ASSESSMENT REPORT TEMPLATE

\*\*DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE AND SOFTWARE ENGINEERING\*\*

The Department of Computer Science and Software Engineering (CSSE) offers the Doctor of Philosophy in Computer Science and Software Engineering. The Ph.D. degree is designated with the major of computer science and software engineering.

Student Learning Outcomes

\*\*1. Specificity of Outcomes\*\*

There are four student learning outcomes (SLO 1-4) defined to implement our PhD-CSSE program vision.

\* SLO 1: Students will demonstrate mastery with in-depth knowledge in algorithms, operating systems, and architecture.

\* SLO 2: Students will be able to develop and evaluate software systems to meet desired requirements.

\* SLO 3: Students will perform cutting-edge research in at least one area of specialty.

\* SLO 4: Students will communicate concepts and results to technical audiences in the format of conference/journal papers as well as oral presentations.

\*\*2. Comprehensive Outcomes\*\*

The four student learning outcomes (SLOs) listed in Section 1 represent the culmination of all coursework related to the PhD-CSSE program. These outcomes represent skills and capabilities that should be fully developed over the course of each Ph.D. student’s education.

Although the program offers a broad education allowing Ph.D. students to improve research and teaching skills in computer science and software engineering disciplines, these SLOs represent the skills and capacities required in careers as computer scientists, researchers, and engineers.

The CSSE faculty measures the SLOs according to the proficiency guidelines offered by the Association of Computing Machinery (ACM), which is the world’s largest professional organization for educational and scientific computing. In the past decade, ACM has produced a series of recommendations for university-level graduate Computer Science programs. The PhD-CSSE program has adopted the ACM recommendations as its education objectives to train well-prepared Ph.D. students. In addition, these four SLOs are in alignment with disciplinary standards set by IEEE Computer Society, Computing Research Association (CRA), and those professionals represented by ACM and IEEE.

\*\*3. Communicating Student Learning Outcomes\*\*

\* \*\*3.1 Faculty\*\*

The graduate programs committee was directly involved in the development of the program vision and student learning outcomes. A copy of this assessment report will be disseminated to newly hired faculty and adjunct faculty members during the orientation week or the beginning of their first academic semester. We have made all the assessment reports available on the department’s shared drive to be accessed by all the CSSE faculty and staff members.

\* \*\*3.2 Students\*\*

Newly admitted CSSE doctoral students receive a copy of the program vision and student learning outcomes in their orientation meeting organized by the Graduate Program Officer. The orientation meetings are held at the beginning of the first semester of the program. Doctoral students are introduced to the program assessment methods used by the graduate program committee. The student learning outcomes are posted on the departmental website to disseminate the SLOs information to current and prospective doctoral students.

\*\*Curriculum Map\*\*

\*\*4. Curriculum Map for the PhD-CSSE program\*\*

The following table is a curriculum map that visually depicts the alignment between the PhD-CSSE student learning outcomes (SLOs) and the courses offered. In each cell of the curriculum map, a letter indicates how a course relates to a student learning outcome. Letters “I”, “R”, and “E” designate courses in the program “introduce”, “reinforce”, or “emphasize” the corresponding learning outcomes.

\*Contribution Weight Notation\*

Introduce: 0.33 I

Reinforce: 0.66 R

Emphasize: 1.0 E

The curriculum map was reviewed and revised by the graduate faculty. More than 90% of the courses in this map have been updated and ratified by the professors who offered the courses.

\*\*Measurement\*\*

\*\*5. Outcome-Measure Alignment\*\*

All the student learning outcomes are assessed using a combination of pre-tests and post-tests, quizzes, midterm and final exams, written assignments, programming assignments, course projects, or presentations. A handful of rubrics have been developed to assess homework and project assignments (e.g., written communication, oral communication, projects). In addition, CSSE doctoral students are required to take Qualifying Exams, a General Doctoral Examination, and a Final Doctoral Examination.

The outcome-measure alignment is listed in the table below.

