



**School of Computing and Engineering Sciences**

**Master of Science in Energy Transitions**

**End of Semester Examination**

**MSSET 8204: Energy Systems Analysis and Decision-making**

**Date: 23<sup>rd</sup> April 2024**

**Time: 18:00-20:30 Hours**

**Instructions:** Answer Question **ONE** and any other **TWO** Questions

**Question ONE (20 Marks) (Compulsory)**

- a) Energy System Models are the mathematical models that are developed to represent as reliably as possible various energy-related problems. They represent the energy system (or its sub-systems) at different temporal, sectoral and spatial granularity. Identify the key features that a responsive energy system model that can be used by Energy and Petroleum Regulator Authority (EPRA) should have. [6 marks]
- b) Access to energy is essential for various household activities including cooking, heating, lighting, and powering appliances. However, the level of energy needs within households can vary significantly depending on socio-economic factors particularly in the rural and remote areas where the factors are more pronounced. Discuss the relationship between socio-economic factors and household energy demands, and show the implication of the understanding how different socio-economic characteristics influence energy consumption patterns. [8 marks]
- c) A household survey to determine the how household income affect the amount of energy consumption in token units consumed was commissioned by an independent solar energy installation company operating within the peri-urban areas of Nairobi. The ultimate goal was

to determine the capacity of the solar panels they will import. The outcome of the survey was as follows:

House hold income (in ten thousands)	100	101	102	102	100	99	97	98	96	95
Energy consumption in units	98	99	99	97	95	92	95	94	90	91

The data analytics department was tasked to conduct a correlation analysis on the two variable and make recommendation to the management. Determine the results of the correlation analysis. From the survey data and results of the correlation analysis, is there a reasonable basis for the company to proceed with the project? [6 marks]

**Question TWO (15 Marks)**

- a) Data exploration analysis (DEA) as the starting point into the data analysis as proposed by John Tukey continue to play critical role in data science. Briefly describe the motivation behind the concept of data exploration. [5 marks]
- b) A correlation exists between two variables when the values of one variable are somehow associated with the values of the other variable. When you see a pattern in the data you say there is a correlation in the data. This process is called data visualization and is the starting point of identifying the ideal model to be used in modeling data driven system. What are the possible models that can be identified using data visualization using a scatter plot? [3 marks]
- c) You are part of a renewable energy planning team in Kenya aiming to increase its share of renewable energy in the overall energy mix. The government has set ambitious renewable energy targets to enhance energy security, reduce greenhouse gas emissions, and promote sustainable development. As part of this initiative, your task is to develop a renewable energy forecasting scenario to optimize the integration of renewable sources into the existing energy infrastructure. Describe the key components/steps to consider so as to achieve the task. [7 marks]

**Question THREE (15 Marks)**

a) Suppose you participated in a study that involved the collection of data at a household level on the levels of consumption of gasoline in a rural community and upon creating a scatter plot to visualize the dataset you realize a number of outliers are evident in the dataset.

Explain how you can handle the outlier values in the dataset [7 marks]

b) Analyzing energy supply, demand, and distribution involves understanding the sources of energy, the consumption patterns, and the infrastructure that facilitates the movement of energy from production to end-users. Discuss the factors considered in conducting energy demand analysis using Kenya as a reference case. [8 marks]

**Question FOUR (15 Marks)**

a) The impact of wind and solar forecasting on power system operations can be significant, as these renewable energy sources are inherently variable and dependent on weather conditions. Nonetheless, accurate forecasting can play a crucial role in ensuring the stability, reliability, and efficiency of power systems. What impact would wind and solar energy forecasting have on Kenya? [7 marks]

b) Most countries use regression models to predict future energy consumption forecasts. This is due to its ability to use past and current energy consumption data values in an easier and more rapid way with the aid of energy modeling and simulation tools. The table below relates to key factors used in energy modeling. Using the data given in the table develop a regression model that can be used to estimate the expected values of Y when X=55.

X	40	50	38	60	65	50	35
Y	38	60	55	70	60	48	30

[8 marks]