The Open University of Sri Lanka
Faculty of Engineering Technology

071

Study Programme	:	Bachelor of Science Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX7305 Renewable Sources of Energy**
Academic Year	:	2022/23
Date	:	17th February 2024
Time	:	1330-1630h
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **Three (3)** pages.
3. Answer **all** questions.
4. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear handwriting.
8. Take acceleration due to gravity and the density of water as 9.81 N/kg and 1000 kg/m^3 respectively.

Question-1 (20 marks)

a) Explain the term 'Energy Conservation'. 02 marks

b) What are the basic steps involved in systematically managing and conserving energy, and how does those steps contribute to reduce energy expenditure and maximize production gains? 05 marks

c) What is meant by 'Nuclear Fission'?

In the context of the Uranium-235 nuclear fission reaction, if the loss of mass after the splitting of 235U is 0.220 amu, calculate the energy release of the reaction?' 06 marks

1amu (atomic mass unit) = 1.66×10^{-27} kg, speed of light = 3×10^8 ms^{-1}

d) Discuss the importance of using renewable energy sources from a local perspective. 07 marks

Do you think a Nuclear Power plant would be a suitable solution for meeting Sri Lanka's energy demand? Justify your answer.

Question-2 (20 marks)

a) Name four sources of 'Biomass' available for energy production. 02 marks

b) What is meant by 'Energy Crops'?

Discuss the expected characteristics of energy crops by providing examples. 06 marks

c) Briefly explain the mechanism of 'Anaerobic Digestion' using an appropriate block diagram. 06 marks

d) What are the primary types of biogas plants available in Sri Lanka? Choose one type, and explain its main features, process, advantages and disadvantages. 06 marks

Question-3 (20 marks)

a) Describe the importance of 'Solar Irradiance (I_o)' and 'Declination Angle (δ)', subjected to solar energy. 02 marks

b) Determine the solar irradiance (I_o) and declination angle (δ) subjected to the following dates in a typical calendar year. Take average solar constant (I_{sc}) is 1353 W/m^2.

	March	June	September	December
Day	21st	21st	21st	21st

Provide a brief discussion on the significance and impact of the results obtained. 06 marks

You may use the following equations for this calculation.

$$I_o = I_{sc}[1 + 0.034 \cos\frac{360 \times N}{365}]$$

$$\delta = 23.45 \sin\left[360\left(\frac{284 + N}{365}\right)\right]$$

N is the day number of the particular year starting from January 1st.

c) Briefly explain the active and passive solar systems with appropriate examples. 04 marks

d) How can Sri Lanka maximize the collection and utilization of solar energy?

Provide a detailed analysis considering factors such as solar panel installation strategies, grid integration, policy frameworks, and community engagement initiatives. 08 marks

Question-4 (20 marks)

a) Name types of energy forms found in the ocean that can be utilized for power generation? 03 marks

b) What is meant by a Wave Energy Convertor (WEC)?

Briefly explain one specific type of WECs with its operation principle. 05 marks

c) Do you think tidal energy technologies can be used on a local scale? Provide justification considering the characteristics of tides in Sri Lanka. 05 marks

d) Examine the global outlook of ocean energy in comparison to other renewable sources, incorporating relevant examples and exploring its developmental stage, historical context, and other various contributing factors 07 marks

Question-5 (20 marks)

a) What are the main components of a horizontal axis wind turbine? Use diagram to clarify your answer. 04 marks

b) Discuss the environmental impacts associated with the wind turbine farms. 05 marks

c) A small scale 10 kW wind turbine with the power coefficient of 0.4, installed in 50 m height with its rotor diameter of 10 m. Assume that turbine is operating at 60% of efficiency.

i. Calculate the wind speed at the installed heigh.

ii. If the wind speed is doubled while the rotor diameter is also doubled, what is the power output of the wind turbine?

iii. If the same turbine is installed at a height of 100 m, what would be the power output of the turbine? Assume wind speed is three times the wind speed obtained in (i) 06 marks

You may use the following equations for the calculations.

$$Wind\ Power\ (P) = \frac{1}{2}\rho A V^3 \eta\ C_p$$

ρ – density of air (1.225kg/m^3)
A– swept area of the wind
V– wind speed
η – efficiency of wind turbine
C_p – power coefficient

d) Why have Vertical Axis Wind Turbines (VAWTs) regained popularity in recent years, and what specific uses or applications are driving their increased adoption? 05 marks