MASENO UNIVERSITY

UNIVERSITY EXAMINATIONS 2012/2013

FIRST YEAR SECOND SEMESTER EXAMINATIONS FOR THE DEGREE OF MASTER OF SCIENCE IN PHYSICS (MAIN CAMPUS)

SPH 831: PHYSICS OF NON-CONVENTIONAL ENERGY

Date: 26th July, 2013 *Time: 9.00 – 12.00 noon*

INSTRUCTIONS

- Answer ANY THREE questions

SPH 831: PHYSICS OF NON-CONVENTIONAL ENERGY

MSc. 2012/2013 Second Semester Examinations

Answer any THREE questions

Kinematic viscosity of water $\upsilon = 1.0 \times 10^{-6}\ m^2 s^{-1}$

Qn 1 (a). Electrical energy is one of the most important forms of energy today. Unfortunately, it has to be transported through cables for long distances. Explain, using appropriate relationships, why its transmission at high voltage is preferred. (6mks)

(b). Describe how energy is obtained from nuclear reactions. (6mks)

(c). After capturing a particle of mass 1.00807 amu, a nuclear of an element splits into two parts of masses 9.01464 and 6.01671 amu respectively and, in the process, releases a particle of mass 4.00372 amu. Determine the energy released in this process. (8mks)

Qn 2. KenGen has decided that, in order to exploit a new geothermal potential, it needs water extraction rate of 200 litres per second per square meter. The energy experts from Maseno University have given KenGen the following information regarding this new site:

Temperature gradient	$50^{\circ}C\ km^{-1}$
Rock porosity	10%
Aquifer (rock) thickness	0.5 km
Sediment density	$2500\ kg\ m^{-3}$
Depth	5 km
Specific heat	$800\ J\ kg^{-1}K^{-1}$
Surface temperature	$20^{\circ}C$

(a). What is the initial temperature and heat content per square kilometer above $40^{\circ}C$ of the aquifer? (8mks)

(b). What is the time constant for useful heat extraction? (6mks)

(c). What is the power that can be extracted initially? (6mks)

Qn 3. Sondu-Miriu hydro power station has a tunnel of 200 metres and diameter 0.3 m. The tunnel friction coefficient is 0.005 and the required volume flow rate is 0.1 m^3s^{-1}.

(a). Determine if the flow is laminar or turbulent. (6mks)

(b). Determine the required pressure head for the given flow rate. (8mks)

(c). What should be the gradient of the tunnel? (6mks)

Qn 4. (a). Explain the concept of interference factor in wind energy extraction and how you would go about designing an efficient wind turbine in a given wind regime. (6mks)

(b). A farmer who lives in an area where average wind speed is 20 ms^{-1} wants to use a wind turbine with a sweeping area of 6 m^2 to irrigate his land. He would prefer wind velocity of 15 m s^{-1} to be at the turbine. How much power will he be able to extract from the wind? (8mks)

(c). The farmer also wants to use a 50W solar panel to light his house but he cannot find one. He however discovered that a shop near him sells solar cells 25cm^2 each that can produce peak current and voltage of 100 mA and 1000mV respectively. What is the efficiency of this cell and how many would he need to achieve his objective if average solar radiation in the area is 1000 Wm^{-2}? (6mks)

Qn.5. The design of solar thermal converters is based on attempts to achieve maximum solar radiation absorption while at the same time reducing heat losses as much as possible. Use this information to discuss this assertion with a view to designing an efficient solar air heater of a rectangular shape. (20mks)