2021-2022 Assessment Report for Department: *Computer Science & Engineering*

General Education Core Curriculum Area:

Graduate Programs: *M.S. in Computer Science; M.S. in Computer Science with specialization in Information Technology.*

Department Mission Statement:
The mission of the Computer Science Program is to produce computer science graduates who, trained in the design, implementation, and analysis of computational systems and skilled in technical communication, will contribute towards the advancement of computing science and technology.

Program Outcomes:

At the time of graduation with a Master's degree in Computer Science, our students should have

1. [*Adv. CS*] advanced knowledge of computer science in the areas of theoretical computer science, programming languages, and systems;
2. [*Written Comm.*] the ability to communicate computing concepts through written reports;
3. [*Oral Comm.*] the ability to communicate computing concepts through oral presentations; and
4. [*Research*] the ability to conduct research on a theoretical or applied problem in computer science.

Curricular Map*:*

Courses are mapped against Program Outcomes 1 through 4 (the last four columns); each numeric entry (between 1 and 3) represents the relative weight of a required course towards a program outcome.

Required Courses		Program Outcomes			
Course	Course Title	1. [Adv. CS]	2. [Written Comm.]	3. [Oral Comm.]	4. [Research]
CSE 524	Advanced Programming Languages	3			
CSE 525	Advanced Operating Systems	3			2
CSE 544	Advanced Algorithms	3			
CSE 546	Theory of Computation	3			
CSE 528	Formal Methods in Software Development	3			
CSE 553	Advanced Computer Networks	3			
CSE 585	Graduate Seminar		3	3	1
CSE 591	Thesis / Independent Study				3

In Fall 21 and Spring 22, the courses on this list that were offered are: CSE 525 (Zheng), CSE 544 (Mazumdar), CSE 585 (Jeffery), and CSE 591 (all). Assessment documents were received for CSE 525, 544 and CSE 585. PO #1 is assessed from data in the CSE 525 and 544 assessments, while PO's #2-4 are assessed from data in CSE 585, with some additional information for PO #4 from CSE 525 and CSE 591.

Our Process:

Summary:

For each program outcome, we obtain a numeric score between 1 and 4, where 1 = *Unsatisfactory*, 2 = *Marginal*, 3 = *Satisfactory*, and 4 = *Excellent*. These scores are derived as a linear weighted sum of contributions from one or more courses: each course supplies a numeric score between 1 and 4; this score is weighted according to the curricular map below. (Our report for the *B.S. in Computer Science* provides details about this process.)

Our acceptance threshold is 3.0 for each program outcome.

However, in addition to the numeric score, we pay attention to comments from the instructors regarding strategies that were successful and their plans for future modifications.

Steps**:**

- The above curricular map was obtained by first considering all courses and assigning weights between 1 and 3 (inclusive) to reflect the strength of their contribution, with the following interpretation.

Contribution	*Interpretation*
1	Introductory / preliminary
2	Reinforcement / extension / application
3	Major component

  Next, it was pruned keeping only the required courses, and then pruning it further by eliminating weights of 1 and 2 unless one of three criteria (omitted here) were met.
- For each Program (/Student) Outcome, we obtain a number between 1 and 4 through a weighted sum of scores from contributing courses as per the curricular map shown above. Our acceptance threshold for each student outcome is 3.0.
- The scores from contributing courses come from the respective instructors who are required to submit an assessment report for each offering of such courses. This report outlines the relation between the scores and the course learning outcomes.
- The report also provides comments regarding successful strategies and plans for future modifications. While we have a numeric acceptance threshold, the instructors' comments are always important.
- The numeric score for the j^{th} student outcome is a normalized weighted sum

