所有回答 yes/no 而不須解釋的子題，答對得分，不答零分，答錯倒扣該分。

1. Power Flow (24%)

(1) You are requested to evaluate the transmission capacity of Tai-power system for year 1998 by the power flow software package. Before the formulation of power flow model, you have to select the system swing bus and specify the PV and PQ buses. (9%)

(a) What are your criteria to select the swing bus? (List two criteria.)

(b) How do you specify the power injection (P_g) into each PV bus? (List two power system analysis steps for this specification.)

(c) What generater operating limits does the power flow solution have to comply with? (More precisely, what operating limits do $Q_{g,\max}$ and $Q_{g,\min}$ refer to?)

(2) Assume your power flow model configuration, network parameters and solution algorithm all contain no error. From the flat-start, your algorithm converges to your first power flow solution by the Newton-Raphson technique. Could the stated below happen within this first solution? (Answer yes or no and give one most possible reason for each subproblem.) (6%)

(a) Power injection P_g into the swing bus < 0.

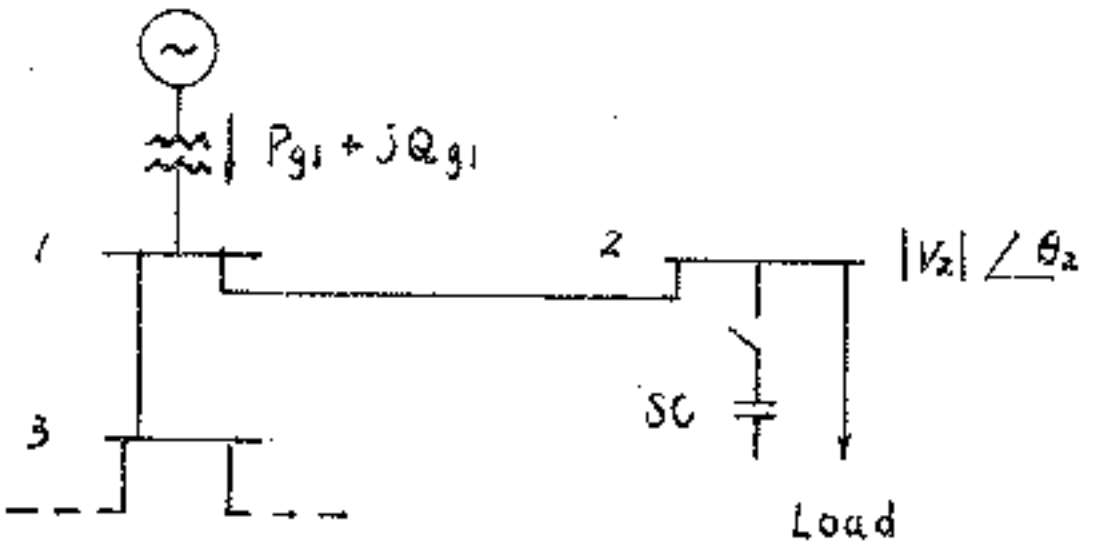
(b) To certain lines:
Lineflow > Line s.s. stability limit.

(3) Let bus 2 denote a load bus which is remote from the system generation source. Assume you already reached a reasonable power flow solution. Now switch on the SC at bus 2. Answer yes or no to each of the subproblem below (but you are not requested to explain). (9%) (See the fig. on the next page)

(a) Does $|V_2|$ increase?

(b) Does the line charge Q_c of line 1-2 decrease?

(c) Does the generator operation move towards the under-excitation mode?



2. Per Unit and Fault Analysis (15%)

A synchronous generator is rated 300 MVA, 12KV, 60Hz. It is wye connected, and its neutral is solidly grounded. The machine reactances are $X''_d = X_2 = 0.20\ pu$ and $X_0 = 0.10\ pu$. The generator is operating at rated voltage at no load when a fault occurs at the generator terminals. (15%)

(1) Find the raio of the short-circuit current for a single-line-to-ground fault to the short-circuit current for a three-phase fault.

(2) Find the ratio of the short-circuit current for a line-to-line fault to the short-circuit current for a three-phase fault.

(3) An inductive reactance is to be inserted between the neural of the generator and ground to limit the short-circuit current for a single-line-to-ground fault to that for a three-phase fault. Determine the required value of reactance in ohms.

3. Overcurrent Protection (25%)

Within the secondary substation of Taipower system,

(1) What are the protection devices in charge of the primary protection of the following equipments (You are requested to give 2 types of protection relays to protect the 69 KV bus, give 4 relay types to protect 11.4 KV feeders, etc.) (9%)

(a) 69KV bus (2)

(b) 11.4KV feeder (4)

(c) SC and PT both on the 11.4KV bus (2)

(d) 11.4KV lateral (1)

(2) The CT's installed for differential protection of the main transformer rated 30 MVA 69/11.95KV with $\Delta - Y$ connection have the following specifications:

CT ratio on the 69KV side: 300/5A

CT ratio on the 11.95KV side: 2000/5A

Current taps: 5-5, 5-5.5, 5-6.6, 5-7.3, 5-8, 5-9, 5-10

Choose one of the taps (and give your calculation steps). (5%)

(3) Give two methods commonly adopted to overcome the maloperation of transformer differential relay caused by in-rush current. (5%)

(4) Can you reduce the CT error of multi-tap CT by the following action? (Answer yes or no only.) (6%)

(a) Choose a higher CT ratio, if permissible.

(b) Choose a higher relay pickup current, if permissible.

4. Overvoltage Protection (15%)

Consider the junction between an overhead line and a substation underground cable. Suppose a voltage surge of step function form and amplitude V_i approaches this junction along the overhead line. Let Z_0, Z_c denote the surge impedance of overhead line and cable respectively.

(1) Decide $Z_0 > Z_c$, $Z_0 = Z_c$ or $Z_0 < Z_c$, and give a mathematical formula to explain your choice.

(2) Let V_2 denote the voltage of surge that penetrates into the cable. Decide $V_2 > V_1$, $V_2 = V_1$ or $V_2 < V_1$, and give a mathematical formula to explain your choice.

(3) Suppose the cable terminates at the substation's main transformer whose surge impedance is Z_t and $Z_t \gg Z_c$. The above surge (V_2) penetrating the cable can cause a high voltage (V_t) at the transformer terminal. Sketch the lattice diagram and estimate V_t under the worst condition.

5. Governor and Exciter (12%)

(1) Write a mathematical formula to define governor droop R.

(2) How does the power utility specify the load reference set point for the governor?

(3) Write a mathematical formula to define synchronous machine time constant T'_{do}.

6. Stability (9%)

A three-phase, 300MVA, 13.8KV, 60Hz, 16-pole synchronous generator has an inertia constant H=2.5 pu-s. The generator is initially operating at steady-state with $P_m = P_e = 1.0$ and $\delta = 20°$. A three-phase fault occurs at the generator terminals. Determine the power angle eight cycles after the fault occurs. Assume that P_m remains constant at 1.0 pu.