Question 1

(a) Draw a schematic diagram of a Fuel cell. Explain how electricity is generated. [5 Marks]

(b) Explain how an electric current is generated in a Photovoltaic cell. [5 Marks]

(c) Discuss advantages and disadvantages of hydroelectricity. Consider both large and small installations. On what parameters does the power output depend? [7 Marks]

(d) Comment on two tidal energy electricity-generation systems. [3 Marks]

(e) Discuss advantages and disadvantages of alcoholic fermentation. What would the application of the final product be? [5 Marks]

Question 2

At a site in the Lea Valley a 15 MW wind farm is to be installed. The annual average wind speed is given in Figure 1 below. Figure 2 shows the power curve for the 77m rotor diameter wind turbine selected for the installation.

(a) Calculate the size if the wind resource at 80 m height (in kW). [5 Marks]

(b) Explain the power curve in Figure 2. [3 Marks]

(c) Calculate the turbine Power Coefficient at 10m/s wind speed. [7 Marks]

(d) Describe ‘Active Pitch’ and ‘Passive Stall’ control mechanisms for power regulation on HAWT. [4 Marks]

(e) How many turbines will you advise to install and why? [6 Marks]
Question 3

A straw-fired 25MWe power generation plant has been installed in Navarra, Spain.

(a) Draw a flow diagram of the plant. Explain the process in as much detail as possible. [5 Marks]

(b) If the average GHV of the baled straw, as received by the power plant, is 16 GJ/tonne, how much fuel is needed to run the plant? Add all necessary well justified assumptions. [10 Marks]

(c) If waste heat were to be used for space heating/cooling, where in the diagram drawn in (a) would the energy be extracted from? [5 Marks]

(d) Discuss the advantages and disadvantages of such an installation. [5 Marks]

Question 4

In Tuscany, Italy an old farm-house, a listed stone building, is being refurbished to be used as a holiday home. Planning permission for a swimming pool has been obtained after local building regulations, regarding mostly visual impact, have been abided for. A grant towards the installation of renewable energy devices has also been obtained. Peak insolation by direct sunlight is taken to be 1800 W/m² at this latitude in Italy.

(a) Describe the main characteristics of the type of water heater you would advise to be installed to provide heating for the swimming pool. Give the reasons for your choice. [3 Marks]

(b) If the budget available allows for a 10m² of PV panel to be installed, estimate the peak power output. [7 Marks]

(c) With the aid of a schematic diagram, identify the components of the system, detail the necessary electric signal conditioning in order to have 230 V, 50HZ power output at the point of appliance. [10 Marks]

(d) Give advice on materials and options that can be made use of for the building to make the most of passive solar gains. [5 Marks]
Question 5

(a) Explain GHG effect on global warming. [15 Marks]

(b) The European Union encourages member states to increase their production and use of Renewable Energy. What are the reasons for this policy? [10 Marks]
DATA SHEET (1 of 1)

Wind

\[ P(W) = \frac{1}{2} \rho AU^3 \]

\[ C_p = \frac{P}{\frac{1}{2} \rho AU^3} \]

Annual Electricity Production = \( KAU_m^3 T \) [kWh/year]

P: Output Power (W)
Cp: Power Coefficient
U: Wind speed (m/s)
\( U_m \): Annual Mean wind Velocity (m/s)
K: 2.5 (Typical Turbine Factor)
T: Number of Turbines
A: Swept area of turbine (m\(^2\))
\( \rho_{atm} \) = 1.23 (kg/m\(^3\))