# B.S. in ELECTRICAL ENGINEERING

**Student Outcomes Assessment Program (SOAP)**

**I. Mission**
The mission of the Department of Electrical and Computer Engineering is to fulfill the needs of the region and state by providing an undergraduate technical education in Electrical Engineering and Computer Engineering to a diverse group of students. The department strives to continually update its strong program of study in order to qualify its graduates for positions in industry located in the region and beyond, while providing sufficient breadth and depth in its program to assure its graduates a successful practice in the profession. At the same time, students are grounded in the rigorous scientific and theoretical foundations of the discipline in order to enable graduates to enter and be successful in any advanced level educational program of their choosing, and to allow them to build upon this strong foundation and extend it to new depths.

**II. Program Objectives**

The Electrical Engineering Program through the academic structure of California State University, Fresno awards degrees to students who within three to five years of graduation, through work experience and/or graduate education in the engineering field will be expected to

1. Have grown technically to the level sufficient to be productive in their respective industry workplace.
2. be capable of addressing technical problems of increasing complexity.
3. communicate and function effectively in an interdisciplinary team environment at a level commensurate with their career development.
4. demonstrate an ability for independent learning and continued professional as well as ethical development.

#### III. Student Learning Outcomes (SLOs)

Graduates of the Electrical Engineering program are expected to achieve the following student learning outcomes.

SLO 1: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

SLO 2: An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

SLO 3: An ability to communicate effectively with a range of audiences

SLO 4: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

SLO 5: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

SLO 6: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

SLO 7: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

 **IV. Relevance of SLOs to Program Educational Objectives**

The student leaning outcomes prepare graduates to attain the program educational objectives in the following ways:

**Program Educational Objective 1** - ***Have grown technically to the level sufficient to be productive in their respective industry workplace.***

Knowledge of mathematics, science, and engineering (SLO 1), conducting analysis, design, analysis, and evaluation using mathematical and engineering tools (SLOs 1, 2, 6), communication skills (SLO 3) are essential attributes to be productive in the workplace. Additionally, the motivation for continuous development of engineering knowledge and skills (SLO 7) is also emphasized.

**Program Educational Objective 2** – ***Be capable of addressing technical problems of increasing complexity.***

This objective is supported by several Student Learning Outcomes. Knowledge of mathematics, science, and engineering (SLOs 1, 2) and conducting analysis, design, evaluation, using tools (SLOs 2, 6) are fundamental of addressing technical problems of increasing complexity.

**Program Educational Objective 3 - *Communicate and function effectively in an interdisciplinary team environment at a level commensurate with their career development.***

This objective is supported by SLOs 3 and 5.

**Program Educational Objective 4** - ***Demonstrate ability for independent learning and continued professional as well as ethical development.***

SLOs 4 and 7contribute directly to developing students the ability for independent learning and continued professional growth. Additionally, SLO 4 provides the foundation for ethical development as engineers.

Table 1 summarizes the above statements that describe the link between student learning outcomes and the program educational objectives. The table shows the relational mapping between student learning outcomes and program educational objectives. The ‘X’ markings on the table identify those student learning outcomes that most directly support a given program educational objective.

|  |
| --- |
| **Table 1** SLO/PEO Map |
| **SLO** | **Program Educational Objectives (PEO)** |
| **1** | **2** | **3** | **4** |
| **1** | X | X |  |  |
| **2** | X | X |  |  |
| **3** | X |  | X |  |
| **4** | X |  |  | X |
| **5** |  |  | X |  |
| **6** | X | X |  |  |
| **7** | X |  |  | X |

