The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX6536 /MEX6236 New and Renewable Sources of Energy**
Academic Year	:	2019/20
Date	:	26.07.2020
Time	:	1330-1630 hrs
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 07 questions and 06pages.
3. **Answer any 05 questions only.** All questions carry equal marks.
4. Answer for each question should commence from a new page
5. Relevant charts/ equations are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Q1 1. Distinguish renewable energy from non renewable energy.

2. What are the renewable energy sources available in Sri Lanka which contribute most to generate electricity?

3. Name renewable energy sources which has not yet given much attention in Sri Lanka which can be used to generate electricity.

4. Give reasons why should we pay more attention to renewable energy.

5. Biomass can be used as a fuel to replace fossil fuel. What is the main disadvantage of biomass as a fuel compared to fossil fuel?

6. What are the obstacles that you have to come across to make use of biomass to replace fossil fuel?

Q2. 1. What are the main features of Geothermal Energy?

2. What are the main disadvantages of geothermal energy?

3. What are the direct uses of Geothermal Energy?

4. What are the objectives of Geothermal exploration?

5. Describe the following geothermal cycles in brief

(i) Indirect condensing cycle

(ii) Direct Non Condensing cycle

(iii) Straight condensing cycle

6. What are the advantages of binary cycle in geothermal plants?

7. What are the application of Geothermal energy as a source of heat?

Q3. 1. Why Dendro power is not yet popular in Sri lanka?

2. What are the main features of a Dendro Power plant?

3. What are the main conversion processes that you can apply in a Dendro Power plant?

4. A Dendro Power plant is operating with 50% efficiency to produce electricity to supply 2 MW uninterrupted power to the main grid. First the moist wood is converted to Syn gas by using a Gasifier. A dryer is used before fuel wood is fed in to the gasifier to reduce the moisture in wood. Find the;

(a) water content of the moist wood entering the dryer.

(b) water content of the moist wood entering the gasifier.

(c) Lower Heating Value (LHV) of the moist wood entering the gasifier.

(d) amount of wood required per day to run the power plant.

(e) Gas flow rate comes out from Gasifier.

Following data and empirical formulas are provided:
Wood consist with 47% wt Carbon, 7% wt Hydrogen, 46% wt Oxygen
Moisture content of the wood before dryer 29%
Moisture content of the wood after the dryer 12%
Gasifier efficiency 95%, LHV $_{Gas}$ =4.6MJ/m^3
Gasifier efficiency is given by the equation below.

$$\eta CG = \frac{LHV_{gas} \times \dot{V}_{gas}}{LHV_{moist} \times \dot{m}_{fuel}} \times 100\%$$

$LHV_{dry} = 0.35\ X_C + 0.939\ X_H - 0.108\ X_O$ MJ/kg

$LHV_{moist} = LHV_{dry}(1-w) - h_{fg}\ w$

enthalpy of evaporation of water h_{fg} = 2256kJ/kg

w = water content

X_C, X_H and X_O are the wt % of Carbon, Hydrogen and Oxygen respectively.

Q4. 1. What are the conditions to be satisfied to install a wind turbine in a location?

2. Name the main factors affecting the wind power of a wind turbine.

3. Why Horizontal Axis Wind turbine are mostly preferred than Vertical Axis Wind turbine?

4. "Vertical Axis Turbine efficiency can be increased if it is installed in high elevation" Do you agree with this statement? If so give reasons.

5. IBIS power in Netherlands invented a new wind turbine. What are the main features of this wind turbine? What are the advantages of this wind turbine compared to other types of wind turbines?

6. People in a village in a small Island want to have a small wind farm to electrify the village. It has decided to install five (05) 1 MW small wind turbines of having 50 m blade length at 50 m height running with 50% efficiency.

   a) Calculate the wind speed at this height.

   b) If they want to install one (01) mega turbine at hub height of 150 m what would be the minimum wind speed to generate the same power output?

   c) What is the minimum blade length required for this new Mega Turbine? Assume this mega turbine work at its full efficiency.

Wind Power (P) = 1/2 ρ A $V^3\eta$ where ρ is the density of the air (1.225 kg/m^3) , A is the swept area of the wind, and V is the wind speed. η is the efficiency of the wind turbine.

The wind velocity variation with hub height is given as below;

$$v_2 / v_1 = [h_2 / h_1]^p$$

Where v_1 – velocity of wind in (m/s) at hub height of h_1 in (m)

v_2– velocity of wind in (m/s) at hub height of h_2 in (m)

p – wind shear exponent and for urban areas p can be taken as p= 0.15

Q5. Write short notes on the following.

(i) Gasification
(ii) Pump storage hydropower systems
(iii) Types of wind farms
(iv) Anaerobic Digestion
(v) Ocean Wave Energy generation concepts

Q6. a) Describe in brief

(i) Tilt angle
(ii) Collector Azimuth angle
(iii) Solar incident angle.

b) On September 21st 2020 at 40 ^{0} N latitude (φ), a surface tilted at 60 ^{0} facing south,

Determine

(i) The direct normal extra-terrestrial irradiance (I_0)
(ii) Solar declination angle (δ)
(iii) Tilt angle (β)
(iv) Latitude (φ)
(v) Collector Azimuth angle (τ_c)
(vi) Sun Rise /Set angle (w_{ss})
(vii) The total of the extra-terrestrial irradiance on a tilted surface (H_0t)

Following empirical formulas are given with their usual notations.

