GUEST SPEAKER

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THREE ENGINEERING OCCUPATIONS

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THREE ENGINEERING OCCUPATIONS

PROFESSIONAL ENGINEER

ENGINEERING TECHNOLOGIST

ENGINEERING TECHNICIAN

A professional engineer deals with *complex* engineering problems; an engineering technologist deals with *broadly-defined* engineering problems; and an engineering technician solves *well-defined* engineering problems.

These 3 types of problems are differentiated below in terms of:

- Level of knowledge required to solve the problem;
- Depth of analysis;
- Extent of use of codified knowledge;
- Use of judgment; and
- Familiarity of issues encountered.

Complex engineering problems cannot be solved without in-depth engineering knowledge at the level of one or more of the following:

- A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline;
- Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much of this specialist knowledge is at the forefront of the discipline;
- Knowledge that supports engineering design in the practice area;
- Knowledge of engineering practice (technology) in the practice areas of the engineering discipline; or
- Engagement with selected knowledge in the research literature of the discipline.

Broadly-defined engineering problems cannot be solved without engineering knowledge at the level of one or more of the following:

- Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for an accepted sub-discipline;
- Knowledge that supports engineering design using technologies of a practice area;
- Knowledge of engineering technologies applicable in the sub-discipline.
- Engagement with the technological literature of the sub-discipline

The above should be supported by a systematic, theory-based formulation of engineering fundamentals required in an accepted sub-discipline.

Well-defined engineering problems cannot be solved without extensive practical knowledge as reflected in:

- Knowledge that supports engineering design based on the techniques and procedures of a practice area; and
- Codified practical engineering knowledge in a recognized practice area.

The above should be supported by theoretical knowledge as defined by a coherent procedural formulation of engineering fundamentals required in an accepted sub-discipline and engineering specialist knowledge that provides the body of knowledge for an accepted sub-discipline.

In terms of depth of analysis the 3 types of engineering problems can be differentiated thus:

Complex engineering problems have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.

Broadly-defined engineering problems can be solved by the application of well-proven analysis techniques.

Well-defined engineering problems can be solved in standardized ways.

In terms of the extent of use of applicable codes the three types of engineering problems can be differentiated thus:

Complex engineering problems are outside problems encompassed by standards and codes of practice for professional engineering.

Broadly-defined engineering problems may be partially outside those encompassed by standards and codes of practice.

Well-defined engineering problems are encompassed by standards and/or documented codes of practice.

In terms of depth of analysis the 3 types of engineering problems can be differentiated thus:

Complex engineering problems have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.

Broadly-defined engineering problems can be solved by the application of well-proven analysis techniques.

Well-defined engineering problems can be solved in standardized ways.

In terms of use of the necessity of making judgment calls, complex and broadly-defined engineering problems require judgment and well-defined problems do not.

In terms of familiarity of issues encountered the three types of engineering problems may be differentiated thus:

Complex engineering problems involve infrequently encountered issues. Solution must extend beyond previous experiences by applying principles-based approaches.

Broadly-defined engineering problems belong to families of familiar problems which are solved in well-accepted ways. Their solutions require knowledge of normal operating procedures and processes.

Well-defined engineering problems are frequently encountered and thus familiar to most practitioners in the practice area. Their solutions require knowledge of practical procedures and practices for widely-applied operations and processes.

“Graduate attributes form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The graduate attributes are exemplars of the attributes expected of graduate from a program accredited under the terms of the Washington, Sydney and Dublin Accords.” – International Engineering Alliance (IES)

The attributes are based on the previous slides of this presentation.

Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
Engineering Knowledge	Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to defined and applied engineering procedures, processes, systems or methodologies.	Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to wide practical procedures and practices.
Problem Analysis Complexity of analysis	Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using *first principles* of mathematics, natural sciences and engineering sciences.	Identify, formulate, research literature and analyze broadly--defined engineering problems reaching substantiated conclusions using *analytical tools* appropriate to the discipline or area of specialization.	Identify and analyze well-defined engineering problems reaching substantiated conclusions using *codified methods* of analysis specific to their field of activity.

Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
Design/ development of solutions Breadth and uniqueness of engineering problems, *i.e.*, the extent to which problems are original and to which solutions have previously been identified or codified	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Design solutions for broadly-- defined engineering technology problems and *contribute to* the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Design solutions for well-defined technical problems and *assist with* the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
The Engineer and Society Level of knowledge and responsibility	Apply *reasoning* informed by contextual knowledge to *assess* societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.	*Demonstrate* understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technology practice and solutions to broadly defined engineering problems.	*Demonstrate* knowledge of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technician practice and solutions to well defined engineering problems.
Environment and Sustainability Type of solutions	Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems	Understand and evaluate the sustainability and impact of engineering technology work in the solution of broadly defined engineering problems in societal and	Understand and evaluate the sustainability and impact of engineering technician work in the solution of well defined engineering problems in societal and

Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
Investigation Breadth and depth of investigation and experimentation	Conduct investigations of complex problems using *research--based* knowledge and *research methods* including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.	Conduct investigations of broadly-defined problems; *locate, search and select* relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions.	Conduct investigations of well--defined problems; *locate and search* relevant codes and catalogues, conduct standard tests and measurements.
Modern Tool Usage Level of understanding of the appropriateness of the tool	Create, select and apply techniques, resources, and modern engineering and IT tools, including *prediction and modeling*, to complex engineering problems, with an understanding of the	Select and apply appropriate techniques, resources, and modern engineering and IT tools, including *prediction and modeling*, to broadly-defined engineering problems, with an understanding of the	Apply appropriate techniques, resources, and modern engineering and IT tools to well-defined engineering problems, with an awareness of the limitations.

Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
Ethics Understanding and level of practice	*Apply* ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	*Understand* and commit to professional ethics and responsibilities and norms of engineering technology practice.	*Understand* and commit to professional ethics and responsibilities and norms of technician practice.
Individual and Team work Role in and diversity of team	Function effectively as an individual, and as a member or *leader* in diverse teams and in *multi--disciplinary* settings.	Function effectively as an individual, and as a member or *leader* in diverse teams.	Function effectively as an individual, and as a member in diverse technical teams.

Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
Communication Level of communication according to type of activities performed	Communicate effectively on complex engineering activities with the engineering community and with 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.	Communicate effectively on broadly-- defined engineering activities with the engineering community and with society at large, by being able to comprehend and *write effective reports* and design documentation, *make effective presentations*, and give and receive clear instructions	Communicate effectively on well--defined engineering activities with the engineering community and with society at large, by being able to comprehend the work of others, document their own work, and give and receive clear instructions.

Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
Project Management and Finance Level of management required for differing types of activity	Demonstrate knowledge and understanding of engineering management principles and *economic decision--making* and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments.	Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.	Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a technical team and to manage projects in multidisciplinary environments.

Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
Lifelong learning Preparation for and depth of continuing 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.*	Recognize the need for, and have the ability to engage in independent and life--long learning in *specialist technologies.*	Recognize the need for, and have the ability to engage in independent updating in the context of *specialized technical knowledge.*

The following table is derived from Table on Graduate Attributes. It breaks down the differentiating characteristics into elements and shows which elements should be part of the curriculum of Professional Engineering, Engineering Technologist and/or Engineering Technician.

Differentiating Characteristic	Curricula & Course Elements	Professional Engineer	Engineering Technologist	Engineering Technician
Problem Analysis	First principles	■		
	Analytical tools	■	■	
	Codified methods	■	■	■
Design	Complex problems	■		
	Broadly-defined problems	■	■	
	Well-defined problems	■	■	■
Design of systems, components or processes	Design	■		
	Contribute to design	■	■	
	Assist with design	■	■	■

Differentiating Characteristic	Curricula & Course Elements	Professional Engineer	Engineering Technologist	Engineering Technician
Project Management and Finance	Economic decision-making	■		
	Engineering management	■	■	■
	Team work	■	■	■
	Multi-disciplinary	■	■	■
Independent Lifelong learning	Broadest aspect of technological change	■		
	Specialist technologies	■	■	
	Specialized technical knowledge	■	■	■

Differentiating Characteristic	Curricula & Course Elements	Professional Engineer	Engineering Technologist	Engineering Technician
Modern Engineering & IT Tool Usage	Create	■		
	Prediction & modeling	■	■	
	Select	■	■	
	Apply	■	■	■
Individual and Team work	Multi-disciplinary	■		
	Leader	■	■	
	Member	■	■	■
	Individual	■	■	■
Communication	Write reports	■	■	
	Make presentations	■	■	
	Comprehend reports	■	■	■
	Design documentation	■	■	■
	Give & receive instructions	■	■	■

Differentiating Characteristic	Curricula & Course Elements	Professional Engineer	Engineering Technologist	Engineering Technician
Considerations in design, solutions, professional work and practice: public health and safety, cultural, societal, environmental, sustainability, ethical and legal	Contextualize, apply & assess			
	Understand			
Investigation	Research literature			
	Technology literature			
	Design, conduct experiments			
	Data bases			

Differentiating Characteristic	Curricula & Course Elements	Professional Engineer	Engineering Technologist	Engineering Technician
Project Management and Finance	Economic decision-making	■		
	Engineering management	■	■	■
	Team work	■	■	■
	Multi-disciplinary	■	■	■
Independent Lifelong learning	Broadest aspect of technological change	■		
	Specialist technologies	■	■	
	Specialized technical knowledge	■	■	■