科目：電力系統(300C)　　校系所組：清華大學電機工程學系（甲組）

一、(10%)　A Y-connected load, as shown in Fig. 1,　is connected to a positive sequence voltage source with $V_{ab}=100\angle 30^0$ V $_{rms}$　and ω=1 rad/sec. Find

(一)、 (3%) line current $I_a$.

(二)、 (4%) the corresponding real and reactive powers, $P_{3\varphi}$ and $Q_{3\varphi}$.

(三)、 (3%) the power factor of the load.

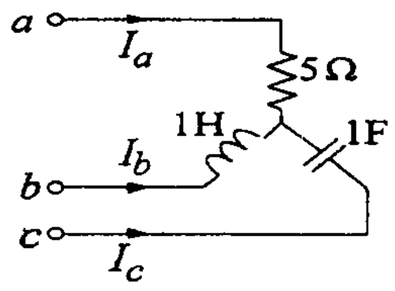


Fig. 1

二、(15%)

(一)、 (5%) Explain the characteristic differences between a PQ bus and a PV bus in power flow analysis of power systems.

(二)、 (5%) What are the assumptions made?

(三)、 (5%) Derive the Newton Rapson method for solving a nonlinear algebraic equation $f(x)=0$ by considering the Taylor's series expansion of $f(x)$ at an initial point $x_0$.

三、(10%)　A single-phase, 10kVA, 460/120V, 60Hz transformer has an efficiency of 96% when it delivers 9 kW at unity power factor.

(一)、 (4 %) Find its total loss.

(二)、 (6 %) This transformer is connected as an auto-transformer to supply a load with 460V from a 580V source.

1. (3%) Determine the rating of this autotransformer.
2. (3%) Find the efficiency at full load with unity power factor.

四、(15%) A three-phase 5kVA 220V, 4-pole 60Hz Y-connected synchronous motor has the per-phase equivalent circuit parameters: $R_a=0$, $X_s=10\Omega$. It is connected to an infinite bus with 220V/60Hz.

(一)、 (5%) When the motor is drawing rated kVA at 0.8 PF lagging from the bus, find $E_f\angle\delta$.

(二)、 (10%) If the field excitation current is reduced by 10% (power = constant), find its $E_f\angle\delta'$, $I_a$, power factor,　and reactive power.

五、(15%) As shown in Fig. 2, a transmission line modeled by series reactance $X_L=j0.1$ delivers power to a wye-connected load. Then there is a Single-Line-to-Ground (SLG) fault halfway down the line. The network is balanced before the fault. The voltage sources are positive sequence. Before the fault, $V_{a'n}=V_{a'g}=1$.

(一)、 (5%) Please show how the sequence network can be connected, and validate such connection with circuit analysis.

(二)、 (10%) Find $I^f$, $V_{a''g}$ and $V_{b''g}$ after the fault.

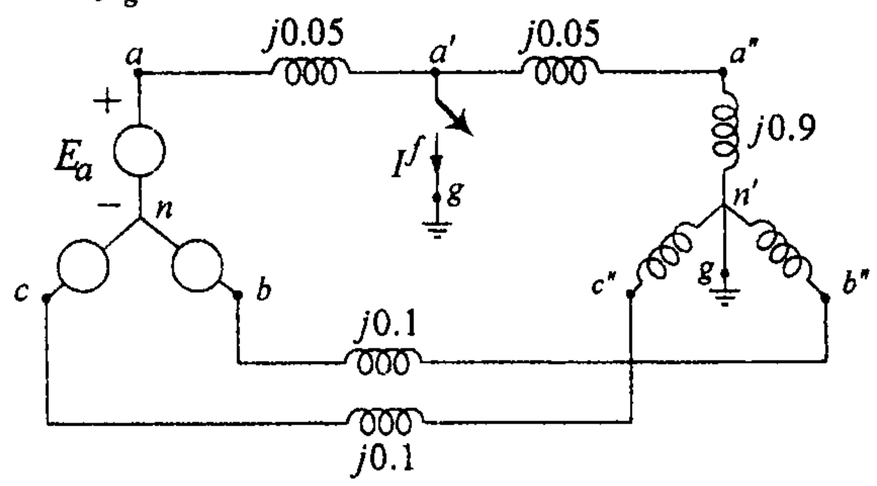


Fig. 2

注意：背面有試題

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六、(10%) A simplified one-line diagram of a three-phase power distribution system is as given in Fig. 3. At PCC, $v_s(t)=392\cos(377t)$ V(line-to-neutral), and the load current $i_{load}(t)=250\cos(377t-\pi/6)+50\cos(1885t)$. A three-phase inverter is installed at the PCC. It is to perform power factor correction so that the power factor at PCC is unity. The inverter filter inductor $L_f$ is 0.2mH.

(一)、 (4%) Calculate the inverter output voltage $v_{inv}(t)$ at steady state.

(二)、 (6%) You are given BJTs, diodes, and thyristors to implement your inverter to achieve this function. Please draw your inverter circuit design, indicate its DC bus voltage, and show how to control your inverter to generate $v_{inv}(t)$ in the first part.

