MASENO UNIVERSITY

UNIVERSITY EXAMINATIONS 2015/2016

FIRST YEAR SECOND SEMESTER EXAMINATIONS FOR THE DEGREE OF MASTER OF SCIENCE IN PHYSICS

MAIN CAMPUS

SPH 831: PHYSICS OF NON-CONVENTIONAL ENERGY

Date: 9th May, 2016

Time: 2.00 - 5.00 pm

INSTRUCTIONS:

- Answer ANY THREE questions.

ISO 9001:2008 CERTIFIED

SPH 831: PHYSICS OF NON-CONVENTIONAL ENERGY

MSc. 2015/2016 Second Semester Examinations

Answer any THREE questions

Density of air $\rho = 1.28$ kg m^{-3}

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

Qn 1(a). Generation of electrical energy is increasingly being encouraged because the process is not associated with adverse environmental impacts. Given that the power extracted by wind turbine is equal to rate of change of momentum at the turbine and that this change is equal to power lost by the wind,

(i.) show that the maximum power that can be extracted from the wind is:

$P_T = C_p P_o$, where P_o is the power in the undisturbed wind and C_p is the power coefficient.

(5mks)

(ii). Determine the value of the interference factor for maximum power extraction.

(5mks)

(b). Explain the concept of "Dynamic matching" as applied to wind turbine design.

(3mks)

(c). A wind turbine operating in a 20 m s^{-1} wind regime has six blades each 0.7 m long. If this machine has an interference factor of ¼ , what is the magnitude of the force that is turning the turbine?

(7mks)

Qn 2. (a).(i). Describe in details, using a suitable diagram, how solar radiation (solar energy) is converted directly into electricity.

(8mks)

(ii). Explain why this energy conversion process is associated with low efficiencies.

(4mks)

(b). A farmer who lives in a region where average solar radiation is 1000 W m^{-2} wants to use a 50 W solar panel to light his house. A nearby shop does not have a panel of this capacity but has small solar cell each 25 cm^2 producing peak current and voltage of 100mA and 1000 mV respectively.

(i). Determine the efficiency of this cell.

(3mks)

(ii). How many of these cells would the farmer need to achieve his objective? (5mks)

Qn.3.(a). Usually electric form of energy has to be transported long distances, through cables, to the region where it is needed. Explain why its transmission at high voltage is preferred. (6mks)

(b). Describe two types of nuclear reactions used in energy production and why one type is currently preferred in electricity production.

(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 4. A power company is considering the development of a new geothermal potential, and needs water extraction rate of 200 litres per second per square meter. This new site is at a depth of 5 km where rock porosity is 10% while sediment density is 2500 kg m^{-3}. The surface temperature and the temperature gradient are 20°C and 50°C km^{-1} respectively. If the aquifer is 0.5 km thick and the specific heat is 800 J kg^{-1}K^{-1},

(a).   What is the initial temperature and heat content per square kilometer above 40°C of the aquifer?
(7mks)
(b)   What is the time constant for useful heat extraction?
(6mks)
(c).   What is the power that can be extracted initially?
(7mks)

Qn 5. A hydro power facility has a tunnel of 200 m long and diameter 0.3 m. The tunnel friction coefficient is 0.005 and the required volume flow rate is 0.1 m^{3}s^{-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)