ELG4125 (Fall2017)

Transmission, Distribution, and Utilization Systems

Case Study of Two Midterms

Power System Planning and Design of

Power Plant, Transmission and Distribution Systems, Substations, Protection and Monitoring Systems, and Wind Farm

Based on Optimization of

Electrical, Mechanical, Environmental, and Economic Factors

Final Exam ePortfolio

Submit an ePortfolio (digital Poster) on the day of the final exam.

Case/Feasibility Study (Total 50 marks)

- This is an open-ended individual case/feasibility task. The given outline is approximate as is the case of any engineering project. The guiding facts when preparing your solutions are common sense, technical facts, and governing standards.
- Typically, the power system is a combination of multiple generators, substations, and transmission lines.
- For this case, consider an electric power system that begins with a power plant delivering a transmission line with a voltage, V_s = 500 kV and current, I_s of 1000 A at 60 Hz. The transmission line feeds a city that is 200 km away from the power plant.

Midterm 1 (10%)

- Design the above system to meet current and future system requirements of load growth, taking into consideration the following:
  - Draw the details of the entire power system.
  - **Power Plant:** Include general specifications of generators and drivers including number of drive trains.
  - **Transmission Line Characteristics:** Estimate the performance of the system in terms of efficiency and voltage regulation. Set up specifications for the transmission line in terms of conductors (resistance; inductance; capacitance); insulators; towers; line loadability, etc. Include appropriate figures for towers and insulators. Identify the three-phase line as single circuit or double circuit. You may use tables A.3 and A.4 from the textbook or other sources for the above reason.
  - **Generation, Transmission, and Distribution Substations:** Include site selection, transformer power ratings, turns ratio, grounding; configurations, efficiency; components of each substation with specifications. Include figures where appropriate.
  - **HVDC:** Conceptually, replace the AC transmission line with a DC line showing all the HVDC technologies in a separate figure. You may read the case study of Chapter 5, page 234 of the textbook.

Transmission Line Design Considerations

- Select a suitable conductor for the overhead transmission line: ACSR; AAAC; ACAR, or others. See Section 4.1 of the textbook.
- Select a suitable tower: number of circuits; number of conductors per phase; type and details of insulators; tower/line protection specifications; and characteristics of shield wires. See Table 4.1!
- Estimate the current that flows in each conductor. Based on this current, the size of the conductor can be estimated. Then use tables to find the parameters such as R, L, and C, then to find Z and Y.
- Build your transmission line model to find ABCD constants.
- Find V_s, I_s, V_r, I_r of each section of the transmission line.
- Find the efficiency and voltage regulation.

- **Based on the transmission system given in Midterm 1, provide all protection, control, and monitoring features taking into consideration the following facts:**
  - Provide appropriate protection zoning (see section 10.8).
  - Provide techniques to protect the system against faults and lightning effects.
  - Provide type and rating of protection equipment for power plant, substations, buses, and transmission lines (use Table 10.2; Sections 10.9-10.12).
  - Provide circuit diagrams of the proposed relays (for example, impedance and differential).
  - Read the case study given in Chapter 10 (pp. 518-524) in regard to communication technologies and provide the key features and trends (types; modulation techniques; drawbacks) of broadband over power line (BPL).
  - Propose and describe shunt connected FACTS devices STATCOM and SVC .
  - Demonstrate with details the principle characteristics of STATCOM using computer simulations such as Matlab/Simulink or PSCAD.
  - Propose and describe a suitable SCADA system for the project.
- **Relate the technical specifications of all the proposed features to the appropriate standards.**

Midterm 2 (10%)

- Continue designing the distribution and utilization system to provide electricity to the city. Take into consideration the following:
  - Specifications of the distribution substation including number and type of transformers; configurations; neutral grounding, etc.
  - The proposed topologies of distribution system for various types of loads: high- and low-density areas.
  - Protection system for transformers, feeders and laterals with technical specifications.
  - Capacitor banks: Read Example 14.3.
  - Specifications of utilization transformers.
  - Your design ends up with three typical loads: residential, commercial, and industrial. Show the sizing of required transformers.
  - Your project task will represents one type of the above loads.
  - **Relate the technical specifications of all the proposed features to the appropriate standards.**
  - **Consider the following Examples to solve:**

ePortfolio (30 marks)

- Remember, in this submission you should try to be creative to develop new knowledge material. Selected submission will be exhibited at g9toengineering.com.
- The **ePortfolio** is about developing a digital poster that exhibit the entire case under consideration.
- The heart of the poster should be a schematic diagram of the entire power system under consideration in the case given including all necessary calculated data.
- A summary of calculation details and important facts should be included.
- The submission should be artistic to certain extent.
- The submission is individual and should be send by email to the instructor on the day of the final exam. Title of submission should be: ELG4125Portfolio(your name).