



Department  
of  
**MECHANICAL  
ENGINEERING**

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# Rubrics for Validation of Program Outcomes

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## **Preface:**

The Program Outcomes are pedagogical assessment tools to measure the quality, skill, and understandings that a student has gained as a result of learning and engaging with the activities offered by the program. The Department of Mechanical Engineering has developed this document to help guide instructors of individual courses, as well as for assessment at the program level to correlate the performance of any activity with the corresponding program outcomes. These rubrics are descriptive while providing a correlation strength (low-1, medium-2, high-3) that can be used to better understand and hence map the activity with the program outcomes.

Rubrics are used for communicating the performance expectations for an activity. They are a way to provide transparent criteria for assessment for all stakeholders (faculty, instructors, students, alumni and Industry). Rubrics are descriptive, and thereby can be used as a tool to promote understanding, and to direct future instruction and learning.

**PO1 Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Knowledge base for Engineering</b>	Apply Mathematics & Basic Sciences	<p>Demonstrates skillful ability to carry out calculations. Calculations are relevant, correct and comprehensive, and are clearly and concisely presented. Mathematical software skillfully used.</p> <p>Chooses an optimal mathematical model that applies to an engineering problem, and develops new models.</p>	<p>Can apply mathematical and scientific principles to design or improve systems and processes.</p> <p>Correct scientific terms, theories and concepts are used to solve problems.</p>	<p>Systems &amp; Processes to be designed or improved require a foundation in mathematics and applied sciences.</p> <p>Correct scientific terms, theories and concepts are identified and interpreted</p>
	Apply Fundamental Engineering Knowledge	<p>Can translate theories or make realistic assumptions to apply or develop models of systems based on engineering fundamentals</p>	<p>Demonstrates ability to apply the fundamentals of engineering theory to the problem.</p>	<p>Demonstrates some ability to understand the application of fundamental engineering theory to the problem.</p>

**PO2 Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Problem Formulation &amp; Analysis</b>	Identify / define and contextualize problems	<p>Demonstrates a skillful ability to identify/articulate a problem that is strongly supported and clearly linked to the issues at hand.</p> <p>Locating resources, integrating knowledge and experience, and formulating a good strategy to solve engineering problems.</p>	<p>Demonstrates an ability to identify a problem and how it fits into the larger context.</p> <p>Locating resources and integrating knowledge from various resources.</p>	<p>Demonstrates an ability to identify a problem.</p> <p>Locating resources limited to text books with less integration of available knowledge.</p>
	Analyze and evaluate problems	<p>Can breakdown complex problems into sub problems and apply theoretical concepts. Understands how various pieces of the large problem relate to each other and the whole system.</p> <p>Excels in taking into account practical constraints.</p>	<p>Complex problems can be identified into sub problems with moderate ability to link them.</p> <p>Ability to correctly identify constraints</p>	<p>Complex problems can be identified into sub problems.</p>

**PO3 Design/Development of Solutions:** Design solutions for engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety and aligned with the cultural, societal and environmental considerations.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
Problem solving	Understanding the design process	Demonstrates a comprehensive ability to explain the design process including the requirements, specifications, and proper selection of design tools.	Demonstrates an ability to understand the design process including the requirements and specifications.	Demonstrates a minimal ability to understand the design process
	Problem solving and implementation	<p>Considers multiple approaches to solving a problem, and develops a logical, consistent plan.</p> <p>A skillful (thorough / creative) ability to execute a solution taking into consideration all design requirements and Constraints.</p>	<p>Considers multiple approaches to solving a problem with some design considerations.</p> <p>Demonstrates ability to execute a solution as per design requirements.</p>	<p>Correctly demonstrates a single approach to solve problems.</p> <p>Demonstrates ability to execute a particular design solution.</p>

**PO4 Conduct Investigations of Complex Problems:** Use research based knowledge and methodologies to analyse, interpret data and synthesize information to make valid conclusions.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Evaluations &amp; Experimental Methods</b>	Problem Investigation	Selects or develops an optimal methodology or theoretical framework to investigate a problem.	Selects an optimal methodology or theoretical framework to investigate a problem.	Selects a methodology or theoretical framework to investigate a problem.
	Evaluating designs	Recognizes consequences of solution and can articulate reason for choosing solution.  Incorporates innovation into considerations.	Demonstrates an ability to evaluate / confirm the functioning of the final design to a sufficient depth.	Demonstrates some ability to evaluate / confirm the final design.
	Data collection & interpretation	Knows many methods to calculate, capture and present data. Plans, organizes, & conducts experiments well.  Findings are well interpreted and skillfully compared with values in literature.	Knows methods to calculate, capture and present data.  Findings are correctly interpreted	Knows methods to calculate, capture and present data.  Findings are presented with limited interpretation.