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| --- |
| **Table 2 Electrical Engineering Curriculum Map** |
| **SLO** | ***ECE 1*** | ***ECE 71*** | ***ECE72*** | ***ECE 85*** | ***ECE 85L*** | ***ECE 90*** | ***ECE 90L*** | ***ECE 102*** | ***ECE 103*** | ***ECE 118*** | ***ECE 118L*** | ***ECE 121*** | ***ECE124*** | ***ECE125*** | ***ECE126*** | ***ECE 128*** |
| **1** | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| **2** |  | 1 |  | 3 | 2 | 1 |  | 2 |  | 1 | 1 |  | 2 | 2 | 1 | 3 |
| **3** | 2 |  |  |  | 1 |  | 2 |  | 3 | 1 | 2 |  |  |  |  |  |
| **4** | 2 | 3 |  | 2 | 1 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 1 |
| **5** | 2 |  |  |  | 3 |  | 3 |  | 2 |  | 3 |  |  |  |  |  |
| **6** | 2 | 2 | 2 |  | 3 |  | 3 |  |  |  | 3 |  |  |  |  |  |
| **7** | 1 |  |  |  |  |  |  |  | 3 |  |  |  |  |  |  |  |
| **3=Strong, 2=Moderate, 1=Possible** |
| 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SLO** | ***ECE128L*** | ***ECE 134*** | ***ECE 138*** | ***ECE 138L*** | ***ECE 155*** | ***ECE 186*** |  | ***ECE Electives*** | ***ECE lab Electives*** | ***GE Courses*** |
| **1** | 2 | 3 | 3 | 3 | 3 | 3 |  | 3 | 2 |  |
| **2** | 2 | 2 | 3 | 3 | 3 | 3 |  | 2 | 1 |  |
| **3** | 2 |  |  | 2 |  | 3 |  |  | 2 | 3 |
| **4** | 1 | 3 | 3 | 3 | 3 | 3 |  | 3 | 3 | 3 |
| **5** | 3 |  |  | 3 |  | 3 |  |  | 3 |  |
| **6** |  3 |  |  | 3 |  | 3 |  | 1 | 3 |  |
| **7** |  |  |  |  |  | 2 |  |  |  |  |
|  |  | **3=Strong, 2=Moderate, 1=Possible** |

**V. Constituencies**

Faculty, students, alumni, and industrial employers are the program’s primary constituencies who provide both informal and formal input to the assessment process. Students’ parents and individuals from the community and state provide informal input to the process on matters affecting the program.

**VI. Assessment Tools**

The department ensures that graduates achieve learning outcomes in two ways: first, by offering a coherent program of study that provides an opportunity for learning (Table 2), and second, by developing and applying ***direct*** and ***indirect*** assessment techniques to determine the success of students in fulfilling learning outcomes. Table 3 summarizes the assessment tools.

***Direct Assessment Tools:***

1. *Culminating Experience* (ECE 186) is assessed through *Capstone Design Reports*. *Capstone Design Reports* provide a strong indicator for many of the outcomes indicated in Table 4. Applying engineering science, open-ended problem solving, use of modern engineering tools, computation competence, problem solving, written communication, and team skills for group projects are elements that can be accessed through oral progress reports and written final reports. Sample reports will be made available during the site visit. (*Scoring rubrics applied*.)
2. *Embedded Questions* provide a moderate indicator for breadth and depth in electrical engineering subjects. Table 4 shows where direct assessment data is collected throughout the curriculum. (*Scoring rubrics applied*.)
3. *Lab Reports* are strong monitoring instruments for hands-on experiences, use of modern engineering tools, following technical instructions, written communication, and teamwork skills. *(Scoring rubrics applied.)*
4. *Poster Sessions/Oral Presentations* strongly demonstrate the student’s written and oral communication skills. These sessions also show examples of hands-on experiences, engineering design, use of modern engineering tools, and teamwork skills. (*Scoring rubric applied*.)

