科目：電力系統(500E)　　校系所組：清大電機工程學系甲組

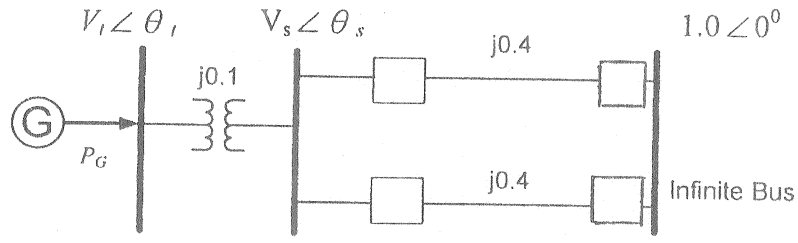
一、(12 %) A synchronous machine is connected to an infinite bus through a transformer and a double circuit transmission line as shown in Fig. 1 with all the p.u. quantities referred to the base of the rating of the synchronous machine. Assume the synchronous generator is modeled as an internal voltage $E\angle\delta$ in series with 0.2 p.u. reactance and delivers P_G=0.8 p.u. when V_t is equal to 1.05 p.u., please find

(一)、 the terminal voltage angle θ_t of the generator in degree.

(二)、 the internal voltage $E\angle\delta$ of the generator in rectangular form, i.e., E cos δ +j E sin δ .

(sin 13.21^0=0.2286, cos 5.29^0=0.9963, cos 13.21^0=0.9735, sin 5.29^0=0.0922).

Fig. 1.



二、(12 %) Consider Problem 1 and draw the corresponding equivalent circuit. By letting $E\angle\delta=V_1\angle\delta_1$, $V_t\angle\theta_t=V_2\angle\delta_2$, $V_s\angle\theta_s=V_3\angle\delta_3$, and $V_4\angle\delta_4=1.0\angle0^0$, please find the corresponding Y Bus for power flow analysis and identify the bus type of $\vec{V}_i=V_i\angle\delta_i$, i=1,2,3,4.

三、(8 %) The fuel-cost curves for two generators are given as follows (Powers in MW)

$$C_1(P_{G1})=500+4P_{G1}+0.002(P_{G1})^2 \text{, and } C_2(P_{G2})=700+6P_{G1}+0.004\,(P_{G2})^2.$$

where P_{Gi} is the corresponding generation power output, i=1,2.

(一)、 Solve this problem for the most economical dispatch to supply a total load of 700MW assuming no line losses and no limits on generator capabilities. Each generator has a minimal limit of 200MW and a maximal limit of 500MW.

(二)、 What is the incremental cost for this solution?

四、(6 %) Two thermal generating units are operating in parallel at 60Hz to supply a total load of 700 MW. Unit 1, with rated output of 600 MW and 4% speed-droop characteristic, supplies 400 MW, and Unit 2, which has a rated output of 500MW and 5% speed droop supplies the remaining 300 MW of load. If the total load increases to 800 MW, determine the new loading of each unit and the common frequency change before any supplementary control action occurs. Neglect losses.

五、(6 %) A generator bus (with 1.0 per unit voltage) supplies a load through a lossless transmission line with per unit (100 MVA base) impedance of j0.1 and no line charging. If the load is increased with the fixed power factor by the parameterized form (150+j50) λ MVA, where $\lambda>0$. Find the condition in terms of λ such that voltage collapse occurs.

六、(10 %) Assume a round-rotor generator with the terminal voltage magnitude V_a and the synchronous reactance X_s delivering power to an infinite bus through a transmission line with reactance X_L. The voltage of the infinite bus is $1.0\angle0^0$. The power angle δ during transients is described by the swing equation

$$M\frac{d^2}{dt^2}\delta + D\frac{d}{dt}\delta + P_G(\delta) = P_M$$

where M is the machine inertia, D is the machine damping, $P_G(\delta)$ is the electrical power output, and P_M is the mechanical output.

(一)、 Express $P_G(\delta)$ in terms of V_a, X_s and X_L.

(二)、 Does this system have multiple equilibrium points? Please classify their stability.

(三)、 Define the corresponding potential energy and the kinematic energy.

(四)、 Use the phase trajectory from the potential energy curve to derive the equal-area stability criterion for determining the critical clearing time.

注意：背面有試題

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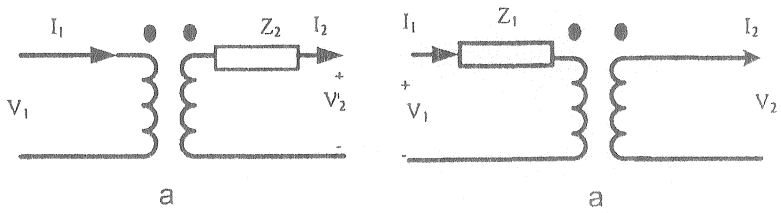
七、(6 %) Consider the circuits shown in Fig. 2. We wish to pick Z_1 in terms of Z_2 so that the terminal behavior of two circuits is identical. The transformer turns ratios, $a=N_1/N_2$, are the same in both circuits.

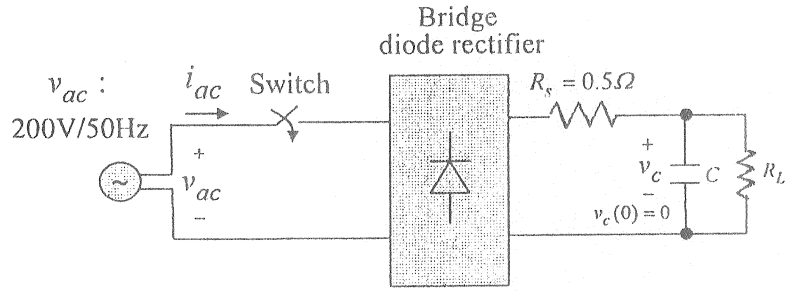
Fig.2.



八、(10%) A three-phase, 100MVA, 12kV, Y-connected synchronous generator possesses the reactances of $X_1 = 20\,\%$, $X_2 = 10\,\%$ and $X_0 = 8\%$. The generator is connected to a 100MVA, 12/115kV delta/Y, three-phase transformer having a reactance of 10%. The neutrals of the generator and transformer windings are solidly grounded. The terminal voltage of the generator is 12kV, and the transformer is at open circuit. Find the interconnected sequence networks with labeled reactances corresponding to the following fault conditions: (1) single line-to-ground fault; (2) line-to-line fault.

九、(10%) (1) For the given three-phase voltage set ($V_a = 100\angle 0^o, V_b = 100\angle -120^0, V_c = 0$), find the corresponding positive sequence component V_1.

(2) For the given circuit, the diode rectifier is assumed ideal, find the possible maximum inrush current of i_{ac} as the switch is randomly closed.



十、(20%)A three-phase balanced load is powered by a three-phase balanced voltage as illustrated. The load draws square wave current of magnitude I_0, and lags behind the line-to-neutral voltage as the waveforms show. An active power filter (APF) is installed so the voltage source sees a unity power factor load.

(a) Calculate the RMS value of i_{loadA}, and the RMS value of the fundamental component of i_{loadA}.

(b) Calculate the complex power consumption of the load.

(c) Calculate the RMS value of i_{apfA}.

(d) The APF is implemented by a conventional voltage source inverter as shown. Although ideal switches are used in the inverter of the circuit diagram, in practical applications the inverter will be implemented by real semiconductor devices. Please use transistors and diodes to replace the ideal switch without sacrificing any functions of the APF.