八十五學年度國立台灣工業技術學院研究所碩士班招生考試

所別：電機工程技術研究所　　組別：電力組　　科目：電力工程

(共六題，滿分一百分)

1. Consider the network shown in Fig. 1. The two branches ③ and ④ in the network are mutually coupled as indicated by the dots beside them and their mutual impedance is j0.15 per unit.
   (a) Write the primitive impedance matrix $\mathbf{Z}_{PR}$ for the network. (2%)
   (b) Calculate the primitive admittance matrix $\mathbf{Y}_{PR}$ for the network. (3%)
   (c) Find the bus admittance matrix $\mathbf{Y}_{bus}$ for the overall network of Fig. 1 including the two mutually coupled branches. (5%)

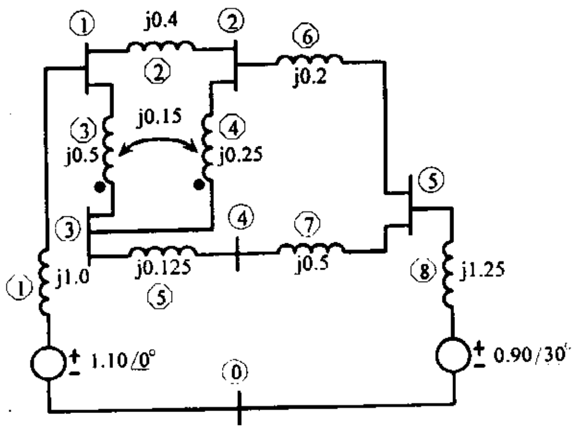

Fig. 1
Values shown are voltages and impedances in per unit.

2. A three-bus network has generators at buses ① and ③ rated 270 and 225 MVA, respectively. The generator subtransient reactances plus the reactances of the transformers connecting them to the buses are each 0.3 per unit on the generator rating as base. The turns ratios of the transformers are such that the voltage base in each generator circuit is equal to the voltage rating of the generator. Line impedances in per unit on a 100-MVA system base are shown in Fig. 2. All resistances are neglected.
   (a) Using node ⓪ as reference, determine the bus impedance matrix $\mathbf{Z}_{bus}$ for the network by the $\mathbf{Z}_{bus}$ building algorithm. (10%)
   (b) Find the subtransient current in a three-phase fault at bus ② and the current coming to the faulted bus over each line. Prefault current is to be neglected and all voltages are assumed to be 1.0 per unit before the fault occurs. (10%)

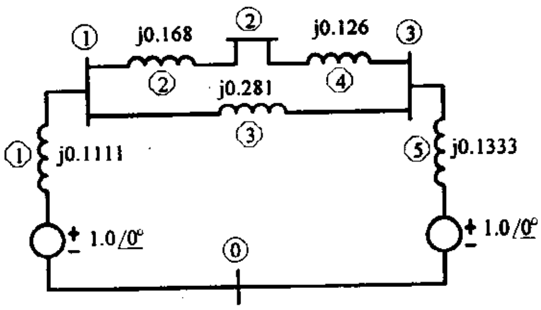

Fig. 2
All values are in per unit on a 100-MVA base.

命題請勿超出線外

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3. Consider the system shown in Fig. 3. Slack bus is bus ②. $\bar{V}_2 = 1\angle 0°$. All data is in per-unit.
   (a) Formulate $\mathbf{Y}_{bus}$ with entries in rectangular form. (2%)
   (b) Reformulate $\mathbf{Y}_{bus}$ with entries in polar form. (2%)
   (c) Write out simplified expressions for the net real and reactive power entering the network at the bus ①, i.e. P_1 and Q_1. The V_1 and δ_1 are variables. (4%)

   The following parts (d)-(h) step through the essence of the Newton-Raphson solution to the power flow problem.
   (d) Formulate the 2×2 Jacobian **J**. The V_1 and δ_1 are variables. (4%)
   (e) Using starting values $V_1 = 1.0$ and $\delta_1 = 0$, evaluate **J** as constructed in (d). (2%)
   (f) Calculate $\mathbf{J}^{-1}$. (2%)
   (g) Calculate the bus mismatch ΔP_1 and ΔQ_1. (2%)
   (h) Calculate ΔV_1 and $\Delta\delta_1$, and upgrade the bus-1 phase angle and voltage, V_1 and δ_1. (2%)

