UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL MANAGEMENT & ENERGY STUDIES

MODULE	**ENS0057** ENERGY MODELLING
CAMPUS	**APK**
EXAM	**NOVEMBER 2016**

DATE	**28 NOVEMBER 2016**	**SESSION**	**12:30 – 15:30**
ASSESSOR(S)		**DR JOHN LEDGER**	
EXTERNAL MODERATOR		**DR D. MARAIS**	
DURATION	**3 HOURS**	**MARKS**	**100**

NUMBER OF PAGES: 2 PAGES

INSTRUCTIONS:

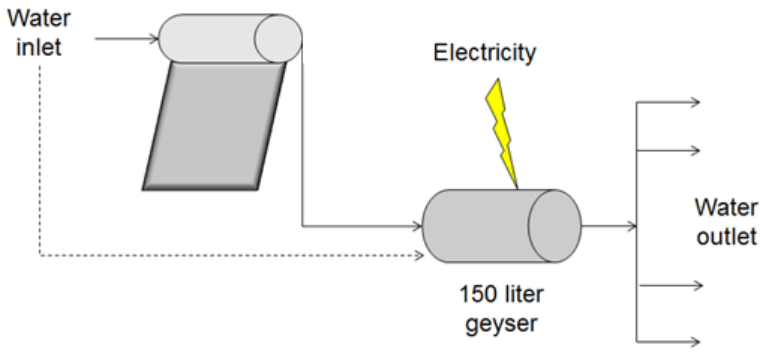
1. **TWO questions. Each answer is worth the stated number of marks.**
2. **Please answer QUESTION 1 and QUESTION 2 – COMPULSORY**
3. **For QUESTION 1, please perform all of the calculations required to arrive at your answer, as you will be marked on each correct step.**

Please answer ONE of the remaining

YOU MAY USE A CALCULATOR FOR THIS EXAM.

QUESTION 1 (COMPULSORY)

1. A household, consisting of three persons, use 70 litres of warm (40°C) water per person per day to shower. The hot water is currently supplied from an electric geyser and reaches the shower head at a temperature of 55°C where it blends with the cold water supply at 18°C. Since the marginal cost of electricity has recently risen to R1,40/ kWh, they are thinking of installing a solar water heater in series with the electric geyser. In this configuration, the solar water heater will act as a pre-heater to the geyser and will thus reduce electricity consumption. The following graphic illustration depicts the proposed design:



Given the assumed living conditions, the head of the household needs to assess the financial benefit that could be derived from this configuration, and then he/she needs to determine how much they can afford to pay for a newly installed solar water heater. The head of the household considers a payback period of 5 years to be acceptable.

If the following conditions are assumed to apply to this household, what would be the amount that they can afford to pay for the complete installation of the solar water heater?

- The electric geyser capacity is 150 litres.
- The estimated energy loss from the electric geyser is 2,6 kWh/day.
- The electric geyser heating element is rated at 3kW.
- The solar water heater does not have any electrical input and is capable of delivering water at an annual average temperature of 43°C.
- The solar water heater is fed from the normal cold water supply at an annual average temperature of 18°C.
- The heat loss from the pipe connecting the solar water heater to the electric geyser is 2%.
- There is no heat loss from the electric geyser to the shower head.

Assume the density (D_w) of water to be 1kg/litre and the heat capacity (C_w) to be 4,2 KJ/kg/°C .

Useful formulae:

1. 1 kWh = 3600 KJ

2. Density D = mass [kg] / volume [litre]

3. The formula for calculating heat absorption of water (H) is given by:

$H = m_w C_w (T_1 - T_0)$

where m_w = mass of water [in units, kg], C_w = heat capacity of water [in units, KJ/kg/°C], T = water temperature [in units, °C]

[40]

QUESTION 2 (COMPULSORY)

2. System Dynamics. You have attended a course on System Dynamics.

   a) Define a system and describe the different types of systems

   b) Explain the Iceberg model.

   c) Explain the concept of System Dynamics

   d) List five rules for drawing Causal Loop Diagrams (CLD).

[30]

QUESTION 3

3. Electricity Costing. Discuss the concepts of 'Overnight Costs' and 'Levelized Costs' of Electricity and describe how you would construct various models to demonstrate to decision-makers that certain electricity generation technologies have advantages/disadvantages over others. Give some practical examples of how misusing one or other type of analysis, a case can be made that wind energy is preferable to coal or nuclear.

[30]

QUESTION 4

4. One of the most important components of energy modelling is the gathering of sufficient data on which to make certain assumptions which can be tested in your model. The University of Johannesburg needs to analyse its Auckland Park Campus (APK) electricity consumption (which is a major expense) in order to implement cost-saving interventions. Given that the university has different electricity demand profiles by day and by night, during the week and at weekends, during term-time and holidays, and bearing in mind that in addition to teaching and research, there are also student residences at APK…

   Compile a detailed and annotated list of the data sets that need to be assembled in order to build a model and test the effects of different interventions on the consumption of electricity over a calendar year at APK.

[30]

TOTAL [100]