



FACULTY OF SCIENCE

DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL MANAGEMENT & ENERGY STUDIES

MODULE **ENS8X05**
ENERGY MODELLING

CAMPUS **APK**

EXAM **JANUARY 2020**

DATE **JANUARY 2020**

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 new house using an electric geyser and using a gas water heater, over a 5-year period.
2. The CO₂ emissions per year associated with the electric geyser and the gas water heater.
3. The minimum additional CO₂ tax required to make the gas water heater a cheaper option.

Assume the following:

- a. The cost of a new gas heater (plus installation) is R10 000
- b. The cost of a new electric geyser is R3 000
- c. The gas heater uses 0.6 kg of liquid petroleum gas (LPG) per day
- d. The power rating of the electric geyser is 3 kW
- e. LPG costs R1 200 for a 48 kg bottle
- f. The electric geyser typically needs to operate for 3 hours a day to heat sufficient water
- g. Electricity costs R1.50/kWh
- h. The gas water heater and the electric geyser both have a 5-year life.
- i. The CO₂ emission factor for the South Africa electricity grid is 1.05 tons per MWh
- j. The CO₂ emission factor for LPG is 2 985 kg of CO₂ per ton of LPG
- k. 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 change in national electricity demand for South Africa over time.
- ii) Explain how the factors that you have identified influence the electricity demand, 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

Describe the modelling approach that is used for the Integrated Resource Plan, considering the inputs, output, scenarios and exclusions.

[100]

TOTAL [300]