**PO5 Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering software and tools to simulate and model engineering problems.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
Use of Engineering Tools	Understand and identify tools	<p>Able to correctly describe and explain the principles behind the use of engineering tools.</p> <p>Selecting the appropriate or multiple tools and/or techniques with consideration to the applicability to given engineering problem.</p>	<p>Ability to identify and explain the use of engineering tools.</p> <p>Selecting the appropriate tools and/or techniques for an engineering problem.</p>	<p>Ability to identify and explain the use of engineering tools.</p> <p>Able to select a tool and/or technique to facilitate problem solving.</p>
	Apply and create tools	<p>Demonstrates skillful ability to use models, techniques and software in solving / analyzing engineering problems</p> <p>Creating tools and evaluating their limitations with proper assumptions</p>	<p>Demonstrates ability to use models, techniques and software in solving / analyzing engineering problems.</p> <p>Understands the limitations of the selected tools.</p>	<p>Demonstrates an ability to use models, techniques and software in solving / analyzing engineering problems.</p>

**PO6 The Engineer and the Society:** Practically contextualize in the society the Mechanical engineering concepts to address health, legal, reliability and safety concerns.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Impact of Engineering on Society</b>	Consider diverse perspectives	Ability to consider other cultural, ethical and diverse perspectives from non engineering sources while investigating the impact on society.	Some consideration to cultural, ethical and diverse perspectives from non engineering sources while investigating the impact on society.	Minimal consideration to diverse perspectives while investigating the impact on society.
	Impact of engineering intervention on society	Considers, explains and evaluates the impact of engineering solutions on the society.  Demonstrates dedicated leadership roles as members of professional and social service bodies.	Accounts for some consideration of the impact of engineering solutions on society.  An active member of professional and social service bodies.	Minimal consideration of the impact of engineering solutions on society.  A member of professional and social service bodies.
	Societal challenges	Identifies and explains multiple solutions to challenges in society and evaluates their consequences.	Identifies and explains multiple solutions to challenges in society.	Identifies some solutions to challenges in society.



**PO7 Environment and Sustainability:** Understand and appreciate the impact of professional engineering solutions in societal and environmental context and to imbibe the professional concern for sustainable development practices.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Impact of Engineering on Environment</b>	Impact of engineering intervention on Environment	<p>Considers, explains and evaluates the impact of engineering solutions on the environment.</p> <p>Demonstrates dedicated leadership roles as members of professional and social service bodies.</p>	<p>Accounts for some consideration of the impact of engineering solutions on environment.</p> <p>An active member of professional and social service bodies.</p>	<p>Minimal consideration of the impact of engineering solutions on environment.</p> <p>A member of professional and social service bodies.</p>
	Environmental challenges	Identifies and explains multiple solutions to environmental challenges and evaluates their consequences.	Identifies and explains multiple solutions to environmental challenges.	Identifies some solutions to environmental challenges.

**PO8 Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
Ethics	Ethical behaviour	Approaches all situations with awareness and consideration of the ethical issues involved, and actively works to resolve them with inclusivity.	Able to approach situations with consideration of ethical issues, and acts to resolve them with inclusivity.	Some ability to approach situations with consideration of ethical issues.
	Accountability and use of others work	Proper ethical use of intellectual property, copyrighted materials, and others' research.  Always assumes responsibility for own actions.	Adopts ethical use of intellectual property, copyrighted materials, and others' research  Assumes responsibility for own actions.	Some recognition of the ethical use of intellectual property, copyrighted materials, and others' research  Recognizes the need to assume responsibility for own actions, but may not always act on this

**PO9 Individual and Team Work:** Contribute effectively as an Individual and as a member or leader in diverse teams amidst multi-disciplinary settings.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Individual Contributions &amp; Team Skills</b>	Individual contribution and time management	<p>Works effectively as an individual and as part of teams and contributes useful idea to advance the work to be done</p> <p>Designated jobs are completed by the deadline and meets all requirements</p>	<p>Contributes useful ideas in individual capacity to complete the work assigned.</p> <p>Designated jobs are completed by the deadline and meets all requirements</p>	<p>Contributes useful ideas sometimes, in individual capacity to complete the work assigned.</p> <p>Designated jobs are completed by the deadline.</p>
	Leadership skills	Exemplifies leadership skills and promotes others to be leaders in their own capacity.	Demonstrates sufficient leadership skills in all endeavours undertaken.	Demonstrates sufficient leadership skills at times.
	Team skills	Strong ability to listens to and collaborates with the efforts of others.	Ability to listens to and collaborates with the efforts of others.	Some ability to listens to and collaborates with the efforts of others.

