**STRATHMORE UNIVERSITY**
**SCHOOL OF COMPUTING AND ENGINEERING SCIENCES**
**MASTER OF SCIENCE IN SUSTAINABLE ENERGY TRANSITIONS**
**END OF SEMESTER EXAMINATION**
**MSSET 8204**
**ENERGY SYSTEMS ANALYSIS AND DECISION MAKING**

**DATE: 6th September, 2022** **Time: 2.5 Hours**

**Instructions: Answer question one (Compulsory) and two other questions**

**QUESTION 1**

a. In energy analysis and modelling, time slices are used to represent periods of time in a year when the demand and supply of energy is assumed to be the same across the modelling period.
   i. Illustrate how 96 time slices covering one year can be obtained for use in a modelling tool such as OSeMOSYS. [**4 Marks**]
   ii. Calculate the value of a Year Split for the OSeMOSYS tool [**1 Mark**]

b. In OSeMOSYS tool, the Specified-Annual-Demand parameter is used for fuels whose demand varies within a given period e.g. day or year. Explain the use of Specified-Demand-Profile when analysing and modelling energy demand. [**5 Marks**]

c. Draw a sample Reference Energy System (RES) that features domestic and imported Coal, Natural Gas and Oil that are used for generating electricity. The RES should illustrate the full chain from commodities to demand. Consider demand from Residential, Commercial and Industrial users. [**10 Marks**]

**(Total Marks: 20)**

**QUESTION 2**

a. Define a backstop technology and explain its role in energy modelling [**3 Marks**]

b. Provide standard names using OSeMOSYS naming convention for the following energy system components; Imported coal, Open cycle natural gas power plant, Combine cycle natural gas power plant, Electricity before transmission, Residential electricity demand [**5 Marks**]

c. Explain the relevance as well as relationship between the following energy technology parameters with respect to a coal power plant: Efficiency, Input Activity Ratio and Output Activity Ratio [**3 Marks**]

d. If the efficiency of a power transmission technology was 93%, calculate its input activity ratio [**2 Marks**]

e. Explain the capacity factor of a power plant [**2 Marks**]

**(Total Marks: 15)**

**QUESTION 3**

a. Explain what Capacity to Activity Unit is [**2 Marks**]

b. Demonstrate that the Capacity To Activity Unit value is 31.536 PJ [**2 Marks**]

c. Explain what Reserve Margin is and discuss its importance in the planning of electricity supply of a country [**3 Marks**]

d. Emissions from an energy technologies affect global warming. State and explain four parameters for emissions representation in OSeMOSYS [**4 Marks**]

e. Discuss factors that can influence a country's decision to incorporate off-grid electrical power in its plan to achieve a higher percentage of electrification [**4 Marks**]

**(Total Marks: 15)**

**QUESTION 4**

a. Apart from OSeMOSYS, evaluate three energy modelling tools in terms of their usage and features [**6 Marks**]

b. You are required to create an electrical power generation plan for a small city. The city's minimum power demand is 4800 Mega Watt (MW), and maximum allowed yearly emissions are 90 Giga Tonnes (GT). Two fuel technologies are available for electrical power generation. A power plant using fuel ***X*** generates 100 MW of power with yearly emissions of 15 GT, while a plant using fuel ***Y*** generates 150 MW of power with yearly emissions of 18 GT. A plant using fuel ***X*** can supply 40 commercial consumers, while that using fuel ***Y*** can supply 60. Determine the fuel combination that will supply the maximum number of industrial consumers [**9 Marks**]

**(Total Marks: 15)**