



# UNIVERSITY OF RUHUNA

## Faculty of Engineering

End-Semester 7 Examination in Engineering: Aug/Sep 2018

Module Number: ME 7312

Module Name: Energy Technology

[Three Hours]

[Answer all the five questions, each question carries 10 marks]

All assumptions must be stated clearly. Sketches and diagrams are to be provided where required. Symbols stated herein denote standard parameters.

- Q1. a) Describe following solar angles with suitable clear sketches.
- Latitude/Longitude Angle.
  - Declination Angle.
  - Zenith Angle.
  - Altitude/Elevation Angle.
  - Azimuth Angle.
- [2.0 Marks]
- b) Describe solar tracking mechanisms with all relevant data.
- [2.0 Marks]
- c) Electricity generation from solar energy is a common renewable energy technology in the world. Electricity can be extracted directly using Photovoltaics (PV) panels.
- Describe briefly four indirect methods of solar electric energy extraction with suitable sketches.
  - What is the use of molten salt in some applications?
- [4.0 Marks]
- d) Solar (Thermal) Cooling is another application of solar power and can be categorized in to "Active Cooling" and "Passive Cooling". Describe them briefly with historical and current development of solar cooling.
- [2.0 Marks]
- Q2. a) What are the five main ocean energy extraction methods? Describe them briefly.
- [2.0 Marks]
- b) Salinity power is one of the largest sources of renewable energy, which is still not exploited. Describe a mechanism of extracting salinity power from ocean.
- [2.0 Marks]
- c) The ocean's natural thermal gradient can be utilized for electric power generation and the corresponding technology is called OTEC technology. Describe the OTEC technology with relevant technical data (with advantages, disadvantages, suitable sketches, etc.).

[3.0 Marks]

Q2. is continued to the next page...

- d) A typical sea wave height record is given during 150 seconds as in the Figure 1: Q2 (d). Using your knowledge on sea wave energy, calculate the wave power with suitable assumptions. You may use the following data:  
 Gravitational constant =  $g = 9.81 \text{ m/s}^2$   
 Density of seawater =  $\rho = 1025 \text{ kg/m}^3$

[3.0 Marks]

- Q3. a) Hydro power plants are consisted with "Dams" to create reservoirs and due to these dams, environmental impacts will be created. Describe briefly the different kind of dams with suitable sketches and write five environmental impacts in point form.
- b) The mechanical energy produced by a turbine is converted into electrical energy using a turbine generator. Categorize different kind of hydro power turbines with respect to type of turbine and head classification.
- c) What is "water hammering" and what are the effects of it? Describe briefly, how to reduce the effects of water hammering.
- d) Explain the operation of an "updraft gasifier" used in thermochemical energy conversion systems with emphasis on the different zones of reaction.
- e) Discuss the "anaerobic digestion process" by clearly identifying its three stages.

[2.0 Marks]

[2.0 Marks]

[1.0 Mark]

[2.0 Marks]

[3.0 Marks]

Q4. "Wind energy is one of the main sources of renewable energy used for electricity generation. Wind turbine rotors convert kinetic energy in the wind to mechanical energy, which drives a generator to produce electricity."

- a) Provide a clear explanation of "Yaw Control" and "Pitch Control" used in wind turbines.
- b) Briefly explain the "Betz Criterion" related to wind energy conversion.
- c) Following information is given for a wind energy conversion system:  
 Speed of free wind at a height of 10 m =  $10 \text{ ms}^{-1}$   
 Air density =  $1.226 \text{ kg/m}^3$   
 Height of Tower = 100 m  
 Diameter of Rotor = 80 m  
 Wind velocity at the turbine inlet reduces to 80% of the free wind speed  
 Generator efficiency = 85%.

[2.0 Marks]

[2.0 Marks]

The equation to estimate the free wind speed,  $U_z$  ( $\text{ms}^{-1}$ ) at a given height,  $z$  (m):  $U_z = U_H(z/H)^\alpha$ , where,  $U_H$  is the wind speed at a reference height  $H$  (m) and  $\alpha = 0.14$ . The power coefficient  $C_p = 4a(1-a)^2$ , where  $a$  is the interference factor.

Q4. is continued to the next page...

Use the above information to calculate the following:

- i. Total power available in the wind.
- ii. Power extracted by the turbine.
- iii. Electrical power generated.

[6.0 Marks]

Q5. a) Briefly describe the ASTM classification of coal.

[2.0 Marks]

b) Describe the following two properties of coal:

- i. Ash fusion temperature.
- ii. Sulphur content.

[2.0 Marks]

c) Write the equation for "API° Gravity of Crude Oil". What is the information that can be obtained from API° Gravity?

[3.0 Marks]

d) Explain the significance of the "Octane Number in Petrol". State the effect of the Self-Ignition Temperature (SIT) of the fuel and its relationship to the Octane Number.

[3.0 Marks]

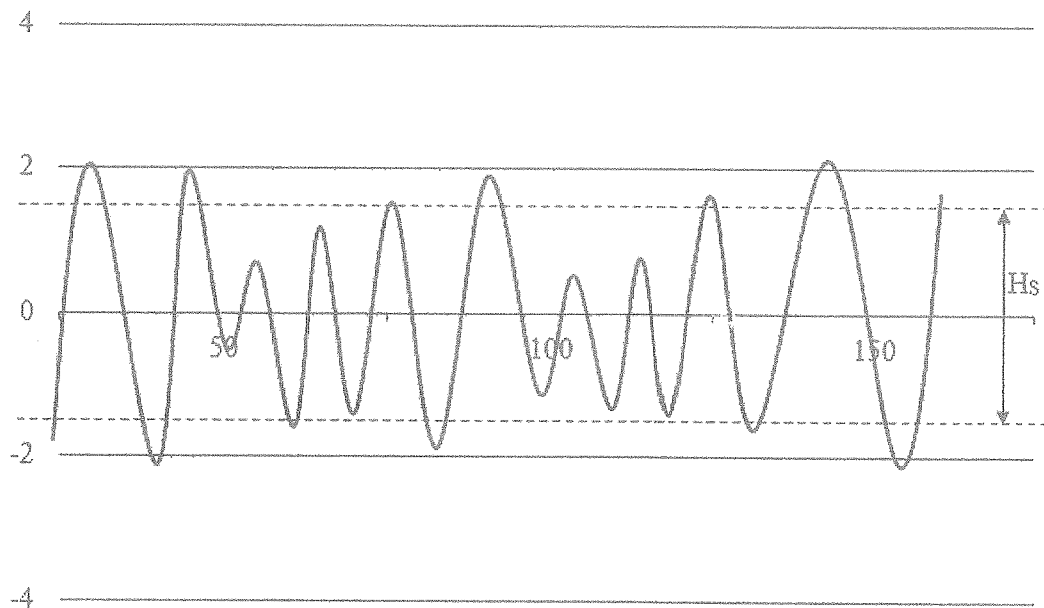


Figure 1:Q2 (d)