

Set of rubrics used for direct assessment of COE student outcomes.

SO1: an ability to *identify, formulate, and solve* complex engineering problems by *applying* principles of engineering, science, and mathematics.

Indicator	Score (1 - 4)	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Identifies problems with a quantifiable solution that can be approached systematically		Correctly identifies problems and the appropriate solution methodology that applies to them, and the steps involved.	Correctly identifies problems and the appropriate solution methodology that applies to them, and the steps involved with minor mistakes	Makes mistakes in identifying the problems and the solution methodologies. Needs to have the problem clearly identified for them.	Unable to identify the problems nor applicable solution methodology at all.
Selects appropriate methods for solving the problem		Correctly selects the best know methods for solving problems, including the applicable principles, equations, optimization, algorithms etc.	Correctly selects the best know methods for solving problems with minor mistakes	Selects wrong methods for solving the problem	Cannot select any methods for solving the problems.
Formulates the problem according to chosen solution method and identifies key issues/variables		Proper formulation of the problem based on the selected solution method and after identification of all applicable specifications and issues/variables.	Proper formulation of the problem based on the selected solution method with minor mistakes.	Some incomplete formulation is provided, omits some specs and/or issues & variables.	Unable to formulate the problem according.
Proper Consideration and justification of alternative solutions		Recognizes the need for multiple solutions, identifies and analyzes alternative solutions, and justifies the solution to an engineering problem	Recognizes the need for multiple solutions, but incomplete identification, analysis, or justification of solutions to an engineering problem	Poor identification of alternatives, little analysis, and no justification of solutions to an engineering problem	Does not consider alternative solutions at all.

SO2: 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.

Performance Indicator	Score (1 - 4)	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Identifies and follows a logical and orderly design procedure		Identifies and follows a clear logical procedure; identify all applicable Requirements & Constraints → Specifications → System Design → component design → Integration and testing	Follows a clear procedure but some steps are incomplete (e.g. missing some constraints)	Follows some procedure with some steps clearly missing altogether	Works in an ad-hoc manner, no procedure identified
Systematically develops, compares and ranks design alternatives to arrive at a final solution		Several good alternatives developed	At least one good alternative is missed	Identifies some alternatives but misses many	Only considers one design option
		Systematically compares and ranks alternatives	Sometimes selects a design without justification	ad-hoc selection	No evidence of systematic comparison or ranking at all
Creates a final solution that satisfies all requirements and constraints identified in formulating the design problem		All identified Requirements & constraints are appropriate, well justified, and properly translated to specifications (system, sub-systems) with adequate precision & resolution	Most of the applicable Requirements & constraints are identified with justification, and properly translated to specifications with minor mistakes	Incomplete Requirements and constraints (Obvious ones are missed) Specs are incomplete with many requirements not mapped to any spec.	Identification of requirements and constraints in formulating the problem is missing or inadequate. No specs.
Justifies design decisions using analyses based on appropriate engineering and/or scientific principles		Applies all relevant principles correctly for major design decisions	Applies all relevant principles correctly for major design decisions with minor mistakes that leads to less ideal decisions	Applies wrong principles that leads to wrong decisions	No analysis of design decisions performed
Proper consideration, where appropriate, of the following factors:		Produces a specific list of constraints resulting from these factors, and applies them, where	Produces a specific list of constraints resulting from these factors, and applies them, where appropriate, throughout	Produces an incomplete list of constraints resulting from these factors, but no clear	No listing of constraints provided
public health					

safety and welfare		appropriate, throughout the design process.	the design process with minor omissions.	application throughout the design process.	
Global, Cultural, Social, and environmental					
economic factors (cost, benefit, ROI etc.)					
Supports the design process with appropriate engineering documentation and references		All supporting documentation is created. Minor improvements in quality are possible	Most supporting documentation is created. Some missing documentation and minor improvements in quality are possible	Supporting documentation is created. many missing documentation and quality is needs significant improvements	Significant pieces of supporting documentation are missing or of a poor quality

SO3: an ability to communicate effectively with a range of audiences.