\*Notation: QZ - Quiz, PE – Pre-test, ME – Midterm Exams, FE – Final Exams, WA – Written Assignments, PA -Programming Assignments, PT – Presentations, PJ – Projects, QF – Qualifying Exam, PD – Proposal Defense, FD – Final Defense, ID – Indirect, SV – Survey.\*

| Outcome | Measure | Description |

|----------------|--------------------|-------------------------------------------|

| SLO 1 | QZ, PE, ME, FE | Exams and quizzes on algorithms, OS, architecture|

| | QF | Qualifying exams in core areas |

| SLO 2 | PA, PJ | Programming assignments and projects |

| | PD, FD | Proposal and final dissertation defenses |

| SLO 3 | PJ, PD, FD | Research projects, proposal, and defense |

| SLO 4 | WA, PT, PD, FD | Written and oral presentations, proposal and defense |

\*\*6. Direct Measures\*\*

Each student learning outcome has a list of direct measurements. Direct measures, requiring Ph.D. students to demonstrate their knowledge and skills, will provide tangible, visible and self-explanatory evidence of what our Ph.D. students have and have not learned as a result of graduate courses and the Ph.D. program. In this section, we elaborate on various ways of measuring actual student behaviors.

\* Authentic Course-Embedded: Exams, Quizzes, Oral Presentations, Assignments, Projects.

\* Discipline Specific Test 1: Ph.D. Qualifying Exams.

\* Discipline Specific Test 2: General Oral Examination (Proposal Defense).

\* Exit Exams: Final Oral Examination (Final Dissertation Defense or Dissertation Defense).

\*6.1 Authentic Course-Embedded Measures\*

This type of direct measure includes exams, tests, quizzes, oral presentations, quizzes, assignments.

We believe the direct measures in this category are most effective because the measures are course-embedded, which means the work accomplished by our Ph.D. students is actually work that counts towards a grade. Our Ph.D. students are likely to take the learning activity more seriously if associated with grades. We directly gauge student knowledge and skills by the virtue of authentic and part of already existing student work.

\*6.2 Discipline Specific Assessment 1: Ph.D. Qualifying Exams\*

Doctoral students are required to take the three qualifying exams to demonstrate knowledge of computer science fundamentals and potential for Ph.D. studies.

\*6.3 Discipline Specific Assessment 2: General Oral Examination\*

Successful completion of a general examination (also referred to as the "Preliminary Examination" or “Proposal Defense”) over the student's major and minor areas is required to become a Ph.D. candidate.

\*6.4 Exit Assessment: Final Oral Examination\*

The final oral examination (also referred to as the “dissertation defense” or “final defense”) takes place at the conclusion of a doctoral student's research.

\*\*7. Data Collection\*\*

CSSE graduate faculty members have taught a total of 33 graduate-level courses in the academic year. At the end of the semester, the director of graduate programs (GPO) designed a course-level data collection form shared on Google Spreadsheet. After the data-collection requests were sent to the instructors, the data collection spreadsheet was collaboratively updated by the CSSE graduate faculty. The response rate is higher than 90%.

For all the four student learning outcomes, individual faculty members collect data for the graduate courses, usually in a wide variety of forms (e.g., quizzes, exams, assignments, course projects, and presentations). The examinations consist of a series of questions administered in class at the end of the semester. The quiz and exam answers are reviewed by the faculty members and reported to the assessment coordinator.

