ESC 101T 2018 – Engineering Science Praxis I

University of Toronto
Faculty of Applied Science and Engineering
Final Examination
April 20, 2018

General Instructions

- Clearly write your name, utorid and student number on the front of the exam book.

Question 1 – Connections

(20% – estimated 25 minutes)

A set of concepts introduced in Praxis is represented in the bulleted list below.

A. Choose **exactly five (5) concepts** from the bulleted list.

B. Connect each concept you selected in step A to **two (2) other concepts** from Praxis.

- ❑ You **must not** connect your selected concept to any concept that appears in the bulleted list below.
- ❑ You **must not** use any concept from Praxis more than once when answering Question 1.

A connection could be either:

i. a "concept-to-concept" connection such as "Objectives link to Metrics," **which then needs to be justified**, or

ii. a "considerations in engineering practice" connection, such as "an engineer might have to prioritize objectives," **which then needs to be justified**.

C. **For each of the 10 connections** that you made in step B, **justify the connection**.

For each connection, the System 1 appropriateness of the connection is worth 0.5%, and the System 2 justification is worth 1.5%.

The concepts introduced in Praxis that you must select from to develop your answer to Question 1 are:

- Evidence
- Assessment
- Anchoring
- Model
- Criteria
- Judgment
- Risk

Remember to start by **selecting exactly five (5) concepts** from the list above. When you have completed this question, you should have referred to fifteen (15) unique Praxis concepts and made ten (10) justified connections.

STOP AND CHECK
Have you selected five (5) concepts from the list and <u>for each</u> made and justified two (2) connections <u>without violating any constraints</u>?

Question 2 – Short Answers

(25% – estimated 35 minutes)

A. In your teamwork you had to find ways to work together effectively. Three areas of competency can contribute to effective teamwork: Organizational (planning, contributing and delivering work), Relational (showing respect, being accountable, listening, and seeking and including input), and Communication (exchanging, expressing and discussing ideas and issues).

Identify and **explain using evidence from your team experience this term** which one (1) of these competencies you feel **most** contributes to an effective team. **(7%)**

B. To answer the question "Which metrics should our team use to develop ratings for our objectives?" what type(s) of resource(s) would you consult **and why? (4%)**

C. Describe how to convert a constraint to a criterion. **Explain your answer. (4%)**

D. If you found that your team's alternative designs were all very similar, identify:

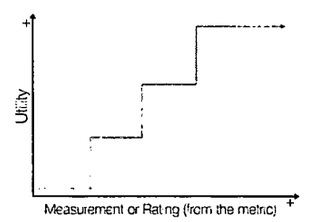
i. Two (2) idea generation methods that could help your team. Explain how the methods contribute to un-anchoring your team's thinking. **(4%)**

ii. One (1) thing that you would use to compare your designs to learn more about them . Explain how checking that thing contributes to expanding your design thinking. **(3%)**

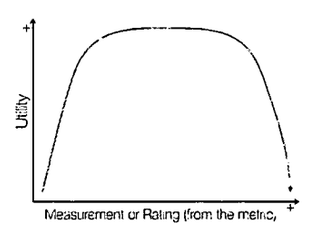
E. In class we discussed how criteria can be represented as a graph relating a rating to a "utility" (e.g. a measure of preference). Simple criteria would look like straight lines with different slopes (e.g. "more is better" would have positive slope and "does not matter" would have a slope of 0).

For the two criteria (aka. utility graphs) shown below, give one (1) **different** real-world example where the criterion would have that shape. **Briefly explain your example and reasoning.**
(1.5% + 1.5%)

i. An ascending step function with multiple steps



ii. An inverted 'U' shape



STOP AND CHECK
Have you answered parts A, B, C, D, and E of Question 2?
Have you answered <u>both</u> sub-parts of part D?
Have you answered <u>both</u> sub-parts of part E?

Question 3 – Interpreting, Recommending, and Iterating

(55% – estimated 75 minutes)

Engineering Science students need to stay physically fit to succeed in the program. Improved physical fitness has many benefits including improved mental health, more restful sleep, and improved concentration. The Division of Engineering Science is regularly asked to recommend how incoming students should maintain their physical fitness.