Outcome	Score (1 - 4)	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
<u>Oral Presentation and Delivery:</u> Contents		Presents and follows an excellent outline and organization, makes smooth transitions, uses visual aids effectively, presents convincing evidences and conclusions, and answers questions effectively.	Presents and follows a satisfactory outline and organization, makes adequate transitions, uses visual aids reasonably, presents some convincing evidences and conclusions, and answers questions moderately.	Presents a fair outline and organization, makes uneven transitions, uses some visual aids improperly, presents few convincing evidences and conclusions, and answers questions barely.	Presents a poor outline and organization, makes rough transitions, uses visual aids poorly, presents no convincing evidences or conclusions, and answers questions poorly.
Delivery		Speaks fluently and effectively with excellent tone and pace, interacts with audience, and uses proper eye contact and body language.	Speaks clearly and effectively with proper tone and pace, interacts - at times - with audience, and uses moderate eye contact and body language.	Speaks fairly with moderate tone and pace, uses little interaction with audience, and uses little eye contact and body language.	Speaks poorly with improper tone and pace, doesn't interact with audience, and uses no eye contact or body language.
<u>Written Communications:</u> Language		Makes rare or no spelling and/or grammatical mistakes, excellent use of punctuation, and smooth and well-structured sentences.	Makes few spelling and/or grammatical mistakes, proper use of punctuation, and moderately smooth and structured sentences.	Makes noticeable mistakes in spelling, grammar and/or in the use of punctuation, and uses weakly structured sentences.	Makes substantial mistakes in spelling, grammar and/or in the use of punctuation, and uses poorly structured sentences.
Organization		Follows a clear organization, uses an effective and accurate abstract, uses visual aids effectively, and cites all sources properly.	Follows an acceptable organization, uses a good abstract, uses visual aids with varying effectiveness, and cites most sources properly.	Follows a less than acceptable organization, uses an inaccurate abstract, uses visual aids barely, and cites some sources.	Follows a poor organization, uses an inaccurate or no abstract, uses visual aids ineffectively, and does not cite most sources.
Effective Communication with a Range of Audiences		Selects the appropriate communication method (selection of terminology, technical level, language, illustration, etc.) to communicate with various audiences (e.g., experts, executives, peers, ...).	Mostly selects the appropriate communication method when communicating with peers or experts, but sometimes inappropriate for other audiences.	Communicate in the same way with all type of audiences.	Slides and/or reports are poorly prepared (i.e., language, visual aids, ...), and are ineffective to communicate with anyone.

SO4: 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.

Performance Indicator	Score (1 - 4)	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Recognition of ethical dilemma		Recognize that there is an ethical issue/ dilemma involved and clearly identifying the type of ethical dilemma in the situation at hand	Recognize that there is an ethical issue/ dilemma involved but does not completely identify its type	Recognize that there is an ethical issue/dilemma involved but completely misses the actual issue	Not recognizing a problem at all
		Focused, clear, and detailed framing of a dilemma, not irrelevant digressions	Good but incomplete framing of a dilemma	Somehow vague framing of the dilemma	Unfocused, unclear, not coherent description of a dilemma
		Clearly identifies all stakeholders (those affected by the ethical issue/dilemma)	Identify most of stakeholders	Identify some of stakeholders	Cannot even identify stakeholders
Providing relevant information for the case at hand		Produces well-crafted arguments based on new information; justifies assumptions and brings information from their own experiences	Produces good arguments based on new information but misses others; recognizes and justifies some of the assumptions	Produces some arguments based on new information but misses many; does not recognize the assumptions involved	Copies arguments from sources but does not critically examine them. Ignores pertinent facts or uses misinformation.
		Identifies <u>all</u> critical issues & components of the new knowledge	Identifies most of the critical issues & components of the new knowledge	Identifies Some of the critical issues & components of the new knowledge	Gets lost in unimportant details and cannot identify any issue

