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Nelly Janet Roa Hernández

Final Exam

Course Title:	**Terminología Especializada en Documentos de Tecnología e Ingeniería**
Course ID:	**IT0627 (Marron, 25-2)**
Cohort ID:	**6A2**
Exam Date:	**24 Apr 2025**

General Instructions: This is a **take-home exam**. The exam is comprehensive and will cover material from the entire course. You are encouraged to organize and review all of your homework and previous exams before starting this final exam. Answer in English unless requested to do so otherwise. Please do your own work and do not share your answers; academic integrity is always your choice.

Attempt to answer all questions, even if you are uncertain. Whenever possible, provide answers in bullet list format with complete content. Tasks will be evaluated by sub-tasks. Three (3) points are available for each sub-task: Accuracy (1 pt), Completeness (1 pt), and Sufficiency (1 pt). Points will be awarded in 0.1 increments. There are **39 points** available.

Please provide your answers on separate sheets of paper. The first page should have the title, "Final Exam." Make sure your name and the date are written in the top right-hand corner of every page. You may type out your answers or answer in written form with pencil or black/blue pen. When you have finished the exam, please staple all of the pages together in the proper order.

This exam is **DUE Thursday, April 24, 2025 by 19:00 hrs in Room 202, UTECA.** If you prefer to take the exam on April 24 during the regular class period you are welcome to do so.

I. Foundations of Science and Engineering

Task 1 (3 pts)

Read the following excerpt and answer the question below (excerpt from Carli and Calaresu (2007) *Language and Science* In: Marlis Hellinger, Anne Pauwels (eds.), Handbook of Language and Communication: Diversity and Change. Handbooks of Applied Linguistics vol. 9. De Gruyter Mouton; pp.525-554.)

The description of scientific language. *One of the main problems when describing scientific language is how to categorize it in relation to the other linguistic varieties inside the diasystem they all belong to. If, for instance,scientific language is treated only as a professional jargon this implies: a) that there are no particular ontological differences in status between the specialized language of a biologist and the equally specialized language of a stockbroker; and b) that the field of its users and that of its scholars is restricted only to those who have a specific working interest in it (scientists, science students, teachers of scientific subjects, translators and specialized journalists).*

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Scientific language, however, beyond the most striking external aspects (lexical ones in particular) which often give it the obscurity of a downright jargon, is instead a type of language which has a broader social and cognitive relevance. It is indeed the language of "complex thought" which reconstructs experience and construes knowledge, and, according to Altieri Biagi (1990: 192-193), should be defined in a balanced three-way relationship with common language on the one hand, and with literary language on the other: both scientific and literary language represent the tools of complex thought which pursues knowledge from the viewpoint of objective perception (scientific language) and of subjective perception (literary language).

a) **Do you think scientific language is just professional jargon or, as Altieri Biagi suggests, do you think scientific language is the language of objective complex thought?**

I think scientific language is best understood as the language of objective complex thought, as Altieri Biagi suggests, rather than just profesional jargon. While it does share some Surface features with jargon like specialized vocabulary and technical terms its purpose and function go far beyond that.

Scientific language plays a central role in constructing, communicating, and validating knowledge. It's designed not only for efficiency among experts but also for reconstructing experience and explaining phenomena objectively, wich makes it a crucial tool for advancing understanding across disciplines. It also connects to broader modes of thinking, standing alongside common and literary language as a means of expressing complex ideas.

So, rather than being exclusive or obscure like typical jargon, scientific language aims at precisión, clarity, and universality, making it foundational to scientific inquirí and intelectual progress.

Task 2 (3 pts)
Johnson-Laird, authoritative scholar on mental models states, "What is the end of perception? What is the output of linguistic comprehension? How do we anticipate the world, and make sensible decisions about what to do? What underlies thinking and reasoning? One answer to these questions is that we rely on mental models of the world." (see Johnson-Laird, Philip N. "The history of mental models." *Psychology of reasoning*. Psychology Press, 2004. 189-222).

a) **Explain the concept of mental models and how they guide scientific inquiry.**

Mental models are internal, cognitive representations that people construct to understand and interact with the world. According to Johnson-Laird, these models help us simulate reality in our minds, enabling us to interpret perception, comprehend language, anticípate outcomes, and make decisions. They are flexible, simplified versions of how things work or how events unfold, and they allow us to mentally "test" possibilities without physically acting them out.