***Indirect Assessment Tools:***

1. *Course Assessment* demonstrates the accomplishment of course objectives as related to learning outcomes in individual courses. The level of student satisfaction is an indicator of relevant knowledge gained. Survey forms are administered in individual courses in which students appraise the contribution of the course to each educational outcome.
2. *Student/Faculty Forum* is administered in an open forum where students from all levels are present. Most of the outcomes can be monitored by such student input. In these meetings students typically tend to discuss issues like laboratory facilities, curriculum, internships and job opportunities, hands-on experience, available modern tools, lab upgrades, communication skills, ethics, and teamwork.
3. *Exit Interviews/Surveys* address most of the outcomes and document students’ level of satisfaction with the learning attributes at the time of graduation. Graduating seniors typically spend between 2-4 years in the department. Therefore, their experiences, usually in the form of oral comments expressed during exit interviews are much more telling and useful than numeric scores on survey sheets. Electrical and Computer Engineering faculty members spend time discussing these comments while placing them in context of other assessment data before considering any changes or adjustments.
4. *Alumni Survey* helps assess program objectives and student learning outcomes*.*
5. *Industry Advisory Council* provides the industry perspective on several related issues including program objectives.

**Table 3** Assessment Tools

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SLO | Culminating Experience | Embedded Questions | LabReports | Poster Presentations | Course Assessment | Student/Faculty Forum | Exit Survey | AlumniSurvey |
| **1** | ● | ● | ● |  | ● | ● | ● | ● |
| **2** | ● | ● | ● |  | ● | ● | ● | ● |
| **3** | ● | ● | ● | ● | ● | ● | ● | ● |
| **4** | ● |  |  |  | ● | ● | ● | ● |
| **5** | ● | ● | ● |  | ● | ● | ● | ● |
| **6** | ● |  | ● |  | ● | ● | ● | ● |
| **7** |  |  |  |  |  | ● | ● | ● |

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
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| **Table 4 Electrical Engineering Direct Assessment** |
| **SLO** | **ECE 1** | **ECE****72** | **ECE****85** | **ECE****85L** | **ECE****90** | **ECE****90L** | **ECE****102** | **ECE****103** | **ECE****118** | **ECE****120L** | **ECE****124** | **ECE****125** |
| ***1*** |  | ● |  |  | ● |  | ● |  |  |  | ● | ● |
| ***2*** |  |  | ● |  |  |  |  |  |  |  |  |  |
| ***3*** | ● |  |  |  |  | ● |  | ● |  |  |  |  |
| ***4*** |  |  |  |  |  |  |  | ● | ● |  |  | ● |
| ***5*** | ● |  |  | ● |  |  |  |  |  | ● |  |  |
| ***6*** |  |  |  |  |  | ● |  |  |  | ● |  |  |
| ***7*** |  |  |  |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SLO** | **ECE****126** | **ECE****128** | **ECE****128L** | **ECE****134** | ***ECE******138*** | ***ECE******138L*** | ***ECE******155*** | ***ECE******186*** |
| ***1*** | ● | ● |  |  | ● |  | ● | ● |
| ***2*** |  |  |  |  | ● |  | ● | ● |
| ***3*** |  |  | ● |  |  |  |  | ● |
| ***4*** |  |  |  | ● |  |  | ● | ● |
| ***5*** |  |  |  |  |  | ● |  | ● |
| ***6*** |  |  | ● |  |  | ● |  | ● |
| ***7*** |  |  |  |  |  |  |  | ● |

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
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**VIII. Assessment Process**

The department established the following comprehensive process to assess students’ learning according to the aforementioned 11 SLOs. The current assessment process has been in place since the year 2000.

1. Reevaluation of the mission statement, program objectives, and student learning outcomes. (This is done with the input from the advisory council, faculty, and survey response from the alumni and the employers.)
2. Reevaluation of surveys and scoring rubrics will be done by faculty during the scheduled faculty retreat sessions.
3. Data is collected using the assessment tools and according to the established time schedule.
4. Data is analyzed according to the established time schedule. (This is done by faculty and advisory council members.)
5. The action items are determined to close the loop of the assessment.
6. Progress is monitored based on the action items.

**Standard**: On a scale of 1 (poor) to 5 (excellent), the faculty members consider a rating of 3.75 or higher to be satisfactory. An overall rating below 2.75 for any of the outcomes requires immediate attention, and a rating between 2.75 and 3.75 requires further observation as a “carry over item” in the next evaluation cycle.

