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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

I SEMESTER M.TECH (ESM) END SEMESTER EXAMINATIONS NOVEMBER 2017

SUBJECT: POWER SYSTEM OPERATION AND CONTROL [ELE 5102]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 21st November 2017** **Max. Marks: 50**

Instructions to Candidates:

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

1A. Derive the block diagram representation of a single area system including power system response. ***(04)***

1B. The one line diagram of a power system is shown in Fig. 1B. The ratings are given as

G : 30MVA, 11 kV, X" = 20%

T1 : Three single phase unit each rated 10 MVA, 220 kV /6.6 kV, X =10%

T2 : 30 MVA, 6.6 kV /220 kV, X = 10%

Find the terminal voltage of the generator if the Motor is drawing 10 MW at 0.9 p.f lagging. The terminal voltage of bus 3 is maintained at 6 kV. Choose a base of 30 MVA, 220 kV on the transmission line.

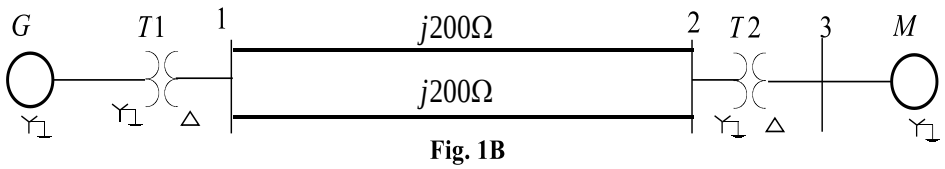

Fig. 1B

(06)

2A. The regulation parameter R of 100MW, 50Hz generator is 3.5%. By how much will the turbine power increase if the frequency drops by 0.12Hz with the speed changer setting unchanged. ***(02)***

2B. Find an expression for the fault current when a single line to ground fault occurs at the terminals of an unloaded generator. Draw the sequence network connection diagram representing the fault. ***(03)***

2C. Derive the expression for voltage equation of an alternator using Park's variables and draw the equivalent circuit model. ***(05)***

3A. How are FACTs controllers classified? What are the benefits with the application of FACTs controllers? ***(02)***

3B. Explain the role of PSS to improve dynamic stability. ***(02)***

3C. If P_{max1}, P_{max2} and P_{max3} are the steady state power limits before, during and post fault conditions, derive an expression for critical clearing angle based on equal area criterion.

A 50 Hz generator is transferring 1.0 per unit power to a load through a short line. The maximum power that can be transmitted under normal condition is 1.8 p.u. A solid three phase fault occurs on the line reducing the maximum power transferable to 0.7 p.u. After the clearance of fault, the maximum power transferable becomes 1.27 p.u.

(i) Determine the critical clearing angle in which the circuit breakers must trip so that synchronism is not lost. Take inertia constant as 5MJ/MVA.

(ii) Also determine the stability of the system if the fault occurs at the system bus and if the fault is cleared at 0.19 sec ***(06)***

4A. Derive the expression for the voltage profile of a 400km symmetrical line on no load. ***(04)***

4B. The sequence components of the terminal voltage of a load in pu are V_{a1}=1+j0.2, V_{b2}=0.3+j0.1 and V_{a0}=0.2+j0.1. The sequence components of load currents are I_{b1}=0.166+j0.789, I_{a2}=0.2-j0.1 and I_{c0}=0.1-j0.01. Determine the 3-phase power in pu. ***(03)***

4C. Draw and explain the block diagram representation of excitation system of a generator with exciter load saturation curve. ***(03)***

5A. Explain different methods of voltage control used in the power system. ***(02)***

5B. A generator has E_a =1.0 pu and the magnitudes of the fault currents in per unit for L-G, LL, LL-G faults are 5.0, 3.464 and 5.454 respectively. Determine the fault current for LLL-G fault. ***(05)***

5C. Derive the expression for voltage and current for midpoint series compensated transmission line. ***(03)***