In scientific inquiry, mental models play a crucial role in several ways:

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1.- Formulating Hypotheses: Scientists use mental mondels to generate ideas about how phenomena might work. These models help frame research questions and predict outcomes that can be tested empirically.

2.- Designing Expriments: By simulating potential outcomes in their minds, scientists can plan experiments that isolate variables and measure specific effects. Mental models help anticípate potential confounds or problems.

3.- Interpreting Data: When analyzing results, scientists compare what actually happened with what their mental models predicted. Discrepancies between the two can lead to refinements in theories or entirely new models.

4.- Communicating Ideas: Scientific explanations often rely on shared mental models. When researchers use metaphors or visualizations (like the “tree of life” in biology or “wave-particle duality” in physics), they are drawing on mental models to make abstract ideas understandable.

In essence, mental models are the cognitive framework that supports reasoning, problema-solving, and learning in science. They allow scientists to move beyond Surface-level observation and into deeper undertanding and theory development.

Task 3 (3 pts)
Lenat states that heuristics are “informal judgmental rules … which guide [a] system toward plausible paths to follow and away from implausible ones. Yet what is the nature of heuristics? What is the source of their power? How do they originate and evolve? Heuristics are compiled hindsight, and draw their power from the various kinds of regularity and continuity in the world” (see Lenat, Douglas B. "The nature of heuristics." *Artificial intelligence* 19.2 (1982): 189-249)

a) **What are heuristics and how are they used in science?**

Heuristics are informal, experience-based strategies or “rules of thumb” that help guide thinking and problem-solving, especially when facing complex or uncertain situations. As Lenat puts it, they are “compiled hindsight”—meaning they are derived from accumulated experience and observations about how the world tends to work. They help decision-makers focus on the most promising paths and avoid unproductive ones by leveraging patterns, regularities, and intuitive insights.

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In science, heuristics are used in several key ways:

1.- Guiding Hypothesis Formation: Scientists often rely on heuristics to generate hypotheses. For example, the idea that "simpler explanations are more likely to be correct" (Occam's Razor) is a heuristic that encourages parsimony in theory building.

2.- Problem Solving and Discovery: Heuristics help scientists navigate large and complex problem spaces by prioritizing likely solutions and filtering out implausible ones. This is especially useful in fields like artificial intelligence, medicine, or theoretical physics.

3.- Model Development: Scientists use heuristics to simplify complex systems and develop models that capture essential features without needing to account for every variable.

4.- Data Interpretation: When interpreting ambiguous or incomplete data, heuristics can guide plausible interpretations based on past patterns or known behaviors.

5.- Scientific Creativity: Many scientific breakthroughs emerge when heuristics help researchers reframe problems, make analogies, or recognize underlying patterns across different domains.

Overall, heuristics provide a pragmatic and adaptive framework that complements formal logic and empirical data, enabling scientists to make progress even when information is incomplete or the path forward is unclear.

Task 4 (9 pts)
Richards provides us with a nice explanation for the foundations of engineering science as well the general method for the analysis of systems (see Donald E. Richards, Rose-Hulman Institute of Technology. Basic Engineering Science LibreTexts (2024) https://libretexts.org)

a) **Briefly explain the six fundamental laws of conservation.**

The six fundamental laws of conservation form the foundation of engineering science and systems analysis, ensuring that key physical quantities remain constant within a closed system. According to Richards, these conservation laws help engineers analyze and design systems by applying consistent principles. Here's a brief explanation of each:

1.- Conservation of Mass: Mass cannot be created or destroyed in a closed system. It can only be transferred or transformed. This principle is key in chemical processes and fluid dynamics.

2.- Conservation of Energy: Energy can change forms (e.g., from kinetic to thermal), but the total amount of energy in an isolated system remains constant. This is the basis for the First Law of Thermodynamics.

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3.- Conservation of Momentum: The total momentum (mass × velocity) of a system remains constant unless acted upon by external forces. This is fundamental in analyzing motion and forces in mechanical systems.

