

Rubrics For Program Outcomes

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems. **[3A]**
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. **[3E]**
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations. **[3C]**
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. **[3B]**
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling to complex engineering activities, with an understanding of the limitations. **[3K]**
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice. **[3J]**
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. **[3H]**
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. **[3F]**
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. **[3D]**
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. **[3G]**
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. **[3I]**

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. **[31]**

RUBRICS FOR VALIDATING PO'S

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Apply Mathematics & Basic Science	Appreciates that systems & processes to be designed or improved require a sound foundation in mathematics, physics, chemistry, and biology. Mathematical and scientific terms are interpreted incorrectly. Can apply mathematical, statistical, or scientific theories and concepts to solve problems, but errors are made. Modeling and calculations have 3 or more errors.	Can apply mathematical and/or scientific principles to design or improve systems and processes. Mathematical and scientific terms are interpreted correctly. Can apply mathematical, statistical, or scientific theories and concepts to solve problems, but with a few errors. Modeling and calculations have very few errors.	Excels in applying mathematical and/or scientific principles to design or improve systems and processes. Excellent interpretation of mathematical, statistical, and scientific terms. Excels in using mathematical, statistical, or scientific theories and concepts to solve problems. Modeling and calculations are done correctly.
Apply General Engineering Knowledge	Modeling, graphics, and calculations have 3 or more errors.	Modeling, graphics, and calculations have very few errors.	Modeling, graphics, and calculations are done correctly using a variety of software.
Apply IE Fundamental Concepts	Makes unrealistic assumptions to develop models of systems and processes. Knows the difference between a system and	Can translate theories or make realistic assumptions to develop models of systems and processes. Knows the difference between a system and a	Excels in using theories, making realistic assumptions and developing good models of systems and processes.

	a model of that system, but cannot validate models. Can apply statistical techniques to model, study, analyze, design, or improve systems, but makes many errors.	model of that system, but is not very good at model validation approaches. Can apply statistical techniques to model, study, analyze, design, or improve systems with very few errors.	Accepts limitations of IE & mathematical models of systems and processes & establishes validity of models before using them to make decisions. Excels in applying statistical techniques to model, study, analyze, design, or improve systems.
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PO 2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Strategy	Fair in locating resources, integrating knowledge and experience, and formulating a good strategy to solve engineering problems.	Good at locating resources, integrating knowledge and experience, and formulating a good strategy to solve engineering problems.	Excellent in locating resources, integrating knowledge and experience, and formulating a good strategy to solve engineering problems.
Tools Used	Fair use of multiple tools, techniques, and software for analyzing existing systems and solving problems. Fair in applying multiple tools to solve problems related to synthesis of new systems.	Good at multiple tools, techniques, and software for analyzing existing systems and solving problems. Good in applying multiple tools to solve problems related to synthesis of new systems.	Excels in multiple tools, techniques, and software for analyzing existing systems and solving problems. Excels at applying multiple tools to solve problems related to synthesis of new systems.
Solution	Can breakdown	Can breakdown	Can breakdown

