Roll No: ----------

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2017

Program Name:	**M.Tech. Energy Systems**	**Semester**	**: II**
Subject (Course):	**Renewable Energy Technologies - 1**	**Max. Marks**	**: 100**
Course Code :	**MNEG 741**	**Duration**	**: 3 Hrs**
No. of page/s:	**3**		

Section A

All questions are mandatory: (Each question: 4 marks)

1) Explain, with the help of a schematic, how power is generated by the '*Wave Dragon*' which is an Overtopping Wave Power device.

2) Identify four negative environmental impacts of Large Hydropower projects based on a dam with reservoir (e.g. Tehri hydropower project).

3) Explain the following terms:
   a) Hour Angle
   b) Declination
   c) Solar Constant
   d) Beam Radiation

4) Identify the Type of Turbine (Impulse turbine OR Reaction turbine) for the following hydropower runners:
   a) Gharat (traditional water mill)
   b) Kaplan turbine
   c) Pelton wheel
   d) Francis turbine

5) Explain why a Up-draft Gasifier is rarely used for power generation, whereas the Down-draft Gasifier is the preferred option.

Section B

All questions are mandatory: (Each question: 8 marks)

6) a) Explain the operation of a "Binary Cycle Power Plant" used to generate electricity from geothermal energy. (draw a schematic).
   b) Explain briefly the operation of a Single Basin Tidal Power Plant.

7) Explain the difference between the following pairs:
   a) Solar Altitude Angle and Zenith Angle.
   b) Cut-in wind speed and Rated wind speed for wind turbines.

8) a) Explain the working of a Solid Oxide Fuel Cell (with the help of a schematic).
   b) Write the chemical equations of the reactions that occur at the Anode and Cathode of the Solid Oxide Fuel Cell.

9) a) Discuss the movement of the gas holder in a Floating Drum biogas plant. Why does the gas holder move up and down? (Draw a schematic).
   b) Explain the technology that uses the Temperature Gradient in the ocean to generate electricity. Give one useful co-product of this technology.

10) a) Explain the following terms with the help of a typical power curve of a wind turbine: i) Cut-in wind speed, ii) Rated wind speed, and iii) Cut-out wind speed.
   b) Explain briefly how the thermal energy from concentrating solar collectors can be used for power generation. Identify the two main types of concentrating solar collectors used for thermal applications.

Section C

Answer both questions: (Each question: 20 marks)

11) Analyze and compare power generation from Wind with power generation from Hydro based on the following:

   a) Any physical characteristics of the two fluids (wind and water) that affect power generation.
   b) The two main types of turbines used to harness windpower and hydropower.
   c) Reliability and the Intermittent nature of the two energy resources.
   d) The equations for calculating power generation from windpower and hydropower.
   e) Suitability for meeting Base Load or Peak Load requirements.
   f) Lifetime of the equipment.

12) Analyze the effect of varying the tilt angle of a flat-plate solar collector by calculating the angle of incidence at 12:00 noon solar time on June 21 (summer solstice) and December 22 (winter solstice). The collector surface is located at Dehradun (30^{o} N, 78^{o} E) and is oriented towards the south.

a) Calculate the angle of incidence for the following two tilt angles and present your results in a table:
- Tilt Angle = Latitude
- Tilt Angle = Latitude + 15^{o}

b) What Tilt Angle would you recommend if the user wants to use hot water from the solar collector only in winter? (based on your calculation in the previous section).

$$\cos\theta = \sin\delta \sin\varphi \cos\beta - \sin\delta \cos\varphi \sin\beta \cos\gamma + \cos\delta \cos\varphi \cos\beta \cos\omega + \cos\delta \sin\varphi \sin\beta \cos\gamma \cos\omega + \cos\delta \sin\beta \sin\gamma \sin\omega$$

(OR)

12) a) Calculate the Day Length for a horizontal surface at Dehradun (30^{o} N, 78^{o} E) on September 23 (Equinox).

b) Find the days of the year when the sun is directly overhead at Dehradun.

c) Explain your results in Section (b) based on the Declination of the sun.