Rubrics for assessing student learning outcomes have been developed and utilized. (Attached)

**IX. Assessment Activities Timeline**

The department collects and analyzes data according to the following schedule:

1. Every semester

(a) Exit Surveys (Spring and Fall Graduates)

(b) Embedded questions

2. Annually

(a) Culminating Experience

(b) Poster Sessions/Oral Presentations

(c) Student/Faculty Forums

(d) Course Evaluations (2 semesters)

(e) Industrial Advisory Meeting

3. Every third year (2009, 2012, 2015, 2018, 2021, 2024)

 (a) Alumni survey

 (b) Lab report (ECE128L and ECE138L)

1. Every sixth years (2006. 2012, 2018, 2024)

(a) Review of a mission statement and program objectives

(b) Assembly of course binders and assessment of the overall success.

# Math Science Engineering Rubric

**SLO 1**

Course: ECE \_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Evaluate on a scale of 1-5 (5 is for excellent); check the proper box

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | N/A |
| Identification of Applicable Physics and Mathematics Principles  | Lack of Knowledge |  |  |  | Complete Knowledge |  |
| Utilization of Physics and Mathematics Principles toward Modeling of an engineering system | Improper utilization or application |  |  |  | Proper and correct utilization |  |
| Application of the Mathematics Methodology toward analyzing an engineering system | Incorrect Application |  |  |  | Correct and Complete Application |  |
| Use of mathematical steps toward solving an engineering problem | Incorrect or invalid mathematical steps |  |  |  | Except for minor errors, completion of appropriate mathematical steps |  |
| Interpretation and appropriate presentation of results |  Lack of Valid  results |  |  |  | Complete results that include proper units |  |

Overall average score \_\_\_\_\_\_\_\_\_\_

Evaluator \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_

#  Engineering Design Rubric

# with consideration of public health, safety, welfare, global, cultural, social, environmental, and economic factors

**SLO 2**

Course#: ECE \_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Evaluate on a scale of 1 – 5 (5 is for excellent); check the proper box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 |
| Design Statement ( Problem explanation and identification of its constraints and specifications) | No clear objectives or identified needs | Unclear objective statement or not appropriate for the level of the activity | Clear objectives but no identified needs or constraints |  | Clear objectives and needs within realistic constraints including at least two of the following: public health, safety, welfare as well as global, cultural, social, environmental, and economic factors.  |
| Design Process including alternative solutions | No evidence of abilityto understandthe design requirements,limitations,analyze differentalternatives, andprovide a feasibledesign | Little evidence ofability to understandthe designrequirements, limitations,analyzedifferent alternatives,and providea feasible design | Some evidence ofability to understandthe designrequirements,limitations, analyzedifferent alternatives,andprovide a feasibledesign |  | Clear evidence ofability to understandthe design requirements, limitations, analyzedifferent alternatives,and provide a feasible design |
| Application of appropriate mathematical models and engineering concepts in the design process | No evidence of abilityto identify and use engineeringprinciples in design  | Identified appropriate concepts and demonstrated some effort to apply them  | Some evidence ofability to use engineeringprinciplesin design  |  | Clear evidence ofability to use mathematical models and/or engineeringprinciplesto design components, devices or systems |
| Final Product | Final design is lacking and the final product doesn’t meet expectations in format  |  | Acceptable final product but needs better presentation format |  | Optimal / creative design in proper format |

 Overall average score: \_\_\_\_\_\_\_\_\_

Evaluator: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Oral Communication Rubric

**SLO 3**

Course #: ECE \_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Evaluate on a scale of 1-5 (5 is for excellent); check the proper box

