國立臺灣科技大學 109 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. For the three-bus system with two generators in Fig. 1, please perform one iteration of Newton's power flow method to determine voltages at bus 2 and 3. Assume that the bus 1 is the slack bus. The initial voltage at load buses are assumed to be $1.0\angle 0°$ per unit. Note that you can use fast decoupled power flow method to simplify the Jacobian matrix. **(20%)**

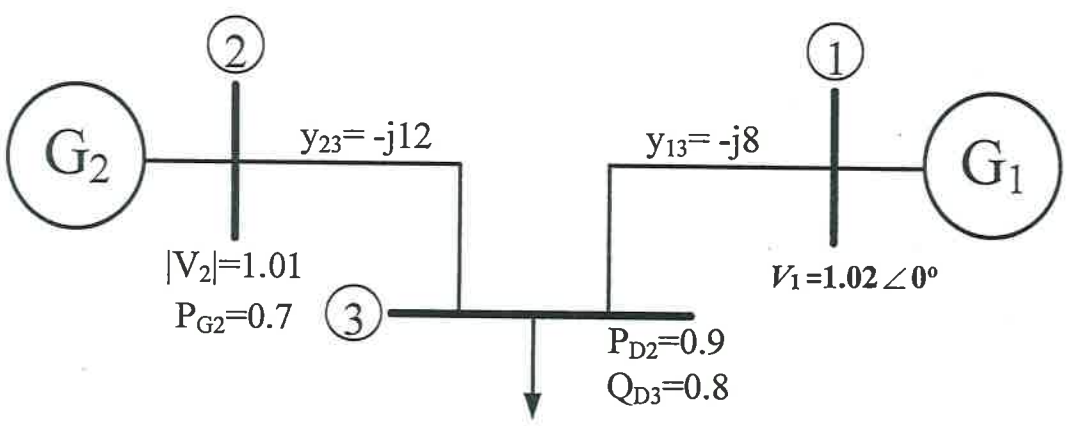

Fig. 1　Power system diagram for Q1

2. A single-phase two-conductor line is as shown in Fig. 2. Please find the inductances L_x and L_y, respectively. **(15%)**

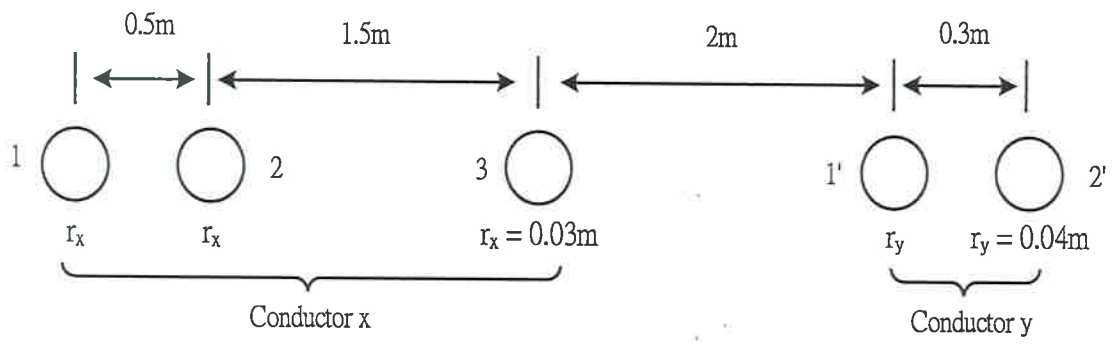

Fig. 2　The configuration of the single-phase two-conductor line for Q2

3. A three-phase, 60 Hz, 345 kV, 200 km has the following line constants:

$$z = 0.032 + j\,0.35\ \Omega/\text{km}$$

$$y = j\,4.2 \times 10^{-6}\ \text{S/km}.$$

Full load at the receiving end of the line is 700 MW at 0.99 power factor leading and at 95% of rated voltage. Please determine the voltage regulation of the line. **(15%)**

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4. The one-line diagram of a simple power system is shown in Fig. 3. The ratings and reactances of the generators and transformers are

   G_1 and G_2: 100 MVA, 20kV　　$X''_d = X_1 = X_2 = 12\%$, $X_0 = 6\%$, $X_n = 4\%$

   T_1 and T_2: 100 MVA, 20/220kV　　$X = 8\%$

   Both transformers are solidly grounded on one side in the figure. On a chosen base of 100MVA, 220kV in the transmission line circuit, the line reactances of L_{12} are $X_1 = X_2 = 13\%$ and $X_0 = 25\%$. The line reactances of L_{13} are $X_1 = X_2 = 13\%$ and $X_0 = 32\%$. The line reactances of L_{23} are $X_1 = X_2 = 20\%$ and $X_0 = 70\%$. The system is operating at nominal voltage without prefault currents.

   Determine the fault current for the following faults.

   (a) A single line-to-ground fault at bus 2 through a fault impedance $Z_f = j0.05$ per unit. **(10%)**

   (b) A line-to-line fault at bus 3 through a fault impedance $Z_f = j0.1$ per unit. **(15%)**

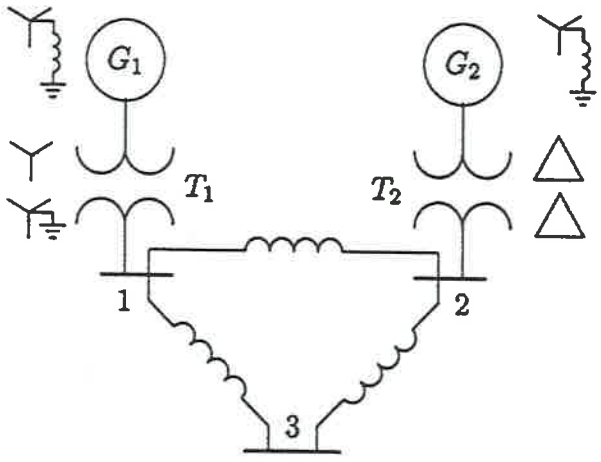

Fig. 3. The one-line diagram for Q4

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5. In a three-bus system, three generating units are connected at buses 1, 2 and 3 and have the fuel-cost in \$/h given in the following equations.

$$f_1(P_{g1}) = 0.004P_{g1}^2 + 7.5\,P_{g1} + 350 \quad (\$/h)$$

$$f_2(P_{g2}) = 0.008P_{g2}^2 + 7.3\,P_{g2} + 550 \quad (\$/h)$$

$$f_3(P_{g3}) = 0.007P_{g3}^2 + 6.4\,P_{g3} + 450 \quad (\$/h)$$

where P_{g1}, P_{g2} and P_{g3} are in MW. Plant outputs are subject to the following limits

$$10\text{ MW} \le P_{g1} \le 250\text{ MW}$$
$$20\text{ MW} \le P_{g2} \le 100\text{ MW}$$
$$30\text{ MW} \le P_{g3} \le 90\text{ MW}$$

(a) If the lossless transmission lines are considered in this problem, determine the optimal dispatch of generation when the total system load is 170 MW. **(10%)**

(b) For this problem, assume the real power loss is given by the simplified expression

$$P_L = 0.05P_{g1} + 0.04\,P_{g2} + 0.07P_{g3} \quad (\text{MW})$$

Determine the optimal dispatch of generation when the total system load is 200 MW. **(15%)**