國立台灣科技大學九十七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 100 分】

1. The annual load in MW of a substation is tabulated below. In the table, the average load and peak load during each month are provided. Determine the annual load factor. (10%)

Month	1	2	3	4	5	6	7	8	9	10	11	12
Average Load	100	80	70	80	100	120	150	140	100	85	75	100
Peak Load	125	110	75	90	105	140	165	155	120	95	80	115

2. Two loads connected in parallel are supplied from a 60-Hz, 11.4-kV three-phase source.
   Load 1: Inductive load, 60-kW and 660-kvar.
   Load 2: A balanced Δ-connected resistive load with a resistance of 650-Ω per phase.
   ❶Find the supply power factor. (5%)
   ❷Find the capacitance in μF per phase of a balanced Y-connected capacitor connected across the loads to improve the overall power factor to unity. (5%)

3. A three-phase, 60-Hz, Y-connected, 75-MVA, 27-kV synchronous generator connected to an infinite bus, has a synchronous reactance of 9.0-Ω per phase. Using rated MVA and voltage as base values,
   ❶determine the per-unit reactance. (5%)
   If the generator supplies rated power, 0.8 lagging power factor at rated terminal voltage,
   ❷determine the excitation voltage of generator. (5%)

4. A single-circuit three-phase, 60-Hz transposed transmission line is composed of one conductor per phase with a flat horizontal configuration. In other words, the distances between phases are D, D and 2D, respectively. The conductor radius is 2.568-cm. The conductor geometric mean radius is 2.0-cm. The line reactance is 0.486-Ω per kilometer.
   ❶Determine the phase spacing D in meter. (5%)
   ❷Determine the capacitance per phase per kilometer of the line. (5%)

5. A three-phase, 60-Hz, 420-kV, lossless transmission line is 463-km long. Assume that the receiving end is open-circuited. At the sending-end, the magnitude of supply voltage is 420-kV and the phase current is $646.6\angle 90°$-A. If the no-load voltage of receiving-end is $700\angle 0°$ kV, determine
   ❶the phase constant in rad/km. (5%)
   ❷the surge impedance in Ω. (5%)

6. The fuel-cost functions in $/h for two 800MW thermal plants are given by

$$C_1 = 400 + 6.0P_1 + 0.04P_1^2$$
$$C_2 = 500 + \beta P_1 + \gamma P_1^2$$

   where P_1 and P_2 are in MW.
   ❶ the incremental cost of power λ is $8/MWh when the total power demand is 500MW. Neglecting losses, determine the optimal generation of each plant. (5%)
   ❷ the incremental cost of power λ is $10/MWh when the total power demand is 1200MW. Neglecting losses, determine the optimal generation of each plant. (5%)
   ❸ from the results of ❶ and ❷ find the fuel-cost coefficients β and γ of the second plant. (5%)

7. A three phase unbalanced source with the following phase-to-neutral voltages

$$\left[V^{abc} \right] = \begin{bmatrix} 300\angle -120° \\ 200\angle 90° \\ 100\angle -30° \end{bmatrix}$$

is applied to the circuit in Figure P7. The load series impedance per phase is $Z_s=10+j40$ and the mutual impedance between phases is $Z_m=j5$. The source neutral is solidly grounded and the load neutral is grounded by $Z_n=j10$. Determine

❶ the load sequence impedance matrix, $[Z^{012}]$. (10%)

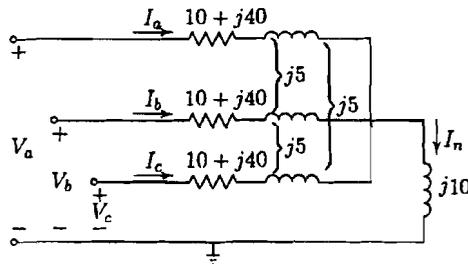❷ the symmetrical components of voltage, $[V^{012}]$. (10%)

Figure P7. Circuit for Problem 7.

8. The per unit bus impedance matrix for the power system shown in Figure P8 is given by

$$[Z_{bus}] = j \begin{bmatrix} 0.150 & 0.075 & 0.140 & 0.135 \\ 0.075 & 0.1875 & 0.090 & 0.0975 \\ 0.140 & 0.090 & 0.2533 & 0.210 \\ 0.135 & 0.0975 & 0.210 & 0.2475 \end{bmatrix}$$

A three-phase fault occurs at bus 4 through a fault impedance of $Z_f=j0.0025$ per unit.
During the fault, use the bus impedance matrix to calculate

❶ the fault current at bus 4. (5%)

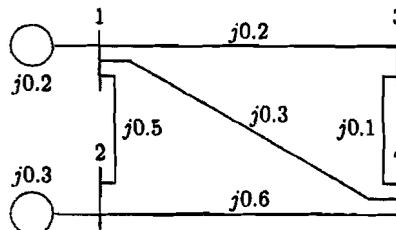❷ the bus voltages V_1, V_2, V_3 and V_4. (5%)

❸ the line currents I_{13} and I_{34}. (5%)

Figure P8. One-line diagram for Problem 8.