國立臺灣科技大學102學年度碩士班招生試題

系所組別： 電機工程系碩士班甲組

科　　目： 電力系統

（總分為100分）

1. The one-line diagram of a three-phase power system is as shown in Fig. 1. The transformer reactance is 20 percent on a base of 100-MVA, 23/115-kV and the line impedance is Z = j66.125Ω. The load at bus 2 is S_2 = 277.2 MW +j9.9 Mar, and at bus 3 is S_3 = 0MW+j30 Mar. It is required to hold the voltage at bus 3 at $115\angle 0^\circ$ kV. Working in per unit, determine the voltage at buses 2 and 1. **(10%)**

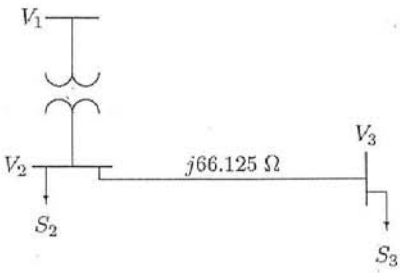

Fig. 1 Circuit for Problem 1.

2. A single-phase transmission line 35 km long consists of two solid round conductors, each having a diameter of 1.0 cm. The conductor spacing is 2.5 m. Calculate the equivalent diameter of a fictitious hollow, thin-walled conductor having the same equivalent inductance as the original line. What is the value of the inductance per conductor? **(10%)**

3. In the two-bus system shown in Fig. 2, bus 1 is a slack bus with $V_1 = 1\angle 0^\circ$ pu. A load of 100MW and 50 Mvar is taken from bus 2. The line impedance is z_{12} = 0.12 + j0.16 pu on a base of 100MVA. Using Newton-Raphson method, obtain the voltage magnitude and phase angle of bus 2. Start with an initial estimate of $|V_2|^{(0)} = 1.0$ pu and $\delta_2^{(0)} = 0^\circ$. Perform the first iteration. **(20%)**

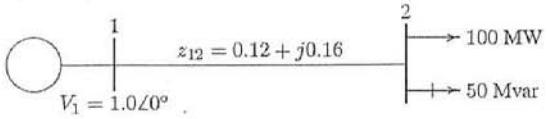

Fig. 2 Circuit for Problem 3.

4. A three-phase 420-kV, 60-Hz transmission line is 500 km long and may be assumed lossless. The line is energized with 420 kV at the sending end. When the load at the receiving end is removed, the voltage at the receiving end is 700 kV, and the per phase sending end current is $650\angle 90^\circ$ A. Find the phase constant β in radians per km and the surge impedance Z_c in Ω. **(10%)**

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5. A single-line diagram of the power system is shown in Fig. 3. The neutrals of the generator and delta-wye transformers are solidly grounded. The motor neutral is grounded through a reactance $X_n = 0.05$ per unit on the motor base.
   (a) Draw the per-unit zero-, positive-, and negative- sequence network on a 100 MVA, 13.8 kV base in the zone of the generator. **(10%)**
   (b) The prefault voltages for both buses 1 and 2 can be approximated to be $1.05\angle 0°$ per unit. At bus 1 Calculate the fault current (actual value) in each phase for a bolted double line-to-ground fault from phase b to c to ground at bus 2. **(10%)**

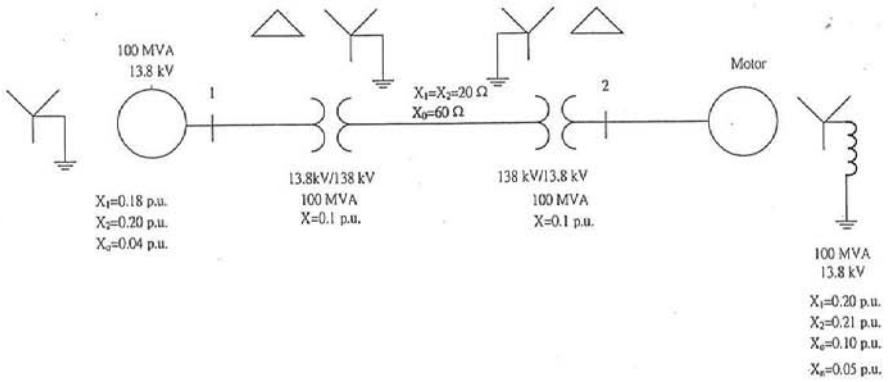

Fig.3 Power System for Problem 5

6. An area of an interconnected power system has three fossil-fuel units operating on economic dispatch. The variable operating costs of these units are given by

$$C_1 = 350 + 4.0P_1 + 0.007P_1^2 \ \$/hr$$
$$C_2 = 500 + 6.0P_2 + 0.006P_2^2 \ \$/hr$$
$$C_3 = 600 + 5.0P_3 + 0.005P_3^2 \ \$/hr$$

, where P_1, P_2 and P_3 are in megawatts.
Determine the power output of each unit, the incremental operating cost, and the total operating cost C_T as the total load demand $P_T = 1500$ MW. Generating unit inequality constraints and transmission losses are neglected. **(15%)**

7. A synchronous generator, capable of developing 500 MW of power, operates at a power angle of 6°. By approximately how much can the input shaft power be increased suddenly without loss of stability? What is the approximate critical angle? (valid to the first digit after the decimal point) **(15%)**