國立臺灣科技大學
八十八學年度碩士班招生考試試題

系所別：電機工程系碩士班 組別：甲組 科目：電力工程

1. A 25MVA three-phase 13.8kV Y-connected two-pole 60Hz synchronous generator was tested by the open-circuit test, and its air-gap voltage was extrapolated with the following results:

Open-circuit test

Field current, A	320	365	380	475	570
Line voltage, kV	13.0	13.8	14.1	15.2	16.0
Extrapolated air gap voltage, kV	15.4	17.5	18.3	22.8	27.4

The short-circuit test was then performed with the following results:

Short-circuit test

Field current, A	320	365	380	475	570
Armature current, A	1040	1190	1240	1550	1885

The armature resistance is 0.24 Ω per phase.

(a) Find the unsaturated synchronous reactance of this generator in ohms per phase and in per-unit. (5%)

(b) Find the approximate saturated synchronous reactance X_s at a field current of 380A. Express the answer both in per phase and in per-unit. (5%)

(c) Find the approximate saturated synchronous reactance X_s at a field current of 475A. Express the answer both in per phase and in per-unit. (5%)

(d) Find the short-circuit ratio for this generator. (5%)

2. A 460V 25HP six-pole 60Hz three-phase induction motor has a full-load slip of 4%, an efficiency 0f 89%, and a power factor 0f 0.86 lagging. At start-up, the motor develops 1.75 times the full-load torque but draws 7 times the rated current at the rated voltage. This motor is to be started with an autotransformer reduced voltage starter.

(a) What should the output voltage of the starter circuit be to reduce the starting torque until it equals the rated torque of the motor? (5%)

(b) What will the motor starting current and the current drawn from the supply be at this voltage? (5%)

3. Six conductors of ACSR Ostrich constitute a 60Hz double-circuit three-phase line arranged as shown in Figure 1. The vertical spacing is 15ft; the longer horizontal distance is 32ft; and the shorter horizontal distances are 25ft. The ACSR Ostrich with outside diameter r=0.68in and the GMR Ds=0.0229ft, Find

(a) The inductance per phase (in H/mile) and the inductive reactance (in ohm/mile). (10%)

(b) The capacitive reactance to neutral (in ohm-mile) and the charging current in A/mile per phase and per conductor at 138kV. (10%)

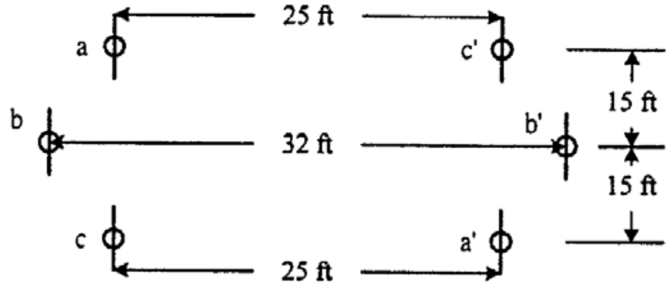

Figure 1 Conductor layout for Problem 3

國立臺灣科技大學
八十八學年度碩士班招生考試試題

系所別：電機工程系碩士班　　組別：甲組　　科目：電力工程

4. A transformer rated 200 MVA, 345Y/20.5Δ kV connects a balanced load rated 180 MVA, 22.5 kV, 0.8 power-factor lag to a transmission line. Determine
   (a) The rating of each of three single-phase transformers which when properly connected will be equivalent to the above three-phase transformer. (5%)
   (b) The complex impedance of the load in per unit in the impedance diagram if the base in the transmission line is 100 MVA, 345 kV. (5%)

5. In the two-bus system shown in Figure 2, bus 1 is a slack bus with $V_1 = 1.0\angle 0°$ pu. A load of 150 MW and 50 Mvar is taken from bus 2. The line admittance is $y_{12} = 10\angle -73.74°$ pu on a base of 100 MVA. The expression for real and reactive power at bus 2 is given by

$$P_2 = 10|V_2||V_1|\cos(106.26° - \delta_2 + \delta_1) + 10|V_2|^2 \cos(-73.74°)$$
$$Q_2 = -10|V_2||V_1|\sin(106.26° - \delta_2 + \delta_1) - 10|V_2|^2 \sin(-73.74°)$$

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 $\delta_2^{(0)} = 0°$. Perform two iterations. (20%)

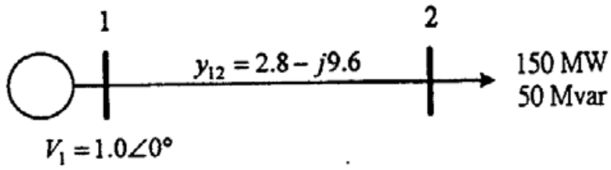

Figure 2 One-line diagram for Problem 5

6. The per unit bus impedance matrix for the power system shown in Figure 3 is given by

$$\mathbf{Z}_{bus} = j\begin{bmatrix} 0.1500 & 0.0750 & 0.1400 & 0.1350 \\ 0.0750 & 0.1875 & 0.0900 & 0.0975 \\ 0.1400 & 0.0900 & 0.2533 & 0.2100 \\ 0.1350 & 0.0975 & 0.2100 & 0.2475 \end{bmatrix}$$

A three-phase fault occurs at bus 4 through a fault impedance of $Z_f = j0.0025$ per unit. Using the bus impedance matrix calculate the fault current, bus voltages and line currents during fault. (20%)

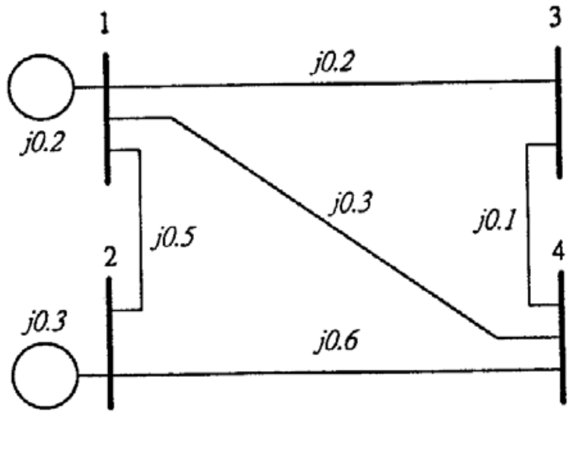

Figure 3 One-line diagram for Problem 6