



SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
MASTER OF SCIENCE IN SUSTAINABLE ENERGY TRANSITIONS
END OF SEMESTER EXAMINATION
MSSET 8302: ENERGY PRACTICUM DESIGN

DATE: 27th April, 2026

Time: 18.00-20.30 Hours

Instructions

1. This examination consists of **FOUR** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

QUESTION ONE

(Total: 20 Marks)

- a. Critically analyze the role of problem-solving and need recognition in the energy sector's transition to a sustainable and low-carbon future. (3 Marks)
- b. SWOT and Pareto analysis are some of the most commonly used problem identification techniques. Discuss what these two entails? (3 Marks)
- c. Discuss the three fundamental reasons for managing workplace health and safety and provide examples to illustrate each. (3 Marks)
- d. Critically analyze the role of ethical decision-making in engineering projects involving high-risk technologies. Discuss the key factors engineers must consider and provide examples of potential conflicts between safety, cost, and project deadlines. (5 Marks)
- e. How can economic tools be applied to address safety and environmental risks in engineering projects, and reduce the likelihood of incidents? Discuss three approaches. (3 Marks)
- f. Discuss three economic instruments that can be used to incentivize sustainability in industrial projects. Explain how each instrument helps reduce environmental or safety risks. (3 Marks)

QUESTION TWO

(Total: 15 Marks)

Case Study 1

Study this case study and answer the following questions

EcoGrid Energy Ltd is a rapidly expanding regional electricity generation company that operates several natural gas and diesel power plants supplying electricity to urban and industrial areas. Due to increasing electricity demand, the company is planning to construct a new 600 MW gas-fired power plant to stabilize power supply and support economic growth. However, the project has generated significant debate among stakeholders. Environmental organizations argue that the new plant will increase carbon emissions and slow the country's transition to renewable energy. Local communities near the proposed site are also concerned about air pollution, land acquisition issues, and potential health impacts. At the same time, EcoGrid Energy argues that renewable energy sources such as solar and wind are intermittent, and the power plant is necessary to maintain grid stability and energy security. Investors and government authorities are also concerned about the financial viability and reliability of the national energy supply.

- a. Identify and explain two ethical issues that may arise from the construction and operation of the proposed gas-fired power plant. (2 Marks)
- b. Explain three ethical responsibilities that EcoGrid Energy Ltd should consider when making decisions about expanding its power generation capacity. (3 Marks)
- c. Suggest three key principles that should guide EcoGrid Energy Ltd in developing a responsible corporate sustainability strategy. (3 Marks)
- d. Discuss how engineers can balance technical, economic, environmental, and social constraints when implementing solutions to large-scale industrial energy problems. (4 Marks)
- e. Critically analyze the role of problem-solving and need recognition in enabling the energy sector's transition toward a sustainable and low-carbon future, with reference to the issues presented in this case study. (3 Marks)

QUESTION THREE

(Total: 15 Marks)

Case Study 2

Study this case study and answer the following questions

You are an Electrical Engineer at PowerTech Engineering Ltd, a company specializing in the design and installation of electrical substations. In your role, you are responsible for designing high-voltage transformers used in power distribution networks.

Recently, BrightGrid Utilities, an electricity distribution company, approached PowerTech to design and supply 35 high-voltage transformers for installation in several new substations across the country. The project comes with a fixed budget and a tight delivery timeline. As part of the design process, you conducted simulations and safety analyses in accordance with international transformer design standards. These standards require that the insulation system be rated for 132 kV and include enhanced thermal protection to ensure long-term reliability and safety. However, a cost analysis revealed that the client's budget is only sufficient to build 30 transformers that meet the required safety standards.

You submitted your findings to your supervisor, Mr. Kamau, the Engineering Manager at PowerTech. He expressed concern that if the client learns the budget is insufficient, they might award the contract to a competitor. To address this, he suggested modifying the design by using lower-grade insulation materials. This would reduce costs enough to deliver all 35 transformers within the client's budget. Mr. Kamau assured you that the modification is unlikely to be detected during routine inspections. He also promised a performance bonus and fast-track promotion if you approve the revised design, while warning that refusing to cooperate could result in your removal from the project team.

- a. Considering all aspects of this situation, explain the decision you would make and justify your answer. (1 Mark)
- b. The paradigm of complexity suggests that ethical decisions often involve multiple layers of uncertainty and competing values. Discuss the three complexities in ethics. (3 Marks)
- c. Using examples from the case study, identify and explain how each of the complexities discussed in Question (b) appears in this scenario. (3 Marks)
- d. Discuss one major ethical dilemma presented in this case study. (2 Marks)

- e. Apply the Line Drawing Methodology (LDM) to analyze the ethical dilemma identified in Question (d) and determine whether the situation exceeds the threshold of an ethical dilemma. *(use the format shown in table 1 for your analysis and use at least 3 features for analysis).* (3 Marks)

Table 1

No.	Feature	Paradigm (Ethical)	Test Case	Paradigm (Non-Ethical)
1				
2				
3				

- f. Discuss three measures that can be taken to rectify the safety concerns identified in this case study. (3 Marks)

QUESTION FOUR

(Total: 15 Marks)

Case Study 3

Study this case study and answer the following questions

You have recently joined a multidisciplinary engineering team responsible for the planning and development of a large-scale geothermal power plant intended to supply electricity to a rapidly growing industrial region. As an Engineer in Training, you will collaborate with senior engineers, environmental specialists, and government agencies to ensure the successful implementation of the project.

The geothermal power plant will utilize heat from underground reservoirs to produce steam that drives turbines connected to electrical generators. The project aims to provide reliable baseload electricity, reduce dependence on fossil fuels, and support sustainable energy development. However, the design and construction process must comply with strict environmental regulations, safety requirements, and community expectations.

- Identify and discuss five major challenges that the engineering team may encounter during the design and development of the geothermal power plant. (5 Marks)
- Identify and briefly explain four regulatory requirements that must be satisfied before the geothermal power plant can begin operation. (2 Marks)
- Describe three strategies that the engineering team can use to effectively engage stakeholders and build public support for the project. (3 Marks)
- Propose a comprehensive roadmap for addressing energy challenges in the industrial sector using sustainable energy solutions. (5 Marks)