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Section A

All questions are mandatory: (Each question: 4 marks)

1) Explain how the Oscillating Water Column device generates power from the energy of waves in the sea.

2) Explain the difference between a Down-draft Gasifier and an Up-draft Gasifier.

3) Explain the following terms:
   a) Diffuse Radiation
   b) Latitude
   c) Extra-terrestrial Radiation
   d) Equinox

4) Identify two positive benefits and two negative environmental impacts of Solar Photovoltaic Power Plants.

5) Explain the difference between Impulse turbines and Reaction turbines used to harness hydropower.

Section B

All questions are mandatory: (Each question: 8 marks)

6) Explain the meaning of the following terms:
   a) Tracking of a solar collector.
   b) Pitch regulation for speed control of wind turbines.

7) a) Explain the working of a Phosphoric Acid Fuel Cell (with the help of a schematic)
b) Write the chemical equations of the reactions that occur at the Anode and Cathode.

8) a) Discuss the change in pressure of Biogas in a Fixed Dome biogas plant. Why does the pressure increase and decrease? (Draw a schematic).
b) Identify the two main techniques used to generate electricity using the Salinity Gradient in the ocean.

9) a) Explain the operation of a "Single Flash Steam Power Plant" used to generate electricity from geothermal energy. (draw a schematic).
b) What is the cause of tides in the seas and oceans? Explain how the positions of the sun and moon relative to the earth produce "Neap tide" and "Spring tide".

10) a) A Pitch-regulated wind turbine has Cut-in Wind Speed = 4 m/s, Rated Wind Speed = 12 m/s and Cut-out Wind Speed = 25 m/s. Draw the power curve of this wind turbine indicating these three parameters.
b) Identify any four applications of Solar Thermal energy that operate at temperatures below 100 degree C.

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Section C

Answer both questions: (Each question: 20 marks)

11) a) Discuss the difference between a "Lift" device and a "Drag" device used to harness wind energy. Give one example of a wind turbine that is a Lift device and one wind turbine that is a Drag device.
b) Compare the two types of hydro turbines with the Lift and Drag devices used in wind energy. Give one example of each type of hydro turbine.
c) Analyze why hydro turbines are much smaller than wind turbines for the same rated power output.
d) Compare "Run-of-the-River" hydropower plants with "Dam-based" hydropower by giving two advantages and two negative impacts of both types.
e) Discuss the advantages of hydropower over wind power for "Stand-alone" (Off-grid) power generation.
f) Explain why the power from the wind is proportional to the cube of the wind speed.

12) Calculate the angle of incidence of beam radiation on a flat-plate solar collector located at Dehradun (30^{o} N, 78^{o} E) at 12:00 noon solar time. The surface is tilted at an angle equal to the Latitude and is pointed towards the south.

a) Calculate the angle of incidence for the following days in the year:

- Equinox (March 20 and September 22).
- Summer Solstice (June 21)
- Winter Solstice (December 22)

b) On which of these four days in the year does the solar collector receive maximum solar radiation?

$$\cos\theta = \sin\delta \sin\varphi \cos\beta - \sin\delta \cos\varphi \sin\beta \cos\gamma + \cos\delta \cos\varphi \cos\beta \cos\omega + \cos\delta \sin\varphi \sin\beta \cos\gamma \cos\omega + \cos\delta \sin\beta \sin\gamma \sin\omega$$

(OR)

12) Analyse the variation in Day Length over the four seasons in the year for a horizontal surface at Dehradun (30^{o} N, 78^{o} E).

a) Calculate the Day Length for the following days in the year representing the four seasons:

- Spring : March 20
- Summer : June 21
- Autumn : September 22
- Winter : December 22

b) At what time does the sun rise in summer (June 21) and in winter (December 22)?

c) Explain why the days are longer in summer than in winter.