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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

I SEMESTER M.TECH (ENERGY SYSTEMS & MANAGEMENT)

END SEMESTER EXAMINATIONS NOVEMBER 2018

SUBJECT: POWER SYSTEM OPERATION AND CONTROL [ELE 5102]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 24 November 2018** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. What is the significance of Park's transformation? Derive the expression for mechanical equation of an alternator using Park's variables. ***(05)***

1B. Derive the block diagram representation of a single area system including power system response. ***(05)***

2A. How are FACTs controllers classified? What are the benefits with the application of FACTs controllers? ***(03)***

2B. Explain the role of PSS to improve dynamic stability. ***(02)***

2C. A 30 MVA, 13.8kV, 3-phase generator has a subtransient reactance of 15% and negative and zero sequence reactances of 15% and 5% respectively. The alternator supplies two motors over a transmission line having transformers T_1 and T_2 at both ends. The motors have rated inputs of 20MVA and 10MVA both 12.5kV with 20% subtransient reactance and negative and zero sequence reactances are 20% and 5% respectively. The current limiting reactors of 2Ω each are in the neutral of the alternator and the larger motor and the neutral of other motor is ungrounded. The transformers are both rated 35MVA, 13.2/115kV (delta-star connection with star point grounded) with leakage reactance of 10% and series reactance of the line is 80Ω and zero sequence reactance of 200Ω. Determine the fault current for a line to ground fault on HV side of transformer T_1. Assume base of 30 MVA, 13.8kV in the generator circuit. ***(05)***

3A. A transformer is rated at 500kVA, 11/0.4kV, 5% reactance. Determine the short circuit MVA of the transformer when connected to an infinite bus. ***(02)***

3B. Derive the expression for the current profile of a 300km symmetrical line on no load. ***(04)***

3C. The fuel cost functions for three thermal plants in Rs/hr are given by

$C_1=35000+371P_1+0.28P_1^2$

$C_2=28000+385P_2+0.42P_2^2$

$C_3=14000+406P_3+0.63P_3^2$

Where P_1, P_2 and P_3 are in MW and the total load demand is 800 MW. Neglecting line losses and generator limits, find the optimal dispatch of the plants and the corresponding cost of generation. ***(04)***

4A. A 50 Hz synchronous generator is connected through a transmission line to a power network represented by a voltage source of 1.0 pu and the maximum power that can be transmitted is 1.735pu. A three phase occurs reducing the maximum power to 0.42pu and after clearance of the fault the maximum power transferred is 1.25pu. The generator is transmitting an active power of 1.0 pu. Draw the power angle characteristics and with the aid of equal area criterion, determine the critical clearing angle. Derive the formulae used. ***(06)***

4B. Draw the circuit diagram for a typical excitation system, derive the transfer function model and draw the block diagram. ***(04)***

5A. Derive the expression for voltage and current for midpoint series compensated transmission line. ***(04)***

5B. Derive an expression for the fault current when a double line to ground fault occurs at the terminals of an unloaded generator. Draw the sequence network connection diagram representing the fault. ***(04)***

5C. Find the open loop gain K of the static AVR, for the static error to be less than 4% of reference input. Why feedback stability compensation is used to the AVR loop? ***(02)***