4.- Conservation of Angular Momentum: In the absence of external torques, the angular momentum of a system remains constant. This is important in the study of rotational dynamics.

5.- Conservation of Charge: Electric charge is neither created nor destroyed. The total charge in a closed system remains constant over time, a cornerstone in electrical and electronic engineering.

6.- Conservation of Number of Particles (sometimes referred to as conservation of species or atoms):

The number of individual particles (like atoms or molecules) in a chemical reaction is conserved. This law supports chemical reaction balancing and reactor design.

Together, these laws provide a unifying framework for analyzing physical systems, regardless of scale or discipline—from mechanical and electrical engineering to thermodynamics and fluid mechanics.

b) **Imagine that you are a scientific researcher. First select a system for study and briefly describe the system, and then answer the following specific questions about your system,**

System Description: The system uses solar energy to power a membrane based filtration unit that purifies contaminated wáter from natural sources like rivers or wells. The system includes solar panels, a battery storage unit, a pump, and a membrane filtration module.

i) **Is the system open or closed?** The system is open, because both matter (wáter and contaminants) and energy (solar energy in, termal energy out) cross the system boundaries

ii) **What are the boundaries of the system?** The boundaries include all physical components of the system: the solar panels, energy storage units, pump, pipes, and filtration membrane. These define the limits of where inputs and outputs occur.

iii) **What are the surroundings of the system?** The surroundings include the external enviroment such as:

- The sun, providing solar energy
- Water sources (e.g., river, well)
- The ambient air, wich interacts thermally

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- The community or storage tanks that receive the purified wáter

iv) **What types of energy / materials flow into and/or out of the system?**

Inflow:

- **Solar energy (electromagnetic radiation)**
- **Contaminated wáter (includes suspended solids, bacteria, etc.)**

Outflow:

- **Clean wáter (after filtration)**
- **Concentrated waste/brine (retained contaminants)**
- **Thermal energy (due to heat los from components**

v) **What measurements will you make on the system?**

- **Solar irradiance (input energy level)**
- **Water inflow rate and quality (turbidity, microbial load, pH)**
- **Water outflow rate and purity (e.g, TDS, bacterial count)**
- **Energy consumption (voltaje/current from solar panel and battery)**
- **Temperature (ambient and inside the system)**
- **System pressure (especially across the membrane)**

<u>Task 5 (3 pts)</u>

The first lecture by David Mackay of Cambridge University in his series on Information Theory deals with the fundamental problem addressed by Claude Shannon: communication across a noisy channel. Mackay also discusses this in the first chapter of his book on Information Theory (see MacKay, David JC. *Information theory, inference and learning algorithms*. Cambridge University Press, 2003)

a) **How does Mackay diagram verbal communication?** In his lecture and book on Information Theory, David MacKay builds on Claude Shannon's model of communication to diagram how verbal communication works in the presence of noise. He maps the components of spoken language into the framework of signal transmission, making it clear how the concepts of information theory apply to everyday human interaction.

That is, in verbal communication

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i) **What is the signal generator?;** The signal generator is the speaker's brain (or mind). It originates the idea or concept that is to be communicated. The brain encodes this idea into a sequence of linguistic symbols (spoken words), which will become the signal.

ii) **What is the communication channel?;** The communication channel is the air (or physical medium) through which the sound waves the spoken words travel. This channel is noisy because various factors (background noise, speech clarity, hearing issues) can interfere with the signal's clarity as it moves from speaker to listener.

iii) **What is the message receiver?** The message receiver is the listener's brain (or mind). The listener perceives the sound through the ears, processes the auditory input, and attempts to decode and reconstruct the original message or intent based on prior knowledge and context.

II. Translation of Research Papers

Task 6 (9 pts)

Scientific research papers typically have a standard format that includes an abstract, an introduction, a methods section, a results section, and a conclusions section.

a) **Which sections of a research paper are most useful to the professional translator? Why?**

The most useful sections of a research paper to a professional translator are the abstract, introduction, and conclusion. Here's why:

1.- Abstract

Why it's useful: It provides a concise summary of the entire paper—covering the aim, methods, key results, and conclusions.