In each graduate course, the faculty member aligned at least one of the direct measures - exams, tests, quizzes, oral presentations, quizzes, and assignments - to at least one of the four student learning outcomes. For each direct measure in a graduate course, student performance ratings are categorized in five camps depending on score ranges:

\*Direct Measure Rating Score Range Notation\*

Outstanding Mastery: [90, 100] OM

Above Satisfactory Mastery: [80, 90) AM

Satisfactory Mastery: [70, 80) SM

Partial Mastery: [60, 70) PM

Minimal or no evidence of Mastery:[0, 60) MM

Each course’s score is derived from the above direct measures. Importantly, the enrollment of a course is treated as the course weight during the data aggregation process, meaning that a course with high enrollment contributes to the final SLO scores more significantly than those with low enrollments. Recall that the curriculum map articulated in Section 4 on page 3 indicates that each course has impacts on one or more SLOs. Such impacts are measured in terms of “introduce” (I), “reinforce” (R), or “emphasize” (E). To aggregate course-level data, we assign 1.00, 0.66, and 0.33 to “introduce” (I), “reinforce” (R), or “emphasize” (E) in the curriculum map. We apply this assignment strategy because a course that “emphasize” on a SLO offers more pronounced contributions than another course rated as “introduce”.

SLO 3 - student capabilities to perform cutting edge research in at least one area of specialty – is assessed through two types of research-oriented courses, namely, COMP 8930 directed studies and COMP 8990 dissertation and research. A rubric for each course project is provided to help identify areas where students’ capability needs improvement.

In a general oral examination (Discipline Specific Test 2, see also Section 6.3 on page 7), the student’s supervisory committee members complete a direct measure to assess the student’s knowledge and research skills before the student becomes a Ph.D. candidate.

Oral and written communication skills (SLO 4) are assessed throughout course projects, directed studies, research and thesis, starting with the introductory course. Rubrics are used to assess both written and oral communication skills during software development lifecycles. The faculty members complete the rubric distributed to students to improve their communication performance. All scores for written reports and presentations are collected by the assessment coordinator at the end of each semester.

All the doctoral students are required to complete dissertation research projects and write a dissertation. A student’s supervisor completes a performance evaluation form to assess the student’s communication, research, and software development skills. The survey is provided as a google document, which is completed either offline or online. To offer feedback to the doctoral students, evaluations are completed at mid-semester with results reported to the student. Final evaluations are completed at the end of each semester collected by the assessment coordinator.

\*\*Results\*\*

\*\*8. Reporting Results\*\*

\*8.1 Direct Assessment Results of the Four SLOs\*

Recall that in each graduate course, the faculty member aligned at least one of the direct measures - exams, tests, quizzes, oral presentations, quizzes, and assignments - to at least one of the four student learning outcomes. Given direct measures in the graduate courses, the instructors rated student performance in the following five categories depending on score ranges.

\*Direct Measure Rating Score Range Notation\*

Outstanding Mastery: [90, 100] OM

Above Satisfactory Mastery: [80, 90) AM

Satisfactory Mastery: [70, 80) SM

Partial Mastery: [60, 70) PM

Minimal or no evidence of Mastery:[0, 60) MM

The table below summarizes the course-level assessment results. The score of each course is mapped to the four SLOs according to the curriculum map delineated in Section 4 on page 3.

Each SLO metric is evaluated in a scale from 0 to 100, where a score in [90, 100] is Exemplary, [80, 90] is Proficient, [70, 80] is Needs Improvement, and [0, 70] is Unsatisfactory. The following table summarizes the SLO results derived from the course-level data.

| SLO | Score | Rating |

|------|--------|----------------|

| SLO1 | 91.9 | Exemplary |

| SLO2 | 93.4 | Exemplary |

| SLO3 | 87.5 | Proficient |

| SLO4 | 54.0 | Unsatisfactory |

\*8.2 Assessment Results of Ph.D. General Oral Exams\*

[Data not provided for this section. Please provide the assessment results of Ph.D. general oral exams]

\*8.3 Assessment Results of Ph.D. Final Oral Exams\*

[Data not provided for this section. Please provide the assessment results of Ph.D. final oral exams]

\*8.4 Indirect Measure Data: Ph.D. Student Annual Reports\*

[Data not provided for this section. Please provide the indirect measure data from Ph.D. student annual reports]

\*8.5 Indirect Measurement Data: Ph.D. and GTA Annual Evaluation\*

[Data not provided for this section. Please provide the indirect measurement data from Ph.D. and GTA annual evaluations]

\*\*9. Interpreting Results\*\*

The aggregate data are summarized in the following table. The detailed assessment data can be found in TABLE - The SLO Results Derived from the Direct Measurement Data on pages 14 and 15 in Section 8.1. The key takeaways from the assessment data are:

\* The ratings of all four SLOs are “Exemplary”.