A team of student engineers was asked by the Division to provide such a recommendation. Due to poor teamwork and time management, the team was only able to produce the following list of Stakeholders, table of Alternatives, and tabular Ratings Matrix.

List 1: Stakeholders

- The (incoming or current) **Engineering Science Student** (who would like the benefits of being fit)
- The **Parents** of the Engineering Science Student (who are likely funding the means of maintaining or improving fitness and who feel a sense of responsibility for their child)
- Other **Campus Users** (e.g. pedestrians, cyclists, vehicles, etc., who are also trying to use campus space, facilities, and services)
- **Campus Health Providers** (who would like to see fewer students for issues that could have been addressed through improved fitness)

Table 1: Alternatives

Lifestyle Choices (Diet and ad-hoc exercise)	**Dietary Supplements**	**Gym**	**Apple Watch** (Alone or with an app)	**Personal Trainer**
• Walking up stairs • Taking longer routes • Standing up regularly • etc.				

Table 2: Ratings Matrix

Objectives	Metrics	Lifestyle	Supplements	Gym	Apple Watch	Trainer
Safety	Likelihood of an accident per year (%; Lesser is preferred)	< 1%	5%	10%	< 1%	15%
	Consequences of an accident (Lesser is preferred)	Low	High	Med	Low	High
Accessibility	(Greater is preferred)	High	High	Medium-High	High	High
Cost	Initial Price ($) (Higher is preferred)	$0	$150	$0	$500	$0
	Ongoing costs ($ per year) (Lesser is preferred)	$0	$1800 (12*$150)	$360	$0	$8000
Usability	Ongoing time per week (minutes) (Lesser is preferred)	180min	30min	360min	180min	360min
	Likelihood of compliance (e.g. following through on planned actions) (greater is preferred)	Very Low	Medium-High	Low-Medium	Low-Medium	High
Effectiveness	Likelihood of improving physical health (greater is preferred)	High	Low	High	High-Medium	High
	Likelihood of improving mental health (greater is preferred)	Medium	Low	High	Medium	Medium-High

A. Correctly use an appropriate holistic decision-making tool to rank the Objectives. **Explain two (2) key decisions you made during the ranking. (5%)**

B. Correctly convert the Ratings Matrix into a Pugh Chart. **Explain two (2) key decisions you made during the conversion. (5%)**

	Lifestyle	Supplements	Gym	Apple Watch	Trainer
Likelihood of an accident per year (%; Lesser is preferred)					
Consequences of an accident (Lesser is preferred)					
(Greater is preferred)					
Initial Price ($) (Higher is preferred)					
Ongoing costs ($ per year) (Lesser is preferred)					
Ongoing time per week (minutes) (Lesser is preferred)					
Likelihood of compliance (e.g. following through on planned actions) (greater is preferred)					
Likelihood of improving physical health (greater is preferred)					

C. Based only on the information provided **and on your analysis in Parts A and B**, recommend which approach Engineering Science students should use to maintain their physical fitness. The Division will share your recommendation with incoming and current students. **(10%)**

D. The Division has hired you to critique and iterate on the work done by the previous team.

i. With respect to their **Framing** of the opportunity (as shown in the lists and tables) identify **two (2) key issues** with what the previous team developed and **explain and justify their significance**. Identify **one (1) key action** you would complete to significantly improve the framing of the opportunity. **Justify your choice of action. (10%)**

ii. With respect to their usability objective, provide a more quantitative unit for measuring "likelihood of compliance". **Explain why that unit is better than the unit currently being used.**

For only the Lifestyle and Gym alternatives briefly describe two (2) tests – a different one for each alternative – you would use to determine the rating based on your new unit. **(10%)**

iii. With respect to the **Diverging** completed by the previous team (as shown in the lists and tables) identify **two (2) key issues** with what the previous team developed and **explain and justify their significance**. Identify **one (1) key action** you would complete to significantly improve future divergence. **Justify your choice of action. (10%)**

E. Choose **exactly one (1)** of the actions you identified in part D. Outline a research strategy (including **types of sources** and **search terms**) that you would follow to locate and acquire additional resources to support your work. **Justify your strategy. (5%)**

STOP AND CHECK

Have you answered parts A, B, C, D, and E of Question 2?
Have you answered all three (3) sub-parts of part D?