$$Score\_Outcome_j = \frac{\sum_i (n_{ij} * s_{ij})}{\sum_i n_{ij}}$$

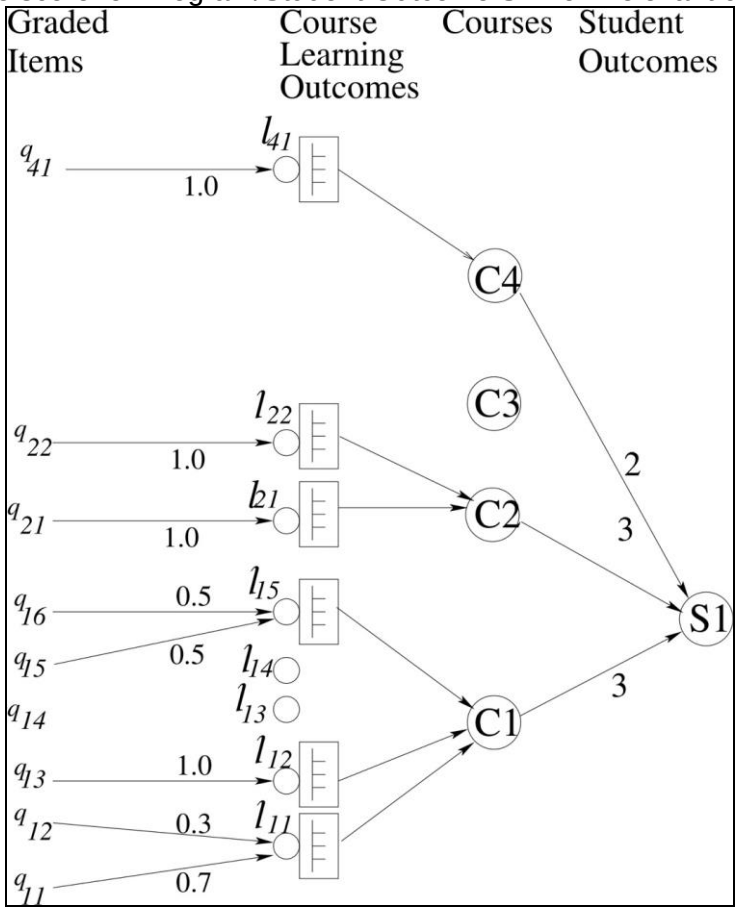
  where the weights n_{ij} are the non-zero entries in the column for student outcome *j* in the curricular map, and each value s_{ij} is a score that comes from the assessment of the i^{th} course specifically for the j^{th} Student outcome.

  We limit the score s_{ij} (reported by a course *i* for a Student outcome *j*) to a number between 1 and 4 with the following interpretation.

Student Outcome score	*Interpretation*	
1	Unsatisfactory	
2	Marginal	
3	Satisfactory	
4	Excellent	

- The instructor of the i^{th} course computes a score S_{ij} for the j^{th} Student outcome as follows.

Example: computing the score for Program/Student Outcome S1 from relevant courses C1, C2, and C4.



The first step is to identify the largest disjoint set L of course learning outcomes corresponding to the Student outcome at hand at hand. For that set L,

1. The instructor decides on a performance metric to interpret an average score for a course outcome as unsatisfactory, marginal, satisfactory, or excellent, resulting in the basis for a four-point scale; this takes care of variations among courses in grading, e.g., relative versus absolute, partial credit versus all-or-none grading.
2. Each course outcome l in L is tied to a set of gradable items in the course, e.g., a project, specific questions in the final exam, a presentation, etc. The sets of items should be disjoint among learning outcomes. In the above figure, course outcome l_{11} would be tied to questions q_{11} and q_{12}.
3. Weights are assigned to these questions or items (in Figure 1, 0.7 and 0.3 for questions q_{11} and q_{12} respectively); using them, a formula is written to compute a normalized weighted sum from the scores for those questions or items;
4. From a table of scores of the students on those gradable items, one numeric score is computed for each student per course outcome l.
5. Those numeric scores are then averaged over the whole class to get one numeric score p_l for each course outcome l.
6. Using the performance metric, a number q_l is obtained by quantizing p_l to a four-point scale.
7. The above is repeated for each l in L.
8. The scores q_l (in the four-point scale) are averaged over all l in L.

