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(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER MAIN EXAMINATIONS

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN PHYSICS

COURSE CODE: SPH 453

COURSE TITLE: OCEAN ENERGY SYSTEMS AND TECHNOLOGY

DATE: MONDAY 25TH APRIL, 2022 **TIME:** 12:00 PM - 2:00 PM

INSTRUCTIONS TO CANDIDATES

Answer question **ONE** and any **TWO** of the remaining
Symbols used bear the usual meaning.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over.

USEFUL CONSTANTS
Density of ocean water 1025 kgm^{-3}
Gravitational constant on Earth g= 10N/kg
Density of air = 1.23 kgm^{-3}

Question One (30 marks)

a. Explain the following abbreviations related to ocean energy/renewable energy: CEFOW, CORE, REREC, and OTEC . (4 marks)
b. State and explain three factors that cause/contribute to tidal energy. (6 marks)
c. Differentiate between
   i. Spring tides , neap tides and slack tides
   ii. Ebb current and eddy currents. (5 marks)
d. Discuss three (3) methods which can be used to 'store' excess oceanic energy for use during periods of maximum demand in the grid. (6 marks)
e. Explain the following terms
   i. Intertidal zone
   ii. Tidal range
   iii. Tidal day (6 marks)
f. What are the three potential advantages to using wave water energy converter that sits near the sea floor versus that floats on the water surface. (3 marks)

Question Two (20 marks)

a. Describe in detail, with help of well labelled diagrams, each of the following: a TEC generator AND an OTEC plant. (8marks)
b. Discuss the advantages, disadvantages, and environmental hazards they pose for each of the generators in (a) above. (12 marks)

Question Three (20 marks)

a.) For the same nominal power output, discuss the relative diameters of pipes carrying water on one hand and that carrying air. Are they the same? If not justify. (4 marks)
b.) Show that the Average power of a 1- dimensional water wave is given by

$$E = \frac{1}{2} A^2 \omega^2 \rho \lambda$$ where λ= linear mass/unit length of wave packet, A= amplitude. (8 marks)

c.) Assuming that tidal waves approximate to a 1D sinusoidal wave, with wavelength 120m, speeds 8 km/hr, and amplitude of 6m. Estimate the maximum potential energy that will be available to turn the turbines from $1m^3$ of water. (8 marks)

Question Four (20 marks)

a.) Differentiate between a barrage TEC and instream devices. (10 marks)
b.) The energy available from a barrage is dependent on the volume of "falling" water. For water, density ρ,falling through a height, H, Generate an expression for potential energy lost by the fluid to the turbines. (4 marks)

c.) Water from a moderately sized river flows through a smooth pipe perpendicularly downhill ,from a dam to the turbines, at the rate of 100 m^3/sec, and falls 50 m onto the turbines. Assuming all the potential energy is converted finally into electricity,

i. How much power is available?

ii. How many houses having an average of about 0.5 Kwhr could this power supply?

(6 marks)

Question Five (20 marks)

a.) What is a Carnot /Rankine engine in thermodynamics? (4 marks)

b.) The Rankine cycle is the most commonly used heat cycle for ocean thermal energy. Starting from the first law of thermodynamics, show that the efficiency of a Rankine engine, operated between source temperature T_0 and sink temperature T_1, is given by

$\eta = 1 - \frac{T1}{T0}$ (6 marks)

c.) Oceanic thermal conversion systems (OTEC), are based on temperature differences between the cooler deep and warmer shallow or surface ocean waters to run heat engines.
If in the tropics the temperatures are 20^0C and 25^0C respectively, estimate the efficiency of the plant as a Carnot engine . (4 marks)

d.) The Archimedean screw is a tidal energy (TEC) converter that uses the principle of a lift pump. With aid of diagrams, Explain how a lift pump works. (6 marks)