

Faculty of Engineering

Post Graduate Course, Master

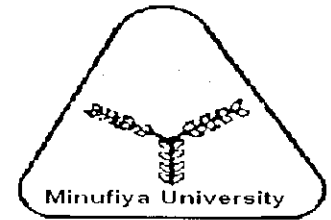
Electrical Engineering Dept.

Course: Power Generation from Renewable Sources

Code Symbol: ELE 612, 600-LEVEL

Date of exam.:25/8/2020

Examination Hours: 3 hours



Answer the following questions:

1-1) Draw the wind power probability density function?

1-2) 9\*(600-kW generator, 48-m rotor) wind turbines are mounted on a 50-m tower in an area with 7 m/s average windspeed at 10-m height. Assuming air density =  $1.22 \text{ kg/m}^3$ , the friction coefficient  $\alpha$  for ground is estimated to be 0.15, and an overall efficiency of 25 %. Estimate the annual energy (kWh/y) delivered, suppose that a wind farm has 4-rotor-diameter tower spacing along its rows, with 6-diameter spacing between rows ( $4D \times 6D$ ). Assume an array efficiency of 80%. Find the annual energy production per unit of land area.

2-1) Draw the speed-power characteristics.

2-2) A wind farm project has  $10 * 1500$ -kW turbines with 64-m blades. Capital costs are \$60 million and the O&M cost is \$1.9 million/yr. The project will be financed with a \$22.5 million, 20-yr loan at 10% plus an equity investment of \$7.5 million that needs a 15% return, turbines wind speed are 8.5 m/s. Suppose that the owner of the wind turbines leases the land from a rancher for \$20 per m per year. What is the cost per kWh generated from this farm?

3-1) Writeabout: Gibb's free energy, basic operation of fuel cell ,types of fuel cell.

3-2) Find the equation of power generated from wind turbine?

3-3) Writeabout: economical and technical model of wind.

4) Design a wind-farm to fed 3Mw load in Egyptian area. The wind speed is shown in table 1, use wind turbine in table2, take the following assumptions, the capital cost is \$ 750/ $\text{m}^2$  of area, the operation cost is 3.0 c/kWh of the annual generation, the lifetime and interest rate are 20 years and %10 and  $\alpha=1/7$ .

Table 1

| Month      | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Wind speed | 7.4 | 7.6 | 7.7 | 7.3 | 7.4 | 7.7 | 6.7 | 6.5 | 7.4 | 6.2 | 6.4 | 7.5 |

Table 2

| Rated power | Cut-in wind speed | Rated wind speed | Cut-out wind speed | Rotor Diameter | Hub height |
|-------------|-------------------|------------------|--------------------|----------------|------------|
| 1500KW      | 3.0 m/s           | 11.8 m/s         | 20.0 m/s           | 77.0 m         | 57 m       |