UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL MANAGEMENT & ENERGY STUDIES

MODULE	**ENS8X05** ENERGY MODELLING
CAMPUS	**APK**
EXAM	**NOVEMBER 2019**

DATE 18 NOVEMBER 2019	**SESSION 08:30 – 11:30**
ASSESSOR(S)	**DR KRISTY LANGERMAN**
EXTERNAL MODERATOR	**DR PHILIP GOYNS**
DURATION 3 HOURS	**MARKS 300**

NUMBER OF PAGES: 3 PAGES

INSTRUCTIONS:

1. **Please answer any THREE of the five questions below.**
2. **Each answer should be in the form of a comprehensive essay, with sketches, diagrams and calculations where these may be appropriate to enhance your answer.**
3. **Each question is worth the same number of marks (100).**
4. **Calculators are permitted.**

Dr Kristy Langerman

Dr Philip Goyns

QUESTION 1

Describe the stages of setting up a mathematical model. Then construct a model to determine:

1. The cost of heating water for a house using a newly installed solar water heater compared to the cost with the existing electric geyser, over a 5-year period
2. The CO_2 emissions avoided per year by using a solar water heater rather than an electric geyser
3. The minimum additional CO_2 tax required to make a solar water heater the cheaper option.

Assume the following:

a. The power rating of the electric geyser is 3 kW
b. The electric geyser typically needs to operate for 3 hours a day to heat sufficient water
c. Electricity costs R1.00/kWh
d. The cost of a solar water heater installation is R25 000
e. The solar water heater and the electric geyser will both not need to be replaced in the 5-year period
f. The CO_2 emission factor for the South Africa electricity grid is 1.05 tons per MWh
g. Inflation and interest rates are zero

[100]

QUESTION 2

Compare and contrast top-down energy models with bottom-up energy models, and suggest applications that both types of model could be used for.

[100]

QUESTION 3

Energy models are frequently used for planning purposes. Evaluate the benefit that can be derived from the use of such models, and the limitations of a modelling approach. What trade-offs need to be considered in energy system models? How are externalities handled by models?

[100]

QUESTION 4

Answer all three parts of this question:

i) Using your knowledge of Systems Thinking and Systems Dynamics, draw a causal loop diagram which shows two factors that influence the electricity consumption of a typical household in Johannesburg.

ii) Explain how the factors that you have identified influence the electricity consumption of the household, with reference to the causal loop diagram.

iii) Identify the system archetype depicted in the causal loop diagram drawn for part i) of this question, and justify your answer.

[100]

QUESTION 5

Critically assess the energy modelling approach that is used for South Africa's Integrated Resource Plan. Consider the inputs, output, scenarios and exclusions for the modelling, and the role that the modelling plays in the compilation of the final plan.

[100]

TOTAL [300]