<p>Approach</p>	<p>complex problems into sub problems and apply theoretical concepts, but makes many errors. Needs to be shown how various pieces of the large problem relate to each other and the whole system. Needs help in taking into account practical constraints (social, environmental, and other). Can generate one alternative only or needs some help.</p>	<p>complex problems into sub problems and apply theoretical concepts, but makes a few errors. Knows how various pieces of the large problem relate to each other and the whole system, but makes a few errors. Good at taking into account practical constraints (social, environmental, and other). Generates very few alternatives and compares them.</p>	<p>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. Excels in taking into account practical constraints (social, environmental, and other). Generates many alternatives and compares them.</p>
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PO 3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Design Strategy	Recognizes the need for a design strategy, but needs an example and guidance.	Develops a design strategy independently with a few errors. May need correction or some aspects need embellishments.	Develops a design strategy, including a plan of attack, decomposition of work into subtasks, and development of a timeline using Gantt chart. No changes needed to the developed strategy.
Applying Engineering and Science Knowledge	Fair in applying engineering and/or scientific principles correctly to design practical components, processes, or systems.	Good at applying engineering and/or scientific principles correctly to design practical components, processes, or systems.	Excellent in applying engineering and/or scientific principles correctly to design practical components, processes, or systems.
Constraints Identified and taken into Account	Realizes that there are economic, safety, environmental, and other constraints, but needs help to generate realistic designs that customers will prefer.	Some constraints are not taken into account in designing components, processes, or systems.	Takes into account economic, safety, environmental, and other constraints to generate realistic designs that customers will prefer.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Problem Recognition and Statement	Understands the system, inputs, outputs, and noise factors. Can develop problem statement, but critical information is left out.	Understands the system, inputs, outputs, and noise factors. Can develop problem statement satisfactorily.	Excellent knowledge of system, inputs, outputs, noise factors, etc. Uses that knowledge to define problem clearly.
Choice of DOE Model.	Can choose the model, but needs reassurance from a mentor. Can recognize controllable noise factors and use blocking.	Can choose model correctly and confidently. Applies blocking where necessary.	Not only chooses models correctly, but also knows how to improve the model through sequential experiments.
Perform Experiments	Knows the difference between repetition and replication, but needs reassurance. Can determine sample size, but needs reassurance and help with experiments and collection of data.	Determines the need for repetition or replication, calculates sample size, conducts experiments confidently, and collects data in an organized manner.	Excellent knowledge of repetition or replication. Knows many methods to calculate sample size. Plans, organizes, & conducts experiments well. Uses data collection forms.

PO 5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling to complex engineering activities, with an understanding of the limitations.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Apply Operations Research Models and Techniques	Good at applying deterministic models. Good at applying Markov processes and queuing models.	Very good at applying deterministic models. Very good at applying Markov processes and queuing models.	Excellent in applying deterministic models. Excellent in applying Markov processes and queuing models.
Apply Work Measurement Techniques	Good at applying work measurement techniques..	Very good at applying work measurement techniques..	Excellent in applying work measurement techniques.
Problem Def., Soln. Strategy, & Research	Good in problem definition, solution, strategy, and research.	Very good in problem definition, solution, strategy, and research.	Excellent in problem definition, solution, strategy, and research.
TeamSkills, Pres., & Comm.	Good team and communication skills.	Very good team and communication skills.	Excellent team and communication skills.