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 |  |
| ***Spoken communication***1. ***Clarity***
2. ***Formality***
 | unclear pronunciation and lacking vocabulary |  |  | clear pronunciation but lacking vocabulary |  | clear pronunciation and appropriate vocabulary  |
| ***Presentation***1. ***Clarity of Voice***
2. ***Eye Contact***
 | Unclear voice and no eye contact  |  |  | clear voice but no eye contact |  | proper level of voice and good eye contact |
| ***Ability to express ideas and answer questions***  | not able to express ideas or answer questions |  |  | Ideas expressed reasonably well but answers to questions is lacking |  | ideas expressed clearly and all questions are answered properly |
| ***Technical content***1. ***Depth***
2. ***Soundness***
 | no depth and unclear approach |  |  | sufficient depth but unclear approach  |  | appropriate depth and sound approaches |

Overall average score \_\_\_\_\_\_\_\_\_\_

Evaluator \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Ethical and Professional Responsibilities

**To make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts**

**SLO 4**

Course #: ECE \_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Evaluate on a scale of 1-5 (5 is for excellent); check the proper box

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| ***Understanding of ethical and professional responsibilities*** | Lack of understanding |  |  |  |  | Correct understanding |
| ***Analysis of ethical and professional responsibility in a case study*** | Wrong analysis |  |  |  |  | Correct analysis |
| ***Make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*** | Incorrect judgement |  |  |  |  | Correct judgement  |

Overall average score \_\_\_\_\_\_\_\_\_\_

Evaluator \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Teamwork Rubric

# SLO 5

Course: ECE \_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Evaluate on a scale of 1-5 (5 is for excellent); check the proper box

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 |
| ***Leadership*** | Doesn’t seem aware of responsibilities |  |  | Aware of responsibilities but does the absolute minimum |  | Engaging and brings new ideas to the table.  |
| ***Responsibility*** | Behind most of the time  |  |  | Delivers on time but doesn’t seem to be engaging  |  | Always on top of what is going on and delivers on time |
| ***Collaboration*** | Rarely supports the efforts of others |  |  | Respects the views of others but not assertive in his views |  | Tries to make people work together and assertive in his actions |
| ***Establish goals and plan tasks*** | Rarely participates in planning the project |  |  | Participates in setting goals and making a plan, but not as a leading role  |  | Actively set goals and make task plans |
| ***Meet objectives*** | Project objectives are not met |  |  | Some project objectives are attained.  |  | Perform the project and successfully meet the project objectives |

Overall average score \_\_\_\_\_\_\_\_\_\_

Evaluator \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_

# Hands-on Experiment Rubric

**SLO 6**

Course: ECE \_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Evaluate on a scale of 1-5 (5 is for excellent); check the proper box

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | N/A |
| Designing Experiments: Develop a methodology to test concepts and produce data to evaluate a specific process | Improper design or technique |  |  |  | Appropriate design or technique to evaluate a specific process |  |
| Conducting Experiments:Operate appropriate laboratory equipment or hardware/software tools to collect data | Unable to operate equipment |  |  |  | Appropriate use of equipment |  |
| Analysis and interpretation of Data: | Improper data analysis and interpretation |  |  |  | Proper data analysis and interpretation |  |
| Engineering judgment to draw conclusions | Incorrect judgement on the experimental results |  |  |  | Correct judgement on the experimental result |  |

Overall average score \_\_\_\_\_\_\_\_\_\_

Evaluator \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_

# Acquire and apply new knowledge as needed

# using appropriate learning strategies

**SLO 7**

Course#: ECE \_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Evaluate on a scale of 1-5 (5 is for excellent); check the proper box

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | N/A |
| Referencing relevant information and awareness of alternative solutions | Inability to satisfactorily demonstrate awareness of background |  | Satisfactory demonstration of at least three indicators |  | Strong demonstration of awareness of background |  |
| Ability to use appropriate learning strategy | Lack of learning strategy to acquire knowledge required |  |  |  | Use of proper learning strategy to acquire knowledge required |  |
| Application of new knowledge  | Lack of demonstration of applying new knowledge on solving of engineering problem or engineering design |  |  |  | Demonstration of proper application of new knowledge on solving of engineering problem or engineering design |  |

Overall average score \_\_\_\_\_\_\_\_\_\_

Evaluator \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_