



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: March 2021

Module Number: ME 7312

Module Name: Energy Technology

[Three Hours]

[Answer all questions in separate booklets (Part A and Part B), each question carries ten marks]

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

Part A

- Q1 a) Show that the tip speed ratio for maximum power extraction (λ_0) for a "Horizontal Axis Wind Turbine (HAWT)" having "n" number of blades is given by,
- $$\lambda_0 = \frac{4\pi}{n}$$
- [5.0 Marks]
- b) A two blade HAWT is installed at a location with free wind velocity of 20 m/s. The rotor diameter is 30m. Estimate the rotational speed required to produce maximum output.
- [3.0 Marks]
- c) What do you understand by the terms "Yaw Control" and "Pitch Control"? Discuss them in your own words (Provide sketches where necessary).
- [2.0 Marks]
- Q2 a) What do you understand by the term "Rank" of coal? Clearly state the basis of ranking.
- [2.5 Marks]
- b) "Ash Fusion Temperature" is an important property of coal. Explain the significance of this property.
- [2.5 Marks]
- c) State the major properties to be assessed when selecting a crude oil.
- [2.5 Marks]
- d) Discuss the environmental impacts of fossil fuel usage.
- [2.5 Marks]

Part B

- Q3 a) Solar Water Heating (SWH) is heating water by sunlight, using a solar thermal collector. A variety of configurations is available at varying cost to provide solutions in different climates and latitudes. SWHs are widely used for residential and some industrial applications. Discuss the four main solar water heater types with the aid of suitable sketches.
- [2.0 Marks]

- b) Below angles involved in calculating the amount of solar radiation that a PV panel receives at any given time. The angle at which the sun hits a PV panel is the basis for understanding how to design the most efficient PV array for a specific location.

Describe following solar angles with suitable clear sketches.

- i) Declination Angle
- ii) Zenith Angle
- iii) Altitude/Elevation Angle
- iv) Azimuth Angle
- v) Tropic of Cancer/ Tropic of Capricorn

[2.0 Marks]

- c) Solar irradiance is the power per unit area received from the Sun in the form of electromagnetic radiation as measured in the wavelength range of the measuring instrument. The solar irradiance is measured in watt per square metre (W/m^2) in SI units. Solar radiation incident on a surface at earth has three different components. Describe the three components with suitable sketches.

[2.0 Marks]

- d) Wave energy is the most abundant form of hydrokinetic energy in the United States and wave energy converters (WECs) are being developed to extract the maximum possible power from the prevailing wave climate. Discuss five main ocean energy extraction methods with the aid of suitable sketches.

[2.0 Marks]

- e) A concentrating collector comprises a receiver, where the radiation is absorbed and converted to some other energy form, and a concentrator, which is the optical system that directs beam radiation onto the receiver. The aperture of the system is the projected area of the concentrator facing the beam. What are the main two types of solar collectors? Discuss two examples for each type with the aid of suitable sketches.

[2.0 Marks]

- Q4 a) In order to reduce greenhouse gas emissions and to secure a sustainable future for all countries, it is clear that renewable energy sources will play a key role. Marine energy technology which is a renewable source, is at an early stage of development, especially in the case of wave power. Not only that, those technologies affect the environment in different ways. Discuss six environmental impacts of ocean energy extracting technologies briefly.

[2.0 Marks]

- b) If you are assigned to develop a proposal for an osmotic power plant in Sri Lanka as a Mechanical and Manufacturing Engineer and you have to conduct a feasibility study on that. Discuss the breakdown of the way of conducting the study and the parameters to be considered for that.

[2.0 Marks]

- c) Micro-hydro-electric power is both an efficient and reliable form of clean source of renewable energy. It can be an excellent method of harnessing renewable energy from small rivers and streams. The micro-hydro project designed to be a run of river type, because it requires very little or no reservoir in order to power the turbine. As an engineer, you are asked to design a micro-hydro electric power plant which will be beneficial in the rural areas. Discuss the design considerations of micro-hydro-electric power plant under 5 main topics.

[3.0 Marks]

- d) Classify the available hydro turbines respect to the head and discuss the Kaplan turbine and use of it.

[2.0 Marks]

- e) Discuss the pumped storage process with suitable sketches.

[1.0 Mark]

- Q5 a) State the definition of biogas? What would be the normal composition of biogas?

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[2.0 Marks]

- b) What are the three important benefits you can obtain from Biogas Technology?

[1.5 Marks]

- c) By drawing a schematic diagram, briefly explain three stages of anaerobic fermentation of biomass.

[1.5 Marks]

- d) Name five (05) factors that influence the biogas production.

[2.5 Marks]

- e) Based on the construction, what are the three main types of simple biogas plants available in the world? With an appropriate sketch briefly explain the function of any biogas plant stated above.

[2.5 Marks]