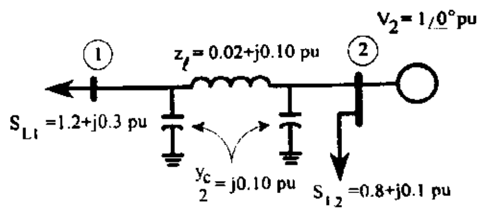

Fig. 3

4. Figure 4 shows a generator supplying a load. A second load is to be connected in parallel with the first one. The generator has a no-load frequency of 61.0Hz and a slope s_p of 1MW/Hz. Load 1 consumes a real power of 1000KW at 0.8 PF lagging, while load 2 consumes a real power of 850KW at 0.707 PF lagging.
   (a) Before the switch is closed, what is the operating frequency of the system ?(5%)
   (b) After load 2 is connected, what is the operating frequency of the system ?(5%)
   (c) After load 2 is connected, what action could an operator taken to restore the system frequency to 60Hz ?(5%)

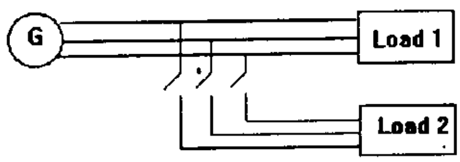

Figure 4

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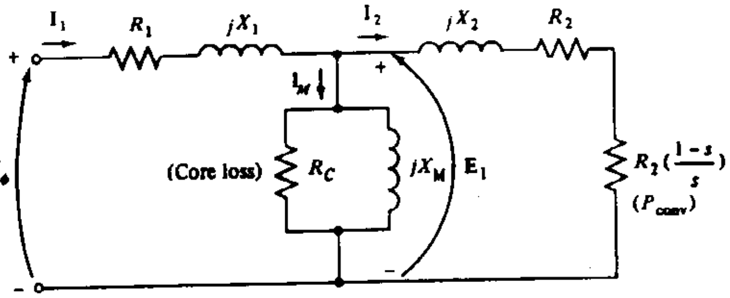
5. A 460V 25HP 60Hz four-pole Y-connected induction motor has the following impedances in ohms per phase refered to the stator circuit :

R_1=0.641 ohms　　R_2=0.332 ohms

X_1=1.106 ohms　　X_2=0.464 ohms　　X_M=26.3 ohms

The total rotational losses are 1100W and are assumed to be constant. The core loss is lumped in with the rotational losses. For a rotor slip of 2% at the rated voltage and rated frequency, find the rotor's

(a) Speed(3%)
(b) Stator current(3%)
(c) Power factor(3%)
(d) Air gap power P_{AG}(3%)
(e) Output power P_{out}(3%)
(f) Output torque T_{out}(3%)
(g) Efficiency(2%)



6. A three phase delta-wye connected 30MVA 69KV/11.5KV transformer, as Figure 6, is to be differentially protected and high side lags low side by 30 degree.

(a) Choose appropriate CT ratios(5%)
(b) Determine the differential relay tap ratios(5%)
(c) Calculate the mismatch(%) based on the tap ratios in (b)(5%)

if the available relay taps are as following :

HV side :	2.9	3.2	3.5	3.8	4.2	4.6	5.0	8.7
LV side :	2.9	3.2	3.5	3.8	4.2	4.6	5.0	8.7

30MVA

69KV/11.5KV

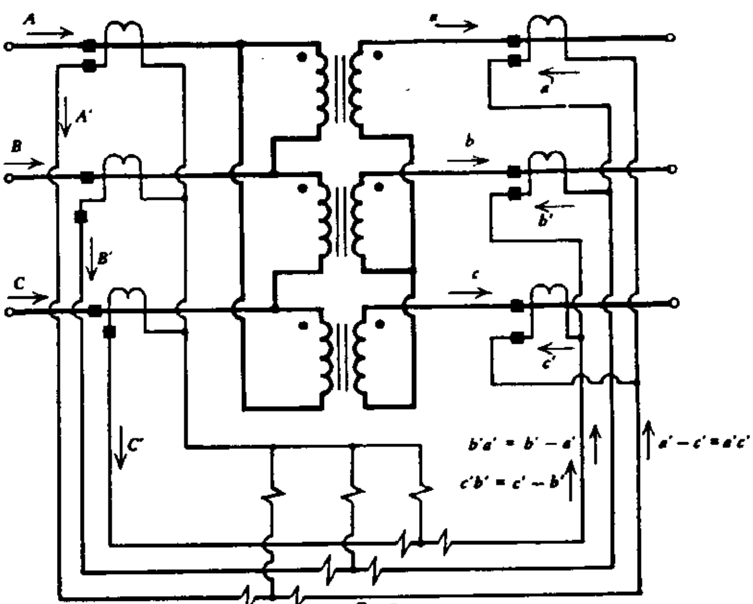


Figure 6

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