UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET		
COURSE CODE	:	DEE 2242
COURSE	:	FUNDAMENTAL OF RENEWABLE ENERGY
SEMESTER / SESSION	:	01 - 2021/2022
DURATION	:	3 HOURS

Instructions:

1. This booklet contains **4** questions. 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 7 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Write down the name of regions of the solar radiation spectrum from (i) to (vii) in Table 1 according to their wavelength ranges.

Table 1 Solar Radiation Spectrum

Radiation Spectrum Region	Wavelength Range (nm)	
(i)	3000 – 1000000	(1 mark)
(ii)	1400 – 3000	(1 mark)
(iii)	700 – 1400	(1 mark)
(iv)	380 – 750	(1 mark)
(v)	315 – 400	(1 mark)
(vi)	280 – 315	(1 mark)
(vii)	100 – 280	(1 mark)

b) Describe the wind energy quantification Wind Power Density (WPD). (8 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) Describe the characteristics of wind turbine blades for upwind positioned HAWT wind turbine. (3 marks)

f) 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) Describe hydroelectricity. (3 marks)

c) Explain the downside of damming in hydroelectricity. (3 marks)

d) State the **two (2)** factors that power extraction from water depends upon in conventional dam hydroelectricity. (2 marks)

e) Explain the storage principle of the pump-storage hydroelectricity operation. (4 marks)

f) Calculate the available hydropower for a pressure head of 90 m with volume flow rate of 30 m^3/s if the turbine used is 65% efficient. (3 marks)

g) Describe the chemical reaction occurring in the following basic fuel cell sections.

i) Anode (3 marks)

ii) Electrolyte (2 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 2.

Table 2

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

(1 mark)

(1 mark)

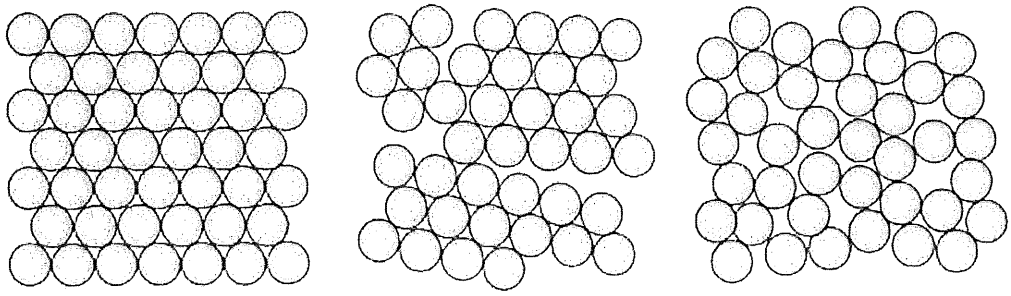
(1 mark)

e) Write down the **six (6)** ocean wave energy converters. (6 marks)

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

QUESTION 4

a) Write down the name of the **three (3)** silicon crystalline formations used in semi-conductor based solar cell shown in Figure 1 (a) to (c). (3 marks)



(a) (b) (c)

Figure 1

b) State the type of geothermal power plant design shown in Figure 2. (1 mark)

