# 國立臺灣科技大學

## 115學年度碩士班招生

# 試題

系所組別：0710電機工程系碩士班甲組

科　　目：電力系統

<<507101>>

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(總分為100分;所有試題務必於答案卷內頁依序作答)

1. **(30%)** Figure 1 shows the oneline diagram of a three-phase power system. By selecting a common base of 100 MVA and 22 kV on the generator side, draw an impedance diagram showing all impedances including the load impedance in per-unit. **(3%** for each of *G, $T_1$, $T_2$, $T_3$, $T_4$, M*; **4%** for each of *Line 1, Line 2, Load*). The data are given as follows:

| | | | |
|---|---|---|---|
| *G*: | 90 MVA | 22 kV | x = 0.18 per unit |
| $T_1$: | 50 MVA | 22/220 kV | x = 0.10 per unit |
| $T_2$: | 40 MVA | 220/11 kV | x = 0.06 per unit |
| $T_3$: | 40 MVA | 22/110 kV | x = 0.064 per unit |
| $T_4$: | 40 MVA | 110/11 kV | x = 0.08 per unit |
| *M*: | 66.5 MVA | 10.45 kV | x = 0.185 per unit |

Lines 1 and 2 have series reactances of 48.4 and 65.43 Ω, respectively. At bus 4, the three-phase load absorbs 57 MVA at 10.45 kV and 0.6 power factor lagging.

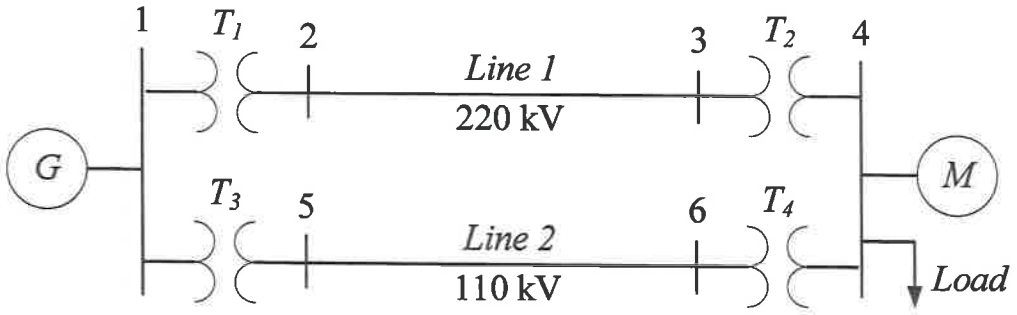


**Figure 1**

2. **(20 %)** A 69-kV, three-phase short transmission line is 16 km long. The line has a per phase series impedance of 0.125 + *j*0.4375 Ω per km. Determine the sending end voltage, voltage regulation, the sending end power, and the transmission efficiency when the line delivers
   (a) **(10%)** 70 MVA, 0.8 lagging power factor at 64 kV.
   (b) **(10%)** 120 MW, unity power factor at 64 kV.

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3. **(20%)** A three-phase, 60-Hz synchronous machine is driven at constant synchronous speed by a prime mover. The armature windings are initially open-circuited and field voltage is adjusted so that the armature terminal voltage is at the rated value (i.e., 1.0 per unit). The generator is suddenly subjected to a symmetrical three-phase short circuit at the instant when direct axis is along the magnetic axis of phase $a$, i.e., $\delta = 0$. An oscillogram of the short-circuited current is obtained. The peak values at the first two cycles, at the 20th and 21st cycles, and the steady value after a long time were recorded as tabulated in the following table.

| | 1st cycle | 2nd cycle | ... | 20th cycle | 21st cycle | ... | Steady state |
|---|---|---|---|---|---|---|---|
| $I_{max}$, pu | 8.7569 | 6.7363 | ... | 2.8893 | 2.8608 | ... | 1.1785 |
| Time, sec | 0.0042 | 0.0208 | ... | 0.3208 | 0.3375 | ... | 5.0000 |

Determine the transient reactance and time constant (20%).

4. **(30%)** A 60-Hz synchronous generator having inertia constant $H = 5$ MJ/MVA and a direct axis transient reactance $X'_d = 0.3$ per unit is connected to an infinite bus through a purely reactive circuit as shown in Figure 2. Reactances are marked on the diagram on a common system base. The generator is delivering real power $P_e = 0.8$ per unit and $Q = 0.074$ per unit to the infinite bus at a voltage of $V = 1$ per unit.

(a) A temporary three-phase fault occurs at the sending end of the line at point $F$. When the fault is cleared, both lines are intact. Determine the critical clearing angle and the critical fault clearing time (20%).

(b) A three-phase fault occurs at the middle of one of the lines, the fault is cleared, and the faulted line is isolated. Determine the critical clearing angle (10%).

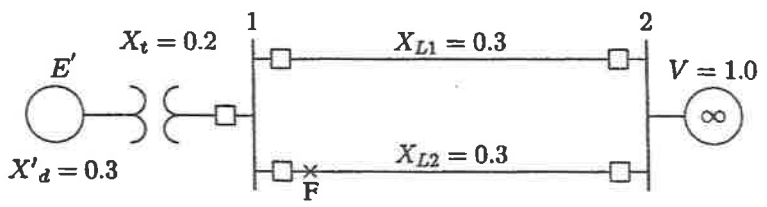


Figure 2 One-line diagram for Problem 4.