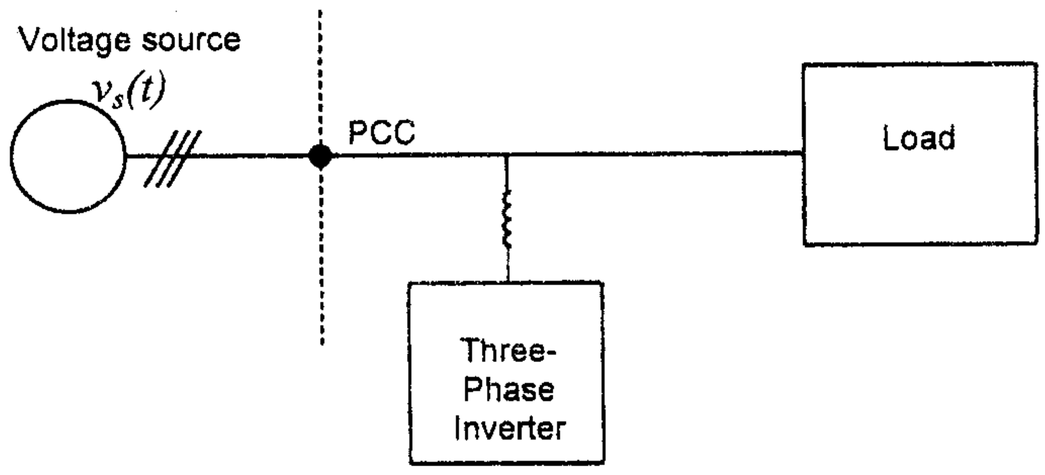




Fig. 3

七、(5%) A 1000-MVA, 60 Hz turbine-generator has a regulation constant $R=0.05$ per unit based on its own rating. If the generator frequency increases by 0.03 Hz in steady-state, what is the decrease in turbine mechanical power output? Assume a fixed reference power setting.

八、(8%) Please illustrate basic operational principle of impedance relays for transmission line protections. It is assumed that the transmission line impedance is $Z=8+j50$ per unit and 80% of the line to be in the zone of protection. Plot the zone of operation of impedance relay.

九、(12%) Fig. 4 shows a one-machine-infinite-bus (OMIB) power system model. Two transmission lines are with identical admittance $Y=jB$. Let $|V|$ and $\angle\delta$ be the magnitude and the phase angle of the synchronous generator $G$. $|V_\infty|$ is the voltage magnitude of the infinite bus. The generator has a round rotor and zero resistance. A fault occurs at the sending end of one line, point $F$ in Fig. 4. Assume that the fault is removed instantaneously by opening the breakers of the faulted line. The fault is not transitory and the breakers lock out in the open position. Suppose the faulted line is repaired and we close the breaker at $t=T$ and remain closed to restore the line to service. Derive the Equal-Area Stability Criterion analytically and find the critical angle $\delta_{\text{critical}}$.

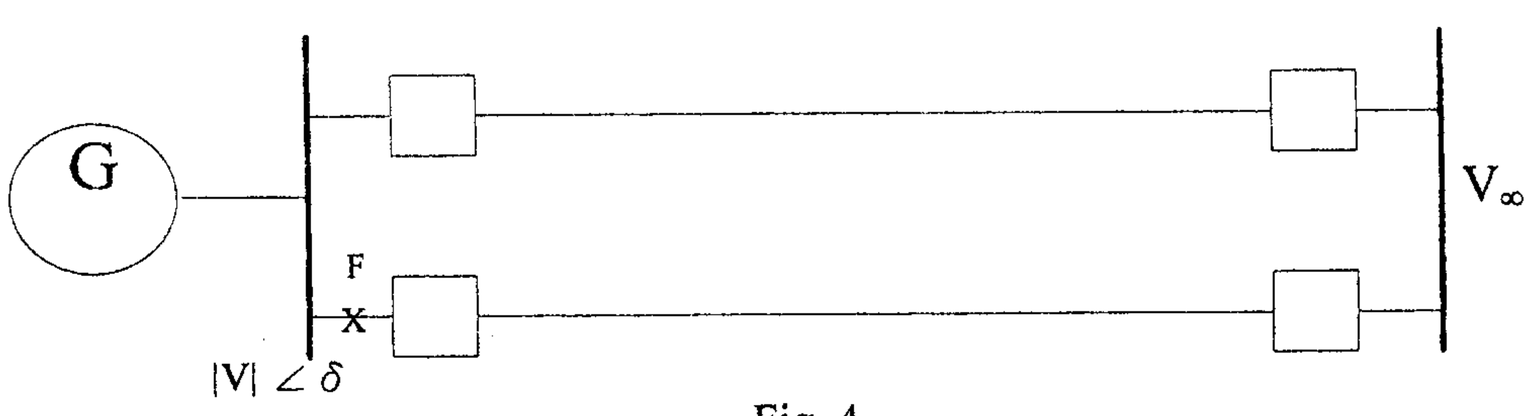


Fig. 4