\* The 2022-2023 student performance ratings are lower than those of the 2019-2020, 2020-2021, and 2021-2022 periods. This drop is mainly due to the new assessment data incorporated in this assessment cycle.

\* In the 2021-2022 cycle, the doctoral students achieved slightly better software development skills than the other measured skills. This year, however, the student research-skill measure - SLO 3 -turns out to be the lowest among its peers.

\*9.1 Results of the Direct Measurements\*

Direct Measurement Data Comparison between the current cycle (2022-2023) and the previous cycles (2019-2022)

| SLO | 2019-2020 | 2020-2021 | 2021-2022 | 2022-2023 |

|------|------------|------------|------------|------------|

| SLO1 | 91.4 | 94.0 | 94.2 | 91.9 |

| SLO2 | 93.5 | 94.0 | 95.1 | 93.4 |

| SLO3 | 91.9 | 92.9 | 96.1 | 87.5 |

| SLO4 | 92.5 | 94.2 | 95.9 | 54.0 |

In the last three assessment cycles (2019-2020, 2020-2021, and 2021-2022), the four SLO scores are (91.4, 93.5, 91.9, 92.5), (94.0, 94.0, 92.9, 94.2), and (94.2, 95.1, 96.1, 95.9) respectively. SLO 1-4 measurement results are consistently lower than its counter parts in the previous three cycles because during this assessment period, we incorporate the general oral exam and final oral exam assessment data into the final analysis.

\*9.2 Results of General Oral and Final Oral Examinations\*

[Data and analysis are missing for this section. Please provide the analysis of the results of general oral and final oral examinations.]

\*9.3 Conference and Journal Publications\*

[Data and analysis are missing for this section. Please provide the analysis of the conference and journal publication data.]

\*\*10. Communicating Results\*\*

The program outcomes were shared with the CSSE faculty through an email announcement. The program outcomes have been posted on the CSSE graduate programs website. This latest annual assessment report was shared with the CSSE faculty members through the graduate faculty mailing list. After we incorporated the faculty’s comments on this report, the assessment report is submitted to the Office of Academic Assessment. In additional, the assessment report was submitted to Dr. Fergus and Dr. Auad, the Associate Deans who oversee program assessment and graduate studies in the Samuel Ginn College of Engineering. The final version of this assessment report will be shared, distributed, and discussed during a faculty meeting scheduled in the first week of the fall semester.

\*\*Use of Results\*\*

\*\*11. Purposeful Reflection\*\*

\*11.1 A Consistent and Ongoing Process\*

The graduate programs committee consists of five professors who are committed to arranging a minimum of three meetings per year to evaluate and improve the Ph.D. program. The recommendations made by the graduate programs committee will be further reviewed by the CSSE graduate faculty in the first faculty meeting scheduled in the fall semester. In some cases, departmental policies will be forged to streamline the management of the Ph.D. program and doctoral students.

\*11.2 Implementation of the Above Process\*

In the spring, the graduate programs committee had three meetings and the CSSE graduate faculty had one group meeting to discuss the updated Ph.D. course requirements and Ph.D. qualifying exam policy. The revised qualifying exam has been implemented for one year without a hitch, and the new Ph.D. curriculum model was approved by the CSSE faculty, Samuel Ginnn College of Engineering, and Auburn University.

\*\*12. Action Plan\*\*

\*12.1 Observations\*

The raw data from COMP 8990 Dissertation Research were collected for the first time. We have quantitatively evaluated doctoral students’ research performance through graduate faculty surveys when the students take the general oral exam (dissertation proposal defense) and/or final oral exam (final dissertation defense).

