Tampereen yliopisto
Tampere University

Exam

EE.REE.320 Wind Power Systems

One sub-question per question is asked in the exam.

The sub-question is selected randomly.

Question 1: Wind turbines

1. **Explain and analyse the reasons for the growth of wind power in Finland and globally.**

2. **Describe the wind farm. What components are included and what are the roles and purposes of those components. Remember to give a good overview, but also explain the most important details. Provide also a short comparison of onshore and offshore wind farms from electricity grid perspective.**

3. **Describe the methods how wind turbines are extracting and maximizing the power from wind. Consider also the differences between different wind turbine schemes.**

4. **Describe the three main wind turbine schemes (fixed-speed, double-fed induction generator and full rated converter) on overall level. Compare the schemes also from component and performance viewpoints.**

Question 2: Generators

1. **Describe the general structure of model of one wind turbine scheme. Explain also the purpose of each component in the general model. You may select the wind turbine scheme (fixed-speed, double-fed induction generator and full-rated converter) based on your own favor.**

2. **Describe the electrical characteristics of fixed-speed induction generation wind turbine scheme. Give the answer based on information related to grid connected induction generator. Consider both the steady-state and dynamic characteristics of fixed-speed wind turbine. Name also which of these characteristics are the most important from grid integration perspective.**

3. **Describe the electrical characteristics of full rated converter wind turbine scheme. Give the answer based on information related to grid connected induction generator. Consider both the steady-state and dynamic characteristics of fixed-speed wind turbine. Name also which of these characteristics are the most important from grid integration perspective.**

4. **Explain the role of power electronic converters/technologies in wind turbine schemes. Explain also what power electronic technologies are typically utilized in wind farms.**

Question 3: Steady-state grid impacts

1. **Describe and explain the most important and influential grid code requirements for the wind turbines. Explain why those requirements are important from grid perspective. In similar way explain why those are influential from wind turbine perspective.**

2. **Large wind farm needs to participate in grid voltage control. At the same time the wind farm should maintain as good reactive power balance as possible. Describe and explain different possibilities how the wind farm may realize the voltage control and reactive power management, describe, and explain also the challenges related to those in case of a wind farm.**

3. **Explain what kind of power flow variations will happen due to large-scale wind power connected to high voltage and extra high voltage distribution and transmission grids. Explain local, regional and system level impacts and provide explanation for the differences between them.**

4. **Large-scale expansion of wind power will require the extension of grid capacity as well. Consider what challenges and solutions grid companies have to answer this task cost effectively from the whole electricity system viewpoint in the long run. Consider all levels of grid expansion: wind farm connection, regional grid, national transmission grid and import/export capacity to neighbouring countries and market areas.**

5. **Describe what is the overplanting of a wind farm and how it may be realized. Explain also why it may be beneficial for the owner of the wind farm.**

Question 4: Dynamic grid impacts

1. **Large-scale wind power may endanger power system security if not properly taken into consideration. Explain first what the power system is and how the large-scale wind power may endanger it. Explain also in detail how those mechanisms/solutions help power system and what impacts they have for wind turbine design and operation.**

2. **Describe what is the fault-ride-through capability and how it is related to power system security. Explain also how a wind turbine may fulfil this requirement.**

3. **Wind farm may participate in frequency control. Describe different methods how wind farm may participate in frequency control from technical perspective and how those methods may be implemented in wind farms.**

4. **Wind farm may provide ancillary services for distribution and transmission grids. Describe and explain what ancillary services wind farms may provide and how they may realize those. Consider both the technical and market aspects of ancillary service provision.**

5. **How the frequency stability of low-inertia power system may be enhanced? Explain alternative solutions and what kind of role they may have in future 100 % renewable based power system.**

Question 5: Market impacts

1. **Forecasting of wind power has important role in the market operating of producer. Explain shortly the main idea of large-scale wind power forecasting. What consequences forecasting error has for the producer? What factors influence wind power forecasting error? How the error might be reduced?**

2. **Explain why and how the smoothing of wind power variation is realized. Explain also what kind of benefits smoothing has for power system operation.**

3. **What kind of impacts large-scale wind power has for the prices of day-ahead and regulation power markets. Provide explanations.**

4. **Explain why the volatility of electricity market price (e.g., day-ahead market system price) will increase due to large-scale wind power production.**

5. **Describe what kind of impacts large-scale wind power has for control and disturbance reserves. Explain why these happen.**