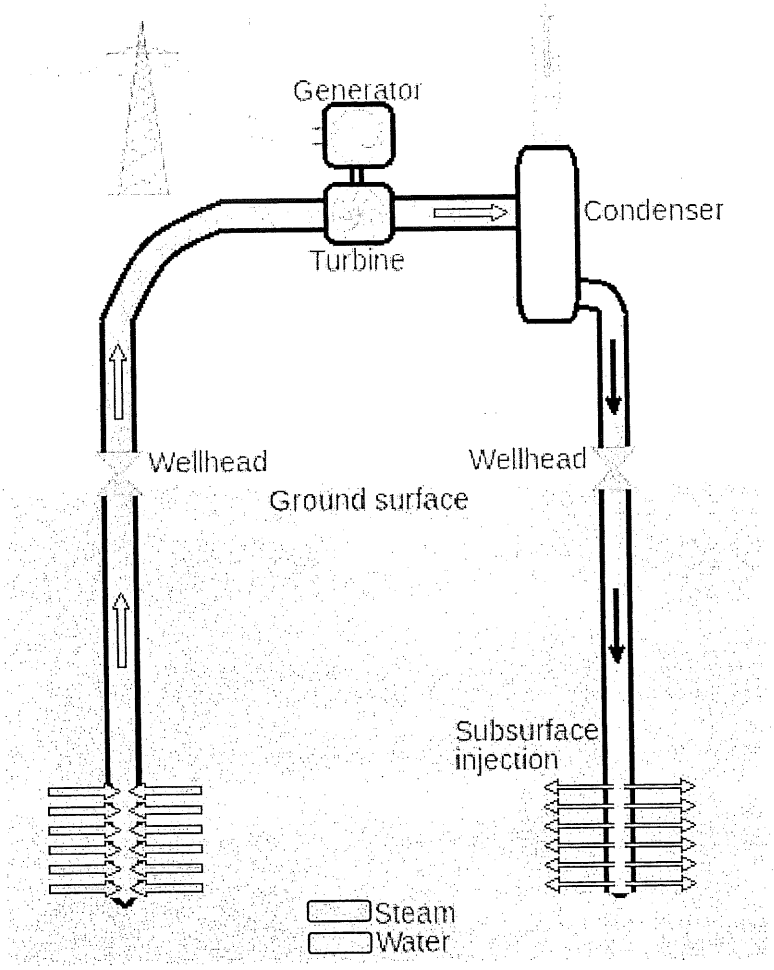


Figure 2

c) List any **two (2)** of the second generation thin film solar cells. (2 marks)

d) Describe the Earth's internal heat. (5 marks)

e) Explain geothermal gradient. (5 marks)

f) Explain binary cycle geothermal power station operation with the help of Figure 3. (4 marks)

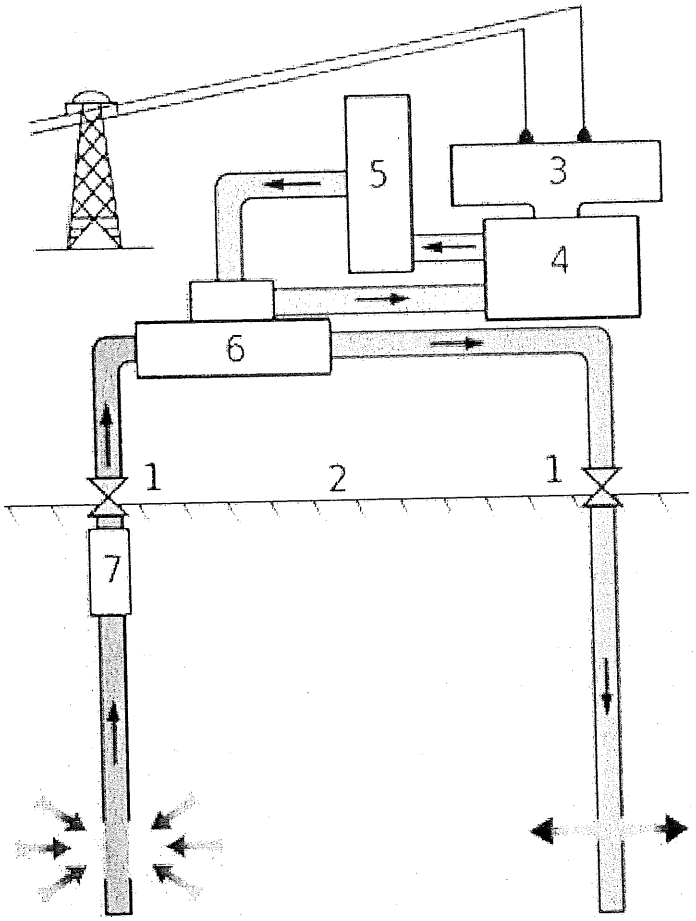


Figure 3

g) List any **two (2)** downsides of the geothermal power station. (2 marks)

h) List any **three (3)** of fuel cell technologies. (3 marks)

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

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Criteria	Marks
All questions answered will be marked according to the answer scheme	/100

FORMULA SHEET

Hydroelectricity

Hydropower output

$$P = \eta \rho g Q H$$

where:

P	: mechanical power produced at the turbine shaft (Watts)
η ('eta')	: hydraulic efficiency of the turbine
ρ ('rho')	: density of water (1000 kg/m^3)
g	: acceleration due to gravity (9.81 m/s^2)
Q	: volume flow rate passing through the turbine (m^3/s)
H	: effective pressure head of water across the turbine (m)

Capacity factor (CF)

$$CF\ (\%) = \frac{\text{energy generated per year (kWh/year)}}{\text{installed capacity (kW) x 8760 hours/year}}$$

Annual Energy Output

Energy (kWh/year) = P (kW) × CF × 8760