COLLEGE OF ENGINEERING & TECHNOLOGY

Department : Electrical & Computer Control Engineering

Lecturer : Prof. Ahmed Anas Elwogoud

Course : Power System I **Marks: 40**

Course Code: EE 342 **Time : 2 hours**

Date : 30 / 5/ 2015 **Starting Time: 14:00**

Final Exam

Answer the following questions:

1.a. ***Explain*** the advantages of the use of per-unit system for power flow analysis.

(A.31) [2 marks]

1.b. The three phase power and line to line voltage ratings of the power system shown in fig.1 are given below.

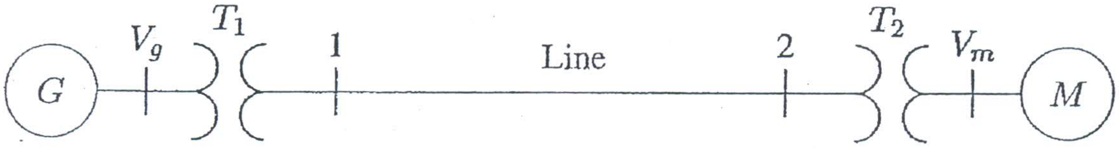

Figure 1

G:	60MVA	20kV	X=9%
T1:	50MVA	20/200kV	X=10%
T2:	50MVA	200/20kV	X=10%
M:	43.2MVA	18kV	X=8%
Line:		200kV	$Z=120+j\,200\ \Omega$

(i) Draw an impedance diagram showing all impedances in per-unit on a 100MVA base. Choose 20kV as the base voltage at the generator.

(ii) The motor is drawing 45MVA, 0.8 power factor lagging at a line to line terminal voltage of 18kV. Determine the terminal voltage and the internal emf of the generator in per-unit and in kV. *(A.31-B.2)* [6 marks]

2.a. ***Define*** the power flow problem; ***discuss*** the different bus types in power system. ***State*** the main steps used to solve power flow problem using Newton-Raphson method.

(A.31) [4 marks]

2.b. Figure 2 shows the one-line diagram of a simple three-bus power system with generation at buses 1 and 3. The voltage at bus 1 is $V_1 = 1.025\angle 0^\circ$ per unit. Voltage magnitude at bus 3 is fixed at 1.03 pu with a real power generation of 300MW. A load consisting of 400MW and 200Mvar is taken from bus 2. Line impedances are marked in per unit on a100MVA base. Line resistances and line susceptances are neglected.

Members of course Examination Committee:	Signature:	Date:
Lecturer: Prof. Ahmed Anas Elwogoud	Amel	20/5/2015
Course Coordinator : Prof. Amany Hanafy	Am	20/5/2015
Head of Department : Prof. Hamdy Ashour	Hamdy	20/5/2015

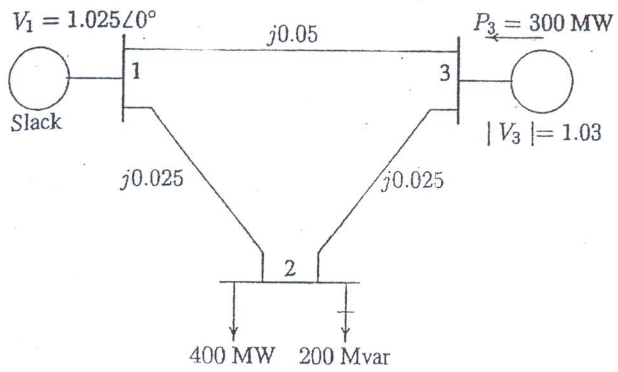

Figure 2

(i) Using Gauss-Seidel method and initial estimates of $V_2^{(0)} = 1.0+j0$ and $V_3^{(0)} = 1.03+j0$ and keeping $|V_3| = 1.03$, determine the phasor values of V_2 and V_3.

(ii) If after several iterations the bus voltages converge to;

$$V_2 = 1.0012\angle -2.1^o \text{ and } V_3 = 1.03\angle 1.36851°$$

determine the line flows, line losses and the slack bus real and reactive power.

(A.31-B.2) [8 marks]

3.a. ***Explain*** the synchronous generator power angle characteristics and its effect on the active and reactive power control. *(A.23)* [2 marks]

3.b. A synchronous machine is running over excited with E = 150%, the synchronous reactance has a value of 120%, and the machine delivers power of 0.4 pu, the terminal voltage is 1 pu. If the prime mover torque increased by 1%, with how many percentage P_G and Q_G must change. *(A.1-A.5-A.26-B.1)* [8 marks]

4.a. ***Define*** the optimal dispatch of power generation problem, ***state*** its objective function and the various constraints used for formulation of such optimization problem.

(A.31) [2 marks]

4.b. The fuel-cost functions in \$/h for three thermal plants are given by;

$$C_1 = 500 + 5.3P_1 + 0.004\,P_1^2$$
$$C_2 = 400 + 5.5P_2 + 0.006\,P_2^2$$
$$C_3 = 200 + 5.8P_3 + 0.009\,P_3^2$$

where P_1, P_2, and P_3 are in MW. Neglecting line losses and consider the following limits (in MW);

$$200 < P_1 < 450$$
$$150 < P_2 < 350$$
$$100 < P_3 < 225$$

Find the optimal dispatch for 975 MW total demand load.

(A.26-B.10-B.11) [8 marks]

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