Indian Institute of Technology Patna
Department of Electrical Engineering
EE381 - Power Systems
Autumn - 2024
End Semester Exam
November 29 , 2024

There are 5 questions. They carry equal marks.

$(5 \times 10 = 50)$

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1. For a simple four bus system, the line admittances are given below:

Bus Code	Admittance
1-2	$2 - \jmath 8$
1-3	$1 - \jmath 4$
2-3	$0.666 - \jmath 2.664$
2-4	$1 - \jmath 4$
3-4	$2 - \jmath 8$

The schedule of active and reactive power is given below:

Bus	P	Q	V	Type
1	–	–	1.06	Slack
2	0.5	0.2	–	PQ
3	0.4	0.3	–	PQ
4	0.3	0.1	–	PQ

Assuming a flat voltage start, determine the voltage at the end of first iteration using Gauss-Seidal method. Take $\alpha = 1.6$. (α is acceleration factor.)

2. The fuel inputs per hour of plants 1 and 2 are as follows:

$$F_1 = 0.2P_1^2 + 40P_1 + 120 \text{ Rs/hr}$$
$$F_2 = 0.25P_2^2 + 30P_2 + 150 \text{ Rs/hr}$$

If the maximum and minimum loading on each unit is 100 MW and 25 MW, the demand is 180 MW and the transmission losses are nglected, determine

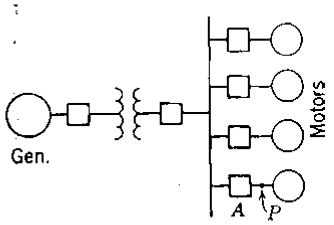
   (a) the economic operating schedule and the correponding cost of generation.

   (b) the savings obtained by loading the units as per equal incremental production cost, if the load is equally shared by both the units.

3. A 25 MVA, 13.8 kV generator with $X_d'' = 15\%$ is connected through a 25 MVA, 13.8/6.9 kV transformer with leakage reactance of 10% to a bus which supplies four identical motors as shown below. The sub-transient reactance of each motor is 20% on a base of 5 MVA and 6.9 kV. The bus voltage at the motors is 6.9 kV when a three phase fault occurs at point P. Find

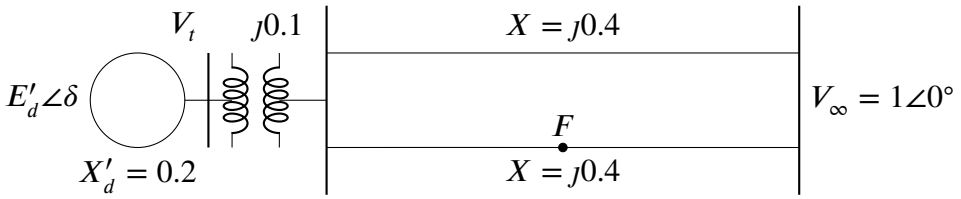
   (a) the sub-transient current in the fault in Ampere.

   (b) the sub-transient current in the breaker A in Ampere.



4. The positive, negative and zero sequence reactances of a 25 MVA, 13.2 kV alternator are 0.3 p.u, 0.2 p.u and 0.1 p.u, respectively. The generator is star connected and neutral is solidly grounded. When it is unloaded, find the fault current in Ampere and line-line voltages in kV when a fault of single line to ground fault occurs at the terminals.

5. A 50 Hz synchronous generator having inertia constant $H = 5$ sec and a direct axis reactance $X_d' = 0.2$ p.u. is connected to an infinite bus through a transformer and a double circuit line. The machine is delivering 1 per unit power with a terminal voltage $|V_t| = 1.0$ per unit.



   A three phase fault occurs at F. The fault is cleared by opening the faulted line. Determine the critical clearing angle.