



## UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DEE 2242
COURSE	: FUNDAMENTAL OF RENEWABLE ENERGY
SEMESTER / SESSION	: 01 - 2023/2024
DURATION	: 2 HOURS

Instructions:

1. This booklet contains **4** question sets. Answer **ALL**.
2. All answers should be written in the answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hand and ask the invigilator.

**DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO**

**THIS BOOKLET CONTAINS 6 PRINTED PAGES INCLUDING COVER PAGE**

**QUESTION 1**

- a) State any one (1) of the regions in the solar radiation spectrum. (1 mark)
- b) Describe the wind energy quantification Wind Power Density (WPD). (5 marks)
- c) Explain the relationship between the WPD calculations and the classes in the NREL class index. (2 marks)
- d) Write down the full name for the following wind turbine classifications.
- i) VAWT (1 mark)
  - ii) HAWT (1 mark)
- e) Explain the net result of the chemical reaction of a basic fuel cell. (3 marks)

**QUESTION 2**

- a) Explain the operation of a concentrated solar power (CSP) system in the generation of electrical power. (5 marks)
- b) State the **two (2)** factors that power extraction from water depends upon in conventional dam hydroelectricity. (2 marks)
- c) Explain the storage principle of the pump-storage hydroelectricity operation. (4 marks)
- d) Calculate the available hydropower for a pressure head of 90 m with volume flow rate of  $30 \text{ m}^3/\text{s}$  if the turbine used is 65% efficient. (3 marks)

**QUESTION 3**

- a) Explain the photovoltaic effect associated with solar cells. (6 marks)
- b) Describe the ocean wave power. (3 marks)
- c) Describe the ocean wave growth contributors. (3 marks)
- d) State the name of location (i) to (iii) for ocean wave energy converter placement based on location distance from the seashore in Table 1.

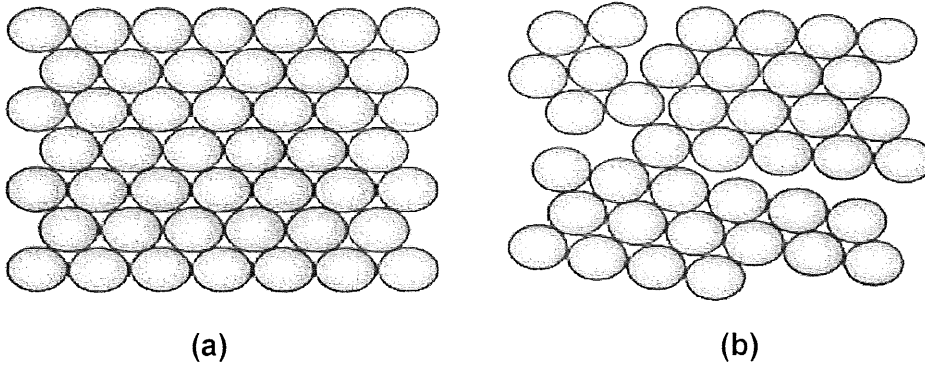
**Table 1**

Location Name	Distance from Shore	
(i)	Water meets shore	(1 mark)
(ii)	To depth of 20 m	(1 mark)
(iii)	From depth of 20 m outward	(1 mark)

- e) Write down the **four (4)** important design features of a basic fuel cell. (4 marks)

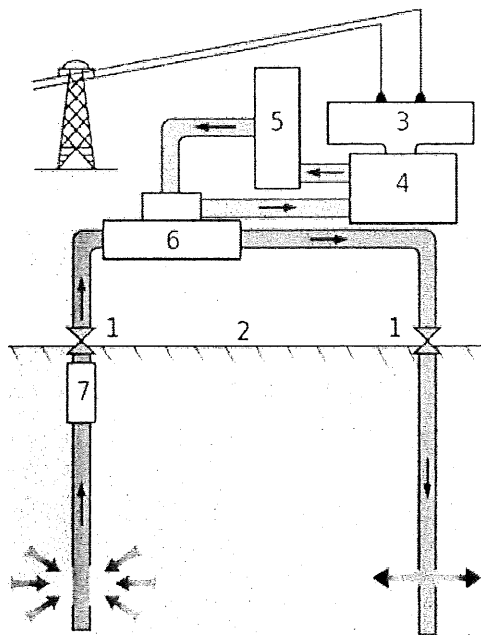
**QUESTION 4**

- a) Write down the name of the silicon crystalline formations used in semi-conductor based solar cell shown in Figure 1 (a) and (b). (2 marks)



**Figure 1**

- b) List any **one (1)** of the second generation thin film solar cells. (1 marks)
- c) Describe the Earth's internal heat. (5 marks)
- d) Explain binary cycle geothermal power station operation with the help of Figure 2. (4 marks)



**Figure 2**

- e) List any **two (2)** fuel cell technologies. (2 marks)

-----End of Questions-----

**FORMULA SHEET**

<b>Hydroelectricity</b>	
<b>Hydropower output</b>	
<b><math>P = \eta \rho g Q H</math></b>	
where:	
<b>P</b>	: mechanical power produced at the turbine shaft (Watts)
<b><math>\eta</math> ('eta')</b>	: hydraulic efficiency of the turbine
<b><math>\rho</math> ('rho')</b>	: density of water (1000 kg/m <sup>3</sup> )
<b>g</b>	: acceleration due to gravity (9.81 m/s <sup>2</sup> )
<b>Q</b>	: volume flow rate passing through the turbine (m <sup>3</sup> /s)
<b>H</b>	: effective pressure head of water across the turbine (m)
<b>Capacity factor (CF)</b>	
energy generated per year (kWh/year) <b>CF (%) =</b> ----- installed capacity (kW) x 8760 hours/year	
<b>Annual Energy Output</b>	
<b>Energy (kWh/year) = P (kW) × CF × 8760</b>	