The result is s_{ij}, the numeric score (between 1 and 4) from course i to student outcome j.

#1 [Adv. CS]

<table>
<tr><th>Student Learning Outcomes</th><th>Assessment Procedures</th><th>Assessment Results</th><th>Assurance</th></tr>
<tr><td>Learning Outcomes of the Program—Students should have:</td><td>Process/Instrument used:
Direct measures. Graded items are weighted and linked to courses; courses are weighted, aggregated, and linked to program outcomes. Covered Fall 2021 and Spring 2022.</td><td>What were your findings?
Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>1. [Adv. CS:] the advanced knowledge of computer science in the areas of theoretical computer science, programming languages, and systems.</td><td>Direct Measure:

Quantitative Assessment Procedure on CSE 525 Advanced Operating Systems and CSE 544 Advanced Algorithms.</td><td>
<table>
<tr><th>Course</th><th>Score</th><th>Wt.</th><th>Overall Score</th></tr>
<tr><td></td><td></td><td></td><td rowspan="5">3</td></tr>
<tr><td>CSE 525 S22</td><td>3.5</td><td>3</td></tr>
<tr><td>CSE 544 S22</td><td>2.5</td><td>3</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>
</td><td>the overall score is equal to 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE 525 *Advanced Operating Systems*: No remedial actions are planned for the next iteration of CSE 525. CSE 544 *Advanced Algorithms*: The instructor wrote: *As mentioned in the previous report, 'there is need to improve the math background of students'. It is important to add that basic logic is also an issue; consequently, proofs of all kinds become challenging. One strategy suggested is a mini-course addressing proofs and logic. Unfortunately, it was not achieved in the last summer.* The CSE chair will bring this up as an agenda item for the CSE faculty in Spring 2023, to decide whether to raise admissions standards, add a new required course as a prerequisite for CSE 544, or reduce CSE 544's expectations. The CSE Chair notes that several core courses in computer science listed for this outcome in our curriculum map have not been offered since he arrived at NMT in 2020 and are unlikely to be offered with the current faculty workload. These include programming languages, the software engineering formal methods course, and the advanced networks course. The CSE Chair proposed to the CS faculty that a new core course in machine learning should be introduced and the untaught courses be removed. Work was done by CS faculty on designing a new machine learning core course, but existing faculty who teach various machine learning topics did not express enthusiasm for making the proposed new course a prerequisite for their more specialized topics in machine learning. They also strongly objected to the removal of untaught core courses, which remain core areas of computer science that we would teach if we had the faculty to do so.

#2 [Written Comm.]

Student Learning Outcomes	Assessment Procedures	Assessment Results	Assurance
Learning Outcomes of the Program—Students should have:	Process/Instrument used: Direct measures. Graded items are weighted and linked to courses; courses are weighted, aggregated, and linked to program outcomes. Covered Fall 2020 and Spring 2021.	What were your findings? Score range: 1 (unsatisfactory), 2 (marginal), 3 (satisfactory), and 4 (excellent).	Our department believes we fulfill this Learning Outcome because: (state evidence in 30 words or less)
2. **[Written Comm.]** the ability to communicate computing concepts through written reports	Direct Measure: Quantitative Assessment Procedure (see below) on CSE585.	*Course* / *Score* / *Wt.* / *Overall Score* CSE 585 F21 / 3.6 / 3 / 3.6	the overall score exceeds **3.0,** our acceptance threshold.

Adjustment/Improvement
CSE 585 *Graduate Seminar*: students would benefit from additional writing assignments to practice their technical writing, which ranges from excellent to poor.

#3 [Oral Comm.]