PO 6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Services to Profession and Society	Not a member, but will become a member and try to be active.	Member now and may be active in the future.	Has demonstrated dedicated leadership roles on campus and may continue in future.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Understanding of Impact of Engineering Solutions in Global and Societal Context	Has a good knowledge of 1 or more international standards that can alleviate the adverse impact of engineering solutions in global and societal context. Will use a strategy for harmonizing standards and management systems for quality, environment, social responsibility, etc., if details are provided.	Has a very good knowledge of 2 or more international standards that can alleviate the adverse impact of engineering solutions in global and societal context. Understands the need for a strategy for harmonizing standards and management systems for quality, environment, social responsibility, etc.	Has excellent knowledge of 3 or more international standards that can alleviate the adverse impact of engineering solutions in global and societal context. Can implement a strategy for harmonizing standards and management systems for quality, environment, social responsibility, etc.
Familiarity with Applications of IE Tools, Methods & Techniques in Global and Societal Context	Will locate resources (libraries, websites, journals, magazines, etc) on 2 or more applications when necessary. Will read papers from one of the above resources only when a need arises.	Good at locating resources (libraries, websites, journals, magazines, etc) on 2 or more applications. Has acquired and read one paper from one of the above resources.	Excels in locating resources (libraries, websites, journals, magazines, etc) on 2 or more applications. Has acquired and read more than one paper from one of the above resources.
Breath and Depth of the Impact of Engineering Solutions in Global and Societal Context	Needs examples and instructions for applying IE methods to analyze global and social issues. Will review and write a report on specific IE methods applied to analyze global and social issues when required.	Is familiar with at least one specific IE method applied to analyze global and social issues. Has reviewed and written a report on one specific IE method applied to analyze global and social issues.	Is familiar with at least two specific IE methods applied to analyze global and social issues. Has reviewed and written a report on two or more specific IE methods applied to analyze global and social issues.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Knowledge of Professional Code of Ethics	Knows about the code of ethics of a society, and will access and use them when ethical problems are faced.	Knows where to access code of ethics of at least 1 professional society. Has read and demonstrated adequate knowledge of at least one professional code of ethics.	Knows where to access code of ethics of 2 or more Professional societies. Has read and demonstrated excellent knowledge of at least one professional code of ethics.
Ability to Recognize Ethical Dilemmas	Will learn to apply the code of ethics from professional societies and/or ethical theories to recognize ethical dilemmas when necessary.	Can apply at least 1 code of ethics from a professional society and/or ethical theory to recognize ethical dilemmas and analyze them.	Can apply the code of ethics from professional societies and/or ethical theories to recognize ethical dilemmas and analyze them in many ways.
Analyze Ethical Problems in IE Work and Make Decisions	Has ability to analyze ethical problems in IE work through case studies, but is not interested. Has generated fair solutions and made fair decisions in the IE field.	Has demonstrated good ability to analyze ethical problems in IE work through case studies. Has generated good solutions and made good decisions in the IE field.	Has demonstrated excellent ability to analyze ethical problems in IE work through case studies. Has generated excellent solutions and made sound decisions in the IE field.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Take Responsibility	Needs prompting from team leader to be organized and keep track of assigned work and due dates. May be tardy sometimes. Shares information & experience sometimes. Must be assigned work and due date, but will not share work and responsibility.	Organized. Will assume team member roles most of the time. Tardy a few times. Shares information & experience most of the time. Remembers work to be done and due dates, but may forget a few.	Well organized. Has many abilities and volunteers to do team work. Never tardy. Shares information & experience always. Writes assignments and deadlines. Delivers work on time.
Contribution to Team Effort & Work	Will do research and gather information and data if reminded often. Will provide innovative ideas, generate creative solutions, and generate good alternative solutions if reminded often. Not prepared for team meetings sometimes.	Will do research and gather information and data if requested. Will provide innovative ideas, generate creative solutions, and generate good alternative solutions if prompted. Not prepared for team meetings once or twice.	Has the initiative to do research, provides innovative ideas, generates creative solutions, and generates good alternative solutions. Always prepared for team meetings.
Respect, Civility, Communication	Courteous to all sometimes. Provides positive feedback sometimes.	Usually courteous to all. Provides positive feedback when	Courteous and Nonjudgmental always. Participates in discussions, respects

	Values others' viewpoints sometimes. Listening skills need improvement.	necessary. Values others' viewpoints almost always. Has good listening skills, attention fades occasionally.	colleagues, makes significant contributions while discussing others' work, values others' viewpoints, & functions effectively as a team member.
Knowledge of other Disciplines	Does not have knowledge of technical skills, issues, and approaches germane to disciplines outside of IE, but will acquire them when needed.	Has elementary knowledge of technical skills, issues, and approaches germane to disciplines outside of IE, but will augment when needed.	Has very good knowledge of technical skills, issues, and approaches germane to disciplines outside of IE.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
<u>Oral Communication Organization & Structure</u>	Difficult to follow presentation due to erratic topical shifts and jumps.	Most information is presented in logical order and is easy to follow.	All information is presented in a logical, interesting and novel sequence and is easy to follow.
<u>Oral Communication Delivery & Speaking Skills</u>	Occasional mispronunciation of terms. Uses appropriate vocabulary. Little eye contact, uneven rate, or only little expression.	Voice is clear and at a proper level. Most words pronounced correctly. Some eye contact, steady rate, and adequately rehearsed.	Clear voice and correct pronunciation of terms. Good eye contact, steady rate, enthusiasm, or confidence.
<u>Oral Communication Personal Appearance & Rapport with Audience</u>	Appearance marginally acceptable. Responds to questions and comments, but is not at ease or confident. Length is adequate.	Appearance is good. Responds to questions and comments well. Length is acceptable.	Appearance is professional. Responds to questions and comments confidently. Length is appropriate.
<u>Written Communication Organization & Style</u>	Work is hard to follow as there is very little continuity. Purpose of work is stated, but does not assist in following work.	Information is presented in a logical manner, which is easily followed. Purpose of work is clearly stated and assists the structure of work.	presented in a logical, interesting way, which is easy to follow. Purpose is clearly stated and explains the structure of work.