Analysis and fairness		Provides clear arguments showing deep understanding and good analysis of ALL relevant issues	Provides many good arguments and show somehow good understanding of directly involved issues (misses some minor issues)	Provides some arguments and show some understanding of directly involved issues (misses some major issues)	Arguments are not clear or coherent, does not show any understanding
		Considers multiple points of view in their analysis; global view with perspectives from multiple entities (e.g. employers, professions, and society)	Considers several points of view in their analysis; but misses some perspectives from some entities	Considers few points of view in their analysis and misses some major perspectives	Takes only one point of view when analyzing a dilemma (e.g. only the employers)
Ethics in professions		Familiar with the value and importance of professional codes	Have some knowledge of the value and importance of professional codes	Can identify some professional codes but shows no appreciation for such codes	Cannot identify even the basic components of professional codes
		Understands personal, professional, and wider social consequences of violations of codes	Generally understands the consequences of code violation but not fully aware of all aspects	Shows some understanding of consequences of code violation with very limited view	Unaware of consequences of violations of codes of ethics

SO5: 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.

Performance Indicator	Score (1 - 4)	Phase	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Capable of establishing goals, plan task and meet objective		Project Planning	Ability to excel in producing a project plan with graphical and textual representation of the timeline, functional decomposition, and requirement specification to fulfil the target goal with no or little support.	Ability to adequately produce a project plan with graphical and textual representation of the timeline, functional decomposition, and requirement specification to fulfil the target goal with some support from instructors.	Barely produces a project plan with graphical and textual representation of the timeline, functional decomposition, and requirement specification to fulfil the target goal with coaching and support from instructors.	Incapable of producing a project plan with graphical and textual representation of the timeline, functional decomposition, and requirement specification to fulfil the target goal even when coached and supported.
			Ability to excel in planning the appropriate expected duration of each task to reach the goal with no or little support.	Ability to adequately plan the expected duration of each task to reach the goal with some support from instructors.	Barely plan the expected duration of each task to reach the goal with coaching and support from instructors.	Incapable of planning the expected duration of each task to reach the goal with coaching and support from instructors.
		Project Execution	Ability to excel in conducting the identified task within the expected time duration that is identified in the original plan	Ability to adequately conduct the identified task within the expected time duration that is identified in the original plan	Barely conducts the identified task within the expected time duration that is identified in the original plan and often takes more time	Incapable of conducting the identified task within the expected time duration that is identified in the original plan.

Capable of functioning effectively in a team		Ability to excel in clearly identifying roles of each team member, assign them responsibilities and effectively executed the given task to reach the planned goal with little or no help from instructors.	Ability to adequately identify roles of each team member, assign them responsibilities and efficiently execute the given task to reach the planned goal with some support from instructors.	Barely identify roles of each team member, assign them responsibilities, and barely executed the given task to reach the planned goal with coaching and support from instructors.	Incapable of identifying roles of each team member, assign them responsibilities and execute the given task to reach the planned goal even after coaching and support from instructors.
		Ability to highly engage team members in a written Team Contract at the planning phase that details each team member responsibility that is well written and ability to conduct it effectively.	Ability to sufficiently engage team members in a written Team Contract at the planning phase that details each team member responsibility that is adequately written and ability to conduct it effectively.	Barely engages team members in a written Team Contract at the planning phase that details each team member responsibility that is written and poor ability to conduct it effectively.	Incapable of engaging team members in a written Team Contract at the planning phase that details each team member responsibility or having a poor written contract that was not conducted effectively.

