies. A high performance computing emphasis will complement the computer science degree program to prepare students with knowledge and skills to run parallel processing for running advanced application programs efficiently.

10. New option/emphasis/concentration objective:

This emphasis will prepare students to have a set of high performance computing skills that can be used in a career to conduct research and/or to improve performance, add responsibilities, and earn promotions.

11. Provide the following:

* 1. Curriculum outline - List of courses in new option/concentration/emphasis – Underline required courses

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| CS 6213, Parallel Processing |
| CS 6243, Heterogeneous Computing |
| CS 6253, Distributed Systems |
| CS 5223, Unix Systems Programming |
| CS 6223, Advanced Computer Architecture  |
| CS 6233, Operating System Design |
| CS 6263, Cloud Computing |

* 1. Provide degree plan that includes new option/emphasis/concentration

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| **Course Number** | **Course** **Name** | **Credit Hours** |
| CS 5713 | Analysis of Algorithms | 3 |
| CS 5313 | Computer Networks | 3 |
| Choose One of the Following: |
| CS 5133 | Compiler | 3 |
| CS 5723 | Automata Theory |
| High Performance Computing Emphasis: |
| CS 6213 | Parallel Processing | 3 |
| CS 6243 (pre fall 2017 #s were 6233 & 6823) | Distributed Systems | 3 |
| CS 6253 (pre fall 2017 #s were 6223 & 6823) | Heterogeneous Computing (pre fall 2017 name was High Performance Computing) | 3 |
| Choose One of the Following: |
| CS 5223 | Unix Systems Programming | 3 |
| CS 6223 | Advanced Computer Architecture |
| CS 6233 | Operating System Design |
| CS 6263 | Cloud Computing |
| Electives | Computer Science Electives | 6 |
| Electives | Computer Science, Math, or Stats Electives | 6 |
| Total |  | 33 |

* 1. Total semester credit hours required for option/emphasis/concentration

 (Option range: 9–24 semester credit hours)

 12

* 1. New courses and new course descriptions
* CS 6243, Distributed Systems (*offered to date as a special topics subject, CS6823*)
Advanced topics on distributed computing systems including computing models, cluster computing, grid computing, service computing, virtual machines, computing in the cloud, peer-to-peer computing and major distributed algorithms.
* CS 6253, Heterogeneous Computing (*offered to date as a special topics subject, CS6823*)
The study of the ecosystem of co-processing elements such as the Graphics Processing Unit or GPU in modern computing systems, covering hardware architecture, software design, the programming paradigm, and related libraries.
* CS 6223, Advanced Computer Architecture (*offered to date as a special topics subject, CS6823*)
Advanced topics on computer architecture, including: memory hierarchy design; instruction-level parallelism in pipelines; data-level parallelism in vector, SIMD and GPU architectures; thread-level parallelism; warehouse-scale computers.
* CS 6233, Operating System Design (*offered to date as a special topics subject, CS6823*)
Advanced topics on the design and implementation of major operating systems, including memory management, kernel data structures, process management, file systems, devices and modules.
* CS 6263, Cloud Computing
Major aspects of the cloud ecosystem including conceptual basis, design, virtualization, architecture, storage, programming paradigms, and software development.
	1. Goals and objectives of program option
* Students will possess a strong foundational knowledge of the theory and application of high performance computing algorithms and processes.
* Students will have the ability to identify and analyze high performance computing problems and to implement their solutions.
	1. Expected student learning outcomes

Student will have:

* a deeper understanding of the theory and application of high performance computing algorithms and processes.
* the ability to apply high performance computing analysis techniques to problem identification.
* the ability to apply high performance computing implementation techniques to problem solution.
	1. Documentation that program option meets employer needs

 [*http://forecasting.tstc.edu/techbriefs/high-performance-computing/*](http://forecasting.tstc.edu/techbriefs/high-performance-computing/)

*Technology has shifted from supercomputers to clusters and grids of commercial off-the-self microcomputers, and thus moving HPC into the mainstream marketplace through business, education, government, and the military. This shift has, in turn, created a demand form HPC technicians, who are in short supply.

Students graduating with HPC skills will have job opportunities across education, military, government, and industry sectors.*

[*http://www.sciencemag.org/careers/2012/03/data-deluge-drives-demand*](http://www.sciencemag.org/careers/2012/03/data-deluge-drives-demand) *As researchers produce more and more data to crunch, national labs and university-affiliated supercomputer centers are expanding and building new supercomputers, which need more and more computer scientists with high-performance computing skills to program and operate them.

"We are certainly having trouble finding people with the appropriate skills,” says William Gropp, a professor of computer science at the University of Illinois, Urbana-Champaign, which is installing a new supercomputer called Blue Waters. “Everyone that I’ve spoken to has said that hiring is a problem.”*

* 1. Student demand (projected enrollment) for program option

 40

* 1. Name of institutions offering similar program or program option and the institution(s) used as a model to develop the proposed program option

 University of Southern California

 Georgia Tech University

 Model used to develop program was the A-State M.S. in Computer Science program

12. Institutional curriculum committee review/approval date:

13. Will the new option/emphasis/concentration be offered via distance delivery? No

 If yes, indicate mode of distance delivery:

 Enter text...

14. Explain in detail the distance delivery procedures to be used:

 N/A

15. Specify the amount of additional costs required for program implementation, the source of funds, and how funds will be used.

 All but one of the courses involved are already being taught as special topics; the rotation will be revised to provide an opening for the one new course. Consequently, there will be no extra funds required.

16. Provide additional program information if requested by ADHE staff.

President/Chancellor Approval Date: Click here to enter a date.

Board of Trustees Notification Date: Click here to enter a date.

Chief Academic officer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: Enter date.

 Name (printed): Click here to enter text.