<table>
<tr><th>Student Learning Outcomes</th><th>Assessment Procedures</th><th>Assessment Results</th><th>Assurance</th></tr>
<tr><td>Learning Outcomes of the Program—Students should have:</td><td>Process/Instrument used:
Direct measures. Graded items are weighted and linked to courses; courses are weighted, aggregated, and linked to program outcomes.</td><td>What were your findings?
Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>3. [Oral Comm.] the ability to communicate computing concepts through oral presentations</td><td>Direct Measure: Quantitative Assessment Procedure (see below) on CSE 585.</td><td>
<table>
<tr><th>Course</th><th>Score</th><th>Wt.</th><th>Overall Score</th></tr>
<tr><td>CSE 525 S22</td><td>4</td><td>3</td><td rowspan="2">3.9</td></tr>
<tr><td>CSE 585 F21</td><td>3.8</td><td>3</td></tr>
</table>
</td><td>the overall score is greater than 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE 525 Advanced OS: no improvement was noted. The CS Chair notes that the 88% mark recorded for this course's oral communication performance was rated by the instructor as "Excellent", while the 88% in CSE 585 was rated as "Satisfactory". Clearly instructor standards and expectations will vary, and of course the number 88% is likely a subjective evaluation of oral speaking performance in any case. CSE 585 *Graduate Seminar*: students would benefit from additional oral assignments to practice their technical speaking, which ranges from excellent to poor. The instructor feels that the grading was probably too lenient. Perhaps this is because the course is often taken by new graduate students, who are often freshly arrived from international origins, and the instructor was used to a graduate seminar course that is Pass/Fail at other universities.

#4 [Research]

<table>
<tr><th>Student Learning Outcomes</th><th>Assessment Procedures</th><th>Assessment Results</th><th>Assurance</th></tr>
<tr><td>Learning Outcomes of the Program—Students should have:</td><td>Process/Instrument used:
Direct measures. Graded items are weighted and linked to courses; courses are weighted, aggregated, and linked to program outcomes.</td><td>What were your findings?
Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>4. [Research:]
the ability to conduct research on a theoretical or applied problem in computer science.</td><td>Direct Measure: based on thesis / independent study work.</td><td>
<table>
<tr><th>Course</th><th>Score</th><th>Wt.</th><th>Overall Score</th></tr>
<tr><td>CSE 525 S22</td><td>4</td><td>2</td><td rowspan="3">3.9</td></tr>
<tr><td>CSE 585 F21</td><td>3.4</td><td>1</td></tr>
<tr><td>CSE 590/591 2021–22</td><td>4</td><td>3</td></tr>
</table>
</td><td>The overall score is higher than 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE 585 Graduate Seminar: The development of an idea into a written proposal was the gradable component. CSE 525 *Advanced OS*: Course outcome 4 was created this year for the research ability which is tied to term research project report. CSE 590/591 *Independent Study / Thesis:* 12 students successfully finished their Independent Study project / Master's Thesis. (This number is based on the Spring 2022 commencement program MSCS recipients list). The chair is unaware of any student failing their MS exam during this period and believes a stronger assessment metric is needed.

Concluding Remarks:

We need to update the PhD program core course requirements, particularly because CSE 524 is no longer being offered regularly. We also need to develop a scheme for assessment of our Ph.D. program. The chair can bring in some ideas from the University of Idaho to assist with this process.

The faculty some time ago (pre-Jeffery) decided that the *M.S. in Computer Science with specialization in Information Technology* should not be continued owing to a lack of demand for its special courses plus our difficulty in offering them given the small size of our faculty. However, this decision does not seem to have propagated out to the catalog and grad application (CAS) software system yet, as new applicants are still able to request this specialization.

Submitted by: Clinton Jeffery Department Chair: Clinton Jeffery Date: 12/23/2022

Reviewed by Assessment Director/Director Signature: Date: (by 10/01)
Comments:

Reviewed by Faculty Senate Assessment Committee/Committee Chair Signature: Date: (by 11/01)
Comments:

Reviewed by Associate VP of Academic Affairs/AVPAA Signature: Date: (by 11/15)
Comments:

Submitted to Vice President of Academic Affairs/Date: (no later than 9/15)