**PO10 Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large in the form of technical reports, journal and conference papers, design documentation and presentations.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Written &amp; Oral Technical Communication</b>	Communication, Active listening and following instructions	<p>Purpose is clear and effectively guides the communication. Choice of communication is optimal.</p> <p>Demonstrates skillful ability to actively listen by rephrasing / repeating / note taking all of the speaker's key ideas and supporting information.</p> <p>Is able to concisely and effectively follow spoken and/or written instructions.</p>	<p>Purpose is evident, and mostly guides the communication.</p> <p>Demonstrates ability to actively listen to all of the speaker's key ideas and supporting information.</p> <p>Is able to follow spoken or written instructions.</p>	<p>Purpose is somewhat clear</p> <p>Demonstrates ability to actively listen to all of the speaker's key ideas and supporting information.</p> <p>Is able to follow spoken or written instructions.</p>
	Formatting / Layout and design of communicating media	<p>Illustrations (graphs, tables, figures &amp; diagrams) are skillfully used to support ideas (correctly cited, skillfully positioned on page, well integrated and designed)</p> <p>Ability to consistently use appropriate or prescribed format, which is effectively designed and professionally presented.</p>	<p>Illustrations are provided and properly used to support ideas</p> <p>Ability to use appropriate or prescribed format and is effectively designed</p>	<p>Illustrations are provided</p> <p>Appropriate or prescribed format is used</p>

**PO11 Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work and in teams, to successfully manage projects in multidisciplinary environments.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Economics and Management</b>	Economic principles	<p>Demonstrates a skillful ability to create, adhere or analyse a budget.</p> <p>Comprehend and employ economic principles, including cost and value estimations.</p>	<p>Demonstrates an ability to adhere to or analyse a budget.</p> <p>Comprehend and employ some economic principles, including cost estimations.</p>	<p>Demonstrates an ability to analyse a budget.</p> <p>Comprehend and employ few economic principles</p>
	Project outcomes	Demonstrates a skillful ability to evaluate project outcomes and adapt for subsequent projects.	Demonstrates an ability to evaluate project outcomes and adapt for subsequent projects.	Demonstrates some ability to evaluate project outcomes and adapt for subsequent projects.
	Time and change management	Ability to estimate time on task, establish deadlines/milestones, follow timeline, monitor and complete project. Ability to plan for contingencies and adapt to change.	Ability to estimate time on task, establish deadlines/milestones, follow timeline, monitor and complete project.	Ability to follow timeline, monitor and complete project.

**PO12 Lifelong Learning:** Recognize the need for, and have the ability to engage in independent and life-long learning in the context of continuous technological change.

Focus Area	Parameter	Level 3	Level 2	Level 1
		High	Medium	Low
<b>Lifelong Learning</b>	Curiosity and initiative	<p>Demonstrates a skillful ability and curiosity for self learning, to explore a subject/topic thoroughly, generating a variety of knowledge and demonstrating</p> <p>Actively creates and seeks additional opportunities for learning</p>	<p>Demonstrates a skillful ability and curiosity for self learning, to explore a subject/topic thoroughly.</p> <p>Finds and pursues additional opportunities to learn</p>	<p>Demonstrates some ability for self learning, to explore a subject/topic.</p> <p>Some inclination to explore additional opportunities for learning.</p>
	Asking questions	<p>Skillful ability to recognize and construct meaningful and pertinent questions.</p>	<p>Demonstrates some ability to recognize and/or construct meaningful or pertinent questions</p>	<p>Ability to recognize and construct few questions</p>
	Adaptability to new situations	<p>Demonstrates a skillful ability to apply prior knowledge, skills and/or behaviours in an innovative way to new situations.</p>	<p>Demonstrates some ability to apply prior knowledge, skills and/or behaviours in an innovative way to new situations.</p>	<p>Demonstrates ability to apply prior knowledge, skills and/or behaviours situations.</p>