For the translator: It gives a quick understanding of the topic, tone, and technical content, helping set the right style and terminology for the rest of the translation.

2.- Introduction

Why it's useful: It outlines the background, purpose, and significance of the study.

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For the translator: It introduces key concepts and terminology and helps with understanding the scientific context, which is essential for accurate translation.

3.- Conclusion

Why it's useful: It summarizes the main findings and their implications.

For the translator: It confirms the core message of the paper, helping ensure consistency and clarity throughout the translation.

These sections are most useful because they provide the conceptual framework and overall narrative, which a translator needs to maintain accuracy, coherence, and appropriate tone in the target language.

b) **Translate the following excerpt into Spanish (from Khan, M.I., Fei, J., Chen, X. *et al.* Usage of permeability ratio to check the stability of a pile-soil model with retaining wall support – Huizhou slope failure as a case study. *Geo-Engineering* 16, 7 (2025)).**

> *This paper presents a comprehensive investigation into the role of soil permeability variation on the stability of slopes reinforced by retaining walls, with a focus on the Huizhou slope failure as a case study. The study demonstrates that rising groundwater levels diminish the Factor of Safety (FoS) for retaining walls, with stability most compromised under combined loading from adjacent soil and lightweight concrete. These findings emphasize the need for enhanced drainage or structural support in retaining wall designs subjected to elevated groundwater conditions. It integrates advanced numerical simulations, utilizing Abaqus and GeoStudio, with empirical field data to analyze the interactions between soil permeability, pore water pressure, moisture content, shear strength, and the overall stability of the slope. The dynamics of water infiltration are influenced by permeability, moisture content, and the groundwater table. These factors change the pore pressure and decrease shear strength, which causes shear failure in the slope mass. This research also looks at how surcharge loading affects slope stability. Higher permeability soils cause faster infiltration rates, leading to higher pore pressures, lower effective shear strengths, and a higher likelihood of slope failure. The opposite is true for reduced permeability, which makes drainage more difficult and ultimately leads to hydrostatic pressure building up behind retaining walls, which in turn makes the slope even more unstable. This study demonstrates the critical need for optimized drainage systems to reduce the hazards of infiltration-induced failure and the role of precise permeability evaluation in geotechnical design. Geotechnical engineers can use these results to better understand how to construct and maintain slope stabilization systems.*

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Este artículo presenta una investigación exhaustiva sobre el papel de la variación de la permeabilidad del suelo en la estabilidad de taludes reforzados con muros de contención, centrándose en el caso del deslizamiento de talud en Huizhou. El estudio demuestra que el aumento del nivel freático disminuye el Factor de Seguridad (FoS) de los muros de contención, siendo la estabilidad más comprometida bajo cargas combinadas del suelo adyacente y del concreto ligero. Estos hallazgos subrayan la necesidad de mejorar el drenaje o el soporte estructural en los diseños de muros de contención sometidos a condiciones de nivel freático elevado. La investigación integra simulaciones numéricas avanzadas, utilizando Abaqus y GeoStudio, con datos empíricos de campo para analizar las interacciones entre la permeabilidad del suelo, la presión del agua en los poros, el contenido de humedad, la resistencia al corte y la estabilidad general del talud. La dinámica de la infiltración de agua está influenciada por la permeabilidad, el contenido de humedad y el nivel freático. Estos factores modifican la presión intersticial y disminuyen la resistencia al corte, lo que provoca fallas por corte en la masa del talud. Esta investigación también analiza cómo la carga por sobrepeso afecta la estabilidad del talud. Los suelos con mayor permeabilidad permiten tasas de infiltración más rápidas, lo que genera presiones de poro más altas, menores resistencias al corte efectivas y una mayor probabilidad de fallas del talud. Lo contrario ocurre con una permeabilidad reducida, que dificulta el drenaje y conduce, en última instancia, a una acumulación de presión hidrostática detrás de los muros de contención, lo que a su vez hace que el talud sea aún más inestable. Este estudio demuestra la necesidad crítica de sistemas de drenaje optimizados para reducir los riesgos de fallas inducidas por infiltración y el papel de una evaluación precisa de la permeabilidad en el diseño geotécnico. Los ingenieros geotécnicos pueden utilizar estos resultados para comprender mejor cómo construir y mantener sistemas de estabilización de taludes.