$I_0 = I_{SC}\ [\ 1 + 0.034 \cos (\ 360N/365)]$ where $I_{SC}=1353 w/m^2$,

$\delta = 23.45 \sin [360\ (284+N)/365]$ where N is the day number from January 01

$w_{SS} = \cos^{-1} [- \tan\delta \tan(\varphi-\beta)]$

$H_{0t} = 24/\pi\ I_0 [\cos\delta \sin w_{SS} (\cos \varphi \cos\beta + \text{Sin}\ \varphi\ \text{Sin}\beta \cos\tau_c) + \pi/180\ w_{SS} \sin\delta (\sin \varphi \cos\beta - \cos \varphi \sin \beta\ \cos\tau_c]$

Q7. a) What are the major types of Hydropower plants?
b) Give examples for each types of Hydro power (HP) plants from Sri Lanka.
c) What are the main types of turbines used in power plants?
d) Give examples for each type of turbines.
e) Describe how do you select the right type of the turbine for your HP system?
f) What are the main disadvantages of HP systems?

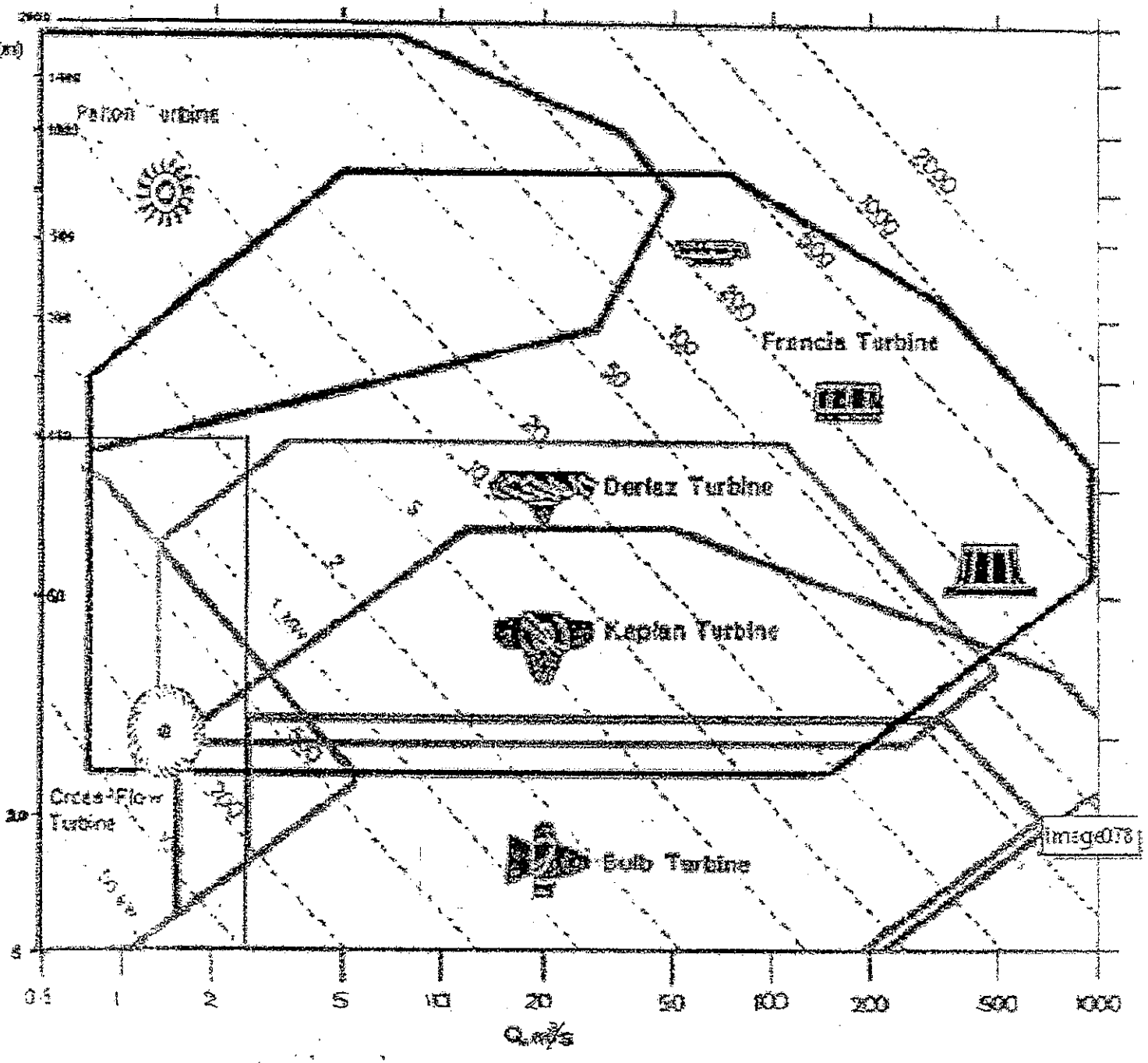
g) Upper Kothmale hydro power system provide 150 MW power to the main grid. Dam height is 35 m, length of the dam is 180 m and width of the dam is 7 m.

i) What is the type of this Dam?

ii) What type of a hydropower plant is this?

iii) Find the flow rate entering the turbine? If the turbine efficiency is 90%. Assume density of water as 1000 kg/m^3 and $g=9.8ms^{-2}$

h) Select the best suitable turbine for this hydropower plant after considering the height of the dam, power output and the water discharge rate.


H(m)
Pelton Turbine
Francis Turbine
Deriaz Turbine
Kaplan Turbine
Cross-Flow Turbine
Bulb Turbine
image078
0.5
1
2
5
10
20
50
100
200
500
1000
Q m³/s

H (3)