In the 2022-2023 assessment cycle, the SLO 3 measure is the lowest among its peers. The CSSE graduate faculty aimed to improve the student performance in terms of SLO 3 in the 2022-2023 semesters. We will be focusing on the SLO 3 score during the next assessment cycle.

Overall, the Ph.D. program in Computer Science and Software Engineering is strong; the graduate faculty will continue improving both the curriculum as well as the opportunities for extracurricular activities.

\*12.2 Future Actions\*

\* \*\*Action 1.\*\* Next year, we will aim to enhance the student performance in terms of SLO3 – “students will perform cutting-edge research in at least one area of specialty”. We expect that the SLO3 score will be improved from 89.4 to 90.0, which is an exemplary level.

\* \*\*Action 2.\*\* To address the low performance in SLO4 ("Students will communicate concepts and results to technical audiences..."), which received an "Unsatisfactory" rating, the graduate programs committee will pilot new approaches to strengthening the communication skills of Ph.D. students. We propose the following ideas:

\* Integrate more technical writing and presentation practice into existing courses, particularly those emphasizing research (e.g., COMP 7990/8990).

\* Organize workshops specifically focused on technical communication for a research audience, potentially in collaboration with the university writing center.

\* Provide students with more opportunities to present their work in departmental seminars and encourage participation in external conferences.

\* \*\*Action 3.\*\* Recall that for the first time, we incorporated the assessment data from COMP 8990 Dissertation Research, but COMP 8930 assessment data were excluded in the aggregated SLO results presented on page 15. During the next assessment period, COMP 8930 data will be seamlessly incorporated into the SLO measures.

\* \*\*Action 4\*\*. Recall that the CSSE doctoral students’ research productivity in terms of both conference and journal publications is 3.65, which jumps by 4.9% compared with last year’s student research productivity. To ensure that the publication productivity is maintained at a high level of 3.5, the CSSE graduate faculty will supervise the Ph.D. students to have preliminary results published in conference proceedings followed by extended versions submitted to journals. We believe that another strategy to push up research productivity is encouraging students to collaborate with one another on their research projects, thereby strengthening publication records.

\* \*\*Action 5\*\*. Some Ph.D. students, including those who are being supported through graduate teaching assistantships, didn’t make acceptable achievements with respect to publishing research papers. To address this concern, we will remind the students holding teaching assistantships that the maximum department support will be four years – the students are expected to publish at least two research papers per year to be on par with the other Ph.D. students in the department.

\* \*\*Action 6\*\*. We will pay attention to SLO1 – “SLO 1: Students will demonstrate mastery with in-depth knowledge in algorithms, operating systems, and architecture.” The following three courses will contribute to the improvements of SLO1 measures. The graduate programs committee will arrange meetings with Drs. Zhou, Baskiyar, and Qin to propose a diversity of approaches to bolstering student performance in these three required courses.

\* COMP 7270 Advanced Topics in Algorithms

\* COMP 7300 Advanced Computer Architecture

\* COMP 7500 Advanced Operating Systems

\* \*\*Action 7\*\*. In this assessment cycle, the data are manually collected by CSSE faculty members. It takes approximately a neighborhood of 20 to 30 minutes to harvest data for a course with an enrollment of 45. We opt to take this approach thanks to its simplicity. As an action item, we will pilot a way to make use of Canvas to align course components - assignments, quizzes, projects - to the graduate program SLOs – the direct measures will be automatically handled by Canvas to improve data collection efficiency.

It is practical to take full advantage of the Canvas system to automatically gauge assessment data. With regard to data collection, we have initiated a collaboration with Dr. Dorothy Thompson at the Academic Assessment Office to pilot an automatic way of gleaning data from the Canvas system. A challenge to be addressed in the pilot study is how to deal with a common case where students from two or more graduate programs are taking the same graduate course managed by Canvas. This challenge is non-trivial because Canvas has no information about students’ graduate programs. We will collaborate with Mr. Paul Springfield – the Canvas system administrator – to dig out a solution that streamlines the data collection process with automation.