<p><u>Written Communication</u> Format & Aesthetics</p>	<p>Mostly consistent format. Figures and tables are legible, but not convincing.</p>	<p>Format is generally consistent including heading styles and captions. Figures and tables are neatly done and provide intended information.</p>	<p>Format is consistent throughout including heading styles and captions. Figures and tables are presented logically and reinforce the text.</p>
<p><u>Written Communication</u> Spelling & Grammar</p>	<p>Several spelling and grammatical errors.</p>	<p>Minor misspellings and/or grammatical errors.</p>	<p>Negligible misspellings and/or grammatical errors.</p>

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Knowledge of Job Market	Poor knowledge of job market and relies on the Placement Services.	Good knowledge of job market and is building a network to seek information.	Excellent knowledge of job market and has an excellent network to seek information.
Planning Budget, Insurance, & Investment,	Has some ideas of personal budget, savings & investment, but is not concerned.	Has a good basis for preparing yearly personal budget showing all costs, savings, and investment	Has sound basis for preparing yearly personal budget showing all costs, savings, and investment.
Ability to Engage in Conversation about Political, Economic, National, Regional, and international Events or Issues	Plans to read newspaper or magazines in future. Plans to use the Web to keep current. Makes minor contributions to discussions.	Reads newspaper or magazines randomly. Uses the Web to keep current randomly. Does contribute to discussions.	Reads newspaper and current magazines on a regular basis. Uses the Web to keep current daily. Can make substantial contribution to discussions.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in

independent and life-long learning in the broadest context of technological change.

Parameter	1: Slight (Low)	2: Moderate (Medium)	3: Substantial (High)
Ability to Locate and Use Resources on the Web	Uses limited resources at websites dealing with IE topics when the URLs are provided.	Uses all web resources when URLs are provided and attempts to locate and use a few additional web resources.	Uses websites listed by instructor and does extensive search to locate and use more than 5 other sources.
Ability to Locate & Learn from Recent Publications in IE	Has fair plan and demonstrated ability for life-long learning. Has fair ability to think, learn from mistakes, and apply new concepts.	Has good plan and demonstrated ability for life-long learning. Has good ability to think, learn from mistakes, and apply new concepts.	Has excellent plan and demonstrated ability for life-long learning. Has excellent ability to think, learn from mistakes, and apply new concepts.
Familiarity with Services Provided by Professional Societies	Plans to be a member in 1 professional society. Does not have leadership role in professional or other societies on campus. Will seek courses or resources available from societies when needed. May use some services provided by the society in the future.	Member of 1 Professional society. Has leadership role in 1 professional society on campus. Knows that the website for the society lists courses on current topics and resources available. Has used a magazine or book from a professional society.	Member of 2 or more professional societies. Has a leadership role in 2 or more professional or other societies on campus. Aware of courses on the current topics and resources available at the website for the society. Has used 2 or more services provided by a professional society.

Ability to Use Reference Books, Books, Periodicals, and Archives, & Inter-Library Loans in Libraries	Has demonstrated fair ability to acquire books and journal articles, understand, interpret, and apply current, new, or innovative concepts in IE and related fields.	Has demonstrated very good ability to acquire books and journal articles, understand, interpret, and apply current, new, or innovative concepts in IE and related fields.	Has demonstrated excellent ability to acquire books and journal articles, understand, interpret, and apply current, new, or innovative concepts in IE and related fields.
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