III. Technology Futures in Mexico

Task 7 (3 pts)

We have read papers which propose engineering research or education specifically geared to boosting Mexico's engineering standing on the international stage.

a) **Of the three engineering areas we looked at (semiconductor engineering, battery engineering, and digital design engineering), which area do you think will have the greatest impact for Mexico? Explain**

- Global Strategic Importance: Semiconductors are essential to almost all modern technology, including electronics, communications, automotive systems, and defense. Countries that

- invest in semiconductor capabilities are seen as strategic players in global innovation and supply chains.
- Economic Opportunity and Job Creation: Developing a semiconductor industry can generate high-value jobs, boost exports, and attract foreign direct investment. Mexico's existing strengths in manufacturing, particularly in electronics and automotive, give it a foundation to build on.

- Regional Integration with North America: Given its geographic and economic ties to the U.S., Mexico is well-positioned to become a key part of North America's semiconductor supply chain, especially as the U.S. looks to reduce dependency on Asia and bring chip manufacturing closer to home.

- Foundation for Other Technologies: Semiconductors enable advancements in battery technology, digital design, artificial intelligence, and smart manufacturing. Strength in this area empowers Mexico to support and lead in multiple high-tech sectors.

While battery and digital design engineering are also important, semiconductor engineering has the potential for the broadest national impact, positioning Mexico as a crucial player in the global tech economy and helping drive long-term technological and economic growth.

IV. Building Vocabulary

Task 8 (6 pts)

From the list of 218 vocabulary words, select 10 words of your choice. Try to select words that you find interesting. Provide a translation and definition for each of the 10 words in both English and Spanish. See the attached document, "6A2_All-Vocab_25-2_Python.txt" for the complete list of vocabulary words.

1.- Entropy / Entropía

A measure of disorder or randomness in a system, often used in thermodynamics and information theory.

Una medida del desorden o aleatoriedad en un sistema, utilizada frecuentemente en termodinámica y teoría de la información.

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2.- Piezoelectric / Piezoeléctrico

Refers to materials that generate an electric charge in response to mechanical stress.

Se refiere a materiales que generan una carga eléctrica en respuesta a una tensión mecánica.

3.- Bayesian / Bayesiano

Related to a statistical approach that uses Bayes' theorem to update the probability of a hypothesis based on new evidence.

Relacionado con un enfoque estadístico que utiliza el teorema de Bayes para actualizar la probabilidad de una hipótesis con base en nueva evidencia.

4.- Diploid / Diploide

A cell or organism that has two sets of chromosomes, one from each parent.

Célula u organismo que posee dos juegos de cromosomas, uno de cada progenitor.

5.- Fourier Transform / Transformada de Fourier

A mathematical transform that decomposes a function into its constituent frequencies, used in signal processing.

Una transformación matemática que descompone una función en sus frecuencias componentes, utilizada en procesamiento de señales.

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6.- Quantum / Cuántico

The minimum amount of any physical entity involved in an interaction, central to quantum mechanics.

La cantidad mínima de cualquier entidad física involucrada en una interacción; concepto central en la mecánica cuántica.

7.- Zwitterion / Zwitterion

A molecule with both positive and negative charges, but overall electrically neutral.

Molécula que tiene cargas positivas y negativas, pero que en conjunto es eléctricamente neutra.

8.- Self-replicating / Autorreplicante

Capable of making a copy of itself without external instruction, as in biological cells or some artificial systems.

Capaz de hacer una copia de sí mismo sin instrucciones externas, como en células biológicas o algunos sistemas artificial.

9.- Phenotype / Fenotipo

The observable characteristics or traits of an organism resulting from the interaction of its genotype and environment.

Las características observables o rasgos de un organismo que resultan de la interacción entre su genotipo y el ambiente.

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10.- Hydrology / Hidrología

The scientific study of the movement, distribution, and quality of water on Earth.

Estudio científico del movimiento, distribución y calidad del agua en la Tierra.

YOU'RE DONE!!!
Congratulations and thank you.