<p>Capability of providing leadership and collaborate in inclusive environment</p>		<p>Ability to excel in communicating with team members, motivating, and inspiring other members by listening and negotiating the various project tasks and influencing team members when they fall behind or cannot achieve the assigned tasks.</p>	<p>Ability to efficiently communicate with team members, motivate, and inspire other members by listening and negotiating the various project tasks and influencing team members when they fall behind or cannot achieve the assigned tasks.</p>	<p>Ability to moderately communicate with team members, motivate, and inspire other members by listening and negotiating the various project tasks and influencing team members when they fall behind or cannot achieve the assigned tasks.</p>	<p>Incapable of communicating with team members, motivating, and inspiring other members by listening and negotiating the various project tasks and influencing team members when they fall behind or cannot achieve the assigned tasks.</p>
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SO6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Outcome	Score (1 - 4)	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Pre-Experiment: Identifying clear goals for the experiment – Hypothesis testing, Knowledge Discovery, etc.		Experiment objectives are clear and well-articulated, expected results, and possible pitfalls of the experiment	Identifies most of the objectives of the experiment and some of the expected results but does not state possible pitfalls	Identifies some of the objectives of the experiment but omits the expected results and possible pitfalls.	Does not identify any objectives for the experiment and/or expected results
Designing a valid and appropriate experimental setup that achieve the experiment objective		Designs a fully valid testbed suitable for achieving the objectives with proper justification	Designs a valid testbed suitable for achieving the objectives with some justification	Designs a testbed that partially achieve the objectives without enough justification	Fails to designs a valid testbed for achieving the objectives
Conducting the experiment using a well-defined valid procedure for achieving the experiment result		Conducts the experiment with no flaws at all, all procedural steps are correct, documented and justified, observations are recorded appropriately.	Conducts the experiment with some minor errors that do not affect the objectives significantly, procedural steps are mostly <i>correct</i> , and documented but not fully justified, observations are recorded appropriately.	Conduct the experiment with some errors that affect the results and the objectives	Conduct the experiment with major conceptual or procedural errors that render the results useless and leave the objectives unachieved
Analyzing and interpreting data and drawing conclusions		Analysis, visualization, interpretation of results, and conclusions exceed requirements of experiment and demonstrate significant higher-order thinking ability.	Analysis, interpretation of results, and conclusions meet requirements of experiment and demonstrate good thinking ability	Results are analyzed but not interpreted; conclusions are drawn but not well supported, very limited evidence of higher-order thinking ability was shown	No evidence of significant analysis and interpretation of results; fail to make proper conclusions; demonstrate only lower-level thinking ability

SO7: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Performance Indicator	Score (1 - 4)	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Capable of acquiring new knowledge when presented with a new engineering problem		Ability to excel in acquiring new knowledge independently from various resources (such as internet, library, textbook, technical magazines/journals, watching video tutorials, interacting with technical forums ...etc.) with no or little support from instructor.	Ability to acquire enough new knowledge from various resources (such as internet, library, textbook, technical magazines/journals, watching video tutorials, interacting with technical forums ...etc.) with little support from instructor.	Ability to acquire the bare minimum new knowledge from various resources (such as internet, library, textbook, technical magazines/journals, watching video tutorials, interacting with technical forums ...etc.) with coaching, support and help from instructor.	Incapable of acquiring new knowledge from various resources (such as internet, library, textbook, technical magazines/journals, watching video tutorials, interacting with technical forums ...etc.) even with coaching, support and help from instructor.
		Ability to identify reliable source of information independently and with no or little support from instructor.	Ability to identify reliable source of information with some support from instructor.	Ability to identify reliable source of information after extensive coaching and support from instructor.	Incapable to identify reliable source of information after extensive coaching and support from instructor.
		Ability to identify old and new information related to the field of study independently and with no or little support from instructor.	Ability to identify old and new information related to the field of study with some support from instructor.	Ability to identify old and new information related to the field of study after coaching and support from instructor.	Incapable to identify old and new information related to the field of study after coaching and support from instructor.
Capable of applying the acquired new knowledge to solve newly presented engineering problems		Ability to produce well-crafted arguments (oral and/or written) based on new information.	Ability to produce good arguments (oral and/or written) based on new information.	Ability to produce some arguments (oral and/or written) based on new information.	Incapable of produce any arguments (oral or written) based on new information.

<p>Capable of identifying suitable learning strategies to learn and apply the new knowledge</p>		<p>Ability to independently devise and communicate a framework for the application of existing knowledge in a novel context or situation with no or little support from instructor.</p>	<p>Ability to identify and communicate a framework for the application of existing knowledge or situation with some support from instructor.</p>	<p>Ability to identify and communicate a framework for the application of existing knowledge or situation with coaching and support from instructor.</p>	<p>Incapable of identifying and communicating a framework for the application of existing knowledge or situation with coaching and support from instructor.</p>
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