八十六學年度 電機 系(所) 甲 組碩士班研究生入學考試

科目 電力系統 科號 3003 共 5 頁第 1 頁 *請在試卷【答案卷】內作答

1. UPS (20%)

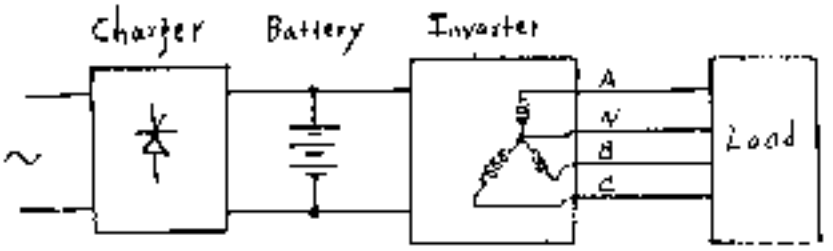

Fig. 1 UPS

(a) Determine the VA rating of an UPS module to supply the following computer room loads. Allow 50% of the actual load for additional growth.

(1) 208/120V, three-phase:

Work station	2 units, 22A each
Work station	1 unit, 17A
Disk drive	4 units, 9.5A each

(2) 120V, one-phase:

PC	4 units, 11A each
Printer	2 units, 3A each
Plotter	6 units, 4A each
Terminals	12 units, 4A each

(b) Determine the ampere-hour requirment and the number of battery cells for the UPS module of (a). Assume that the load is at 0.8PF, the load must be delivered for 5 min, the inverter efficiency is 0.95. the minimum battery voltage is 300V, and the end-of-discharge cell voltage is 1.75V/cell.

2. Transmission Line Modeling--Symmetrical Components (8%)

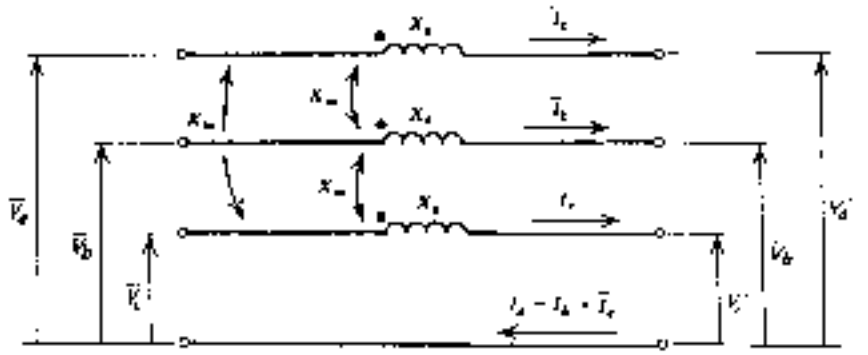

Fig. 2

Figure 2 depicts a simplified transmission line circuit, where Xs refers to the self-reactance and Xm the mutual-reactance.Let X_0, X_1, X_2 denote the corresponding zero, positive and negative sequence reactances respectively.

(a) How do you conduct a field test to measure each of X_0, X_1 and X_2? Answer by drawing a wiring diagram for each test.

(b) Are the following formulas correct? Answer yes or no (If your answer is "no", give your correct formula), and give your reasons based on the wiring diagrams of problem (b).

$X_0 > X_1$, and $X_1 > X_2$

3. Transmission Line Modeling Characteristic Impedance (12%)

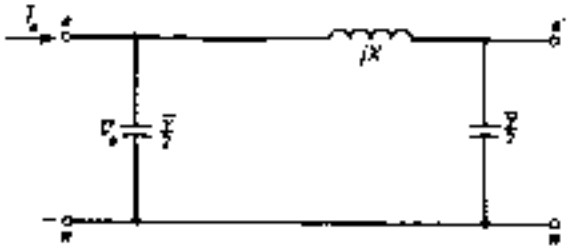

Fig. 3

Figure 3 is a per-phase equivalent circuit for the lossless transmission line of Figure 2. Assume the line length (D) is 20Km.

(a) Express X(of Figure 3) in terms of Xs and Xm(of Figure 2). To derive this expression, what is the most important assumption? Give the expression and your assumption. (You need not give the derivation.)

(b) Express the line characteristic impedance (Zc)in terms of X and Y.

(c) Give two formulas: one to define the surge impedance loading(SIL), and the other to define the surge travelling velocity(STV).

4. Transformer Modeling (10%)

Given the following one line diagram for two transformer banks in parallel. The 1 ϕ transformers in the two banks are specified as follows:

Y-Y bank: n=10, X_t=0.05

Y-Δ bank: n=$\sqrt{3} \times 10$, X_t=0.05

The line-neutral voltage at bus 1 has magnitude of 8KV. The load bus 2 is Y connected with each impedance $Z_{load}=100\angle 0°\Omega$,

(a) Draw the per phase equivalent circuit.

(b) What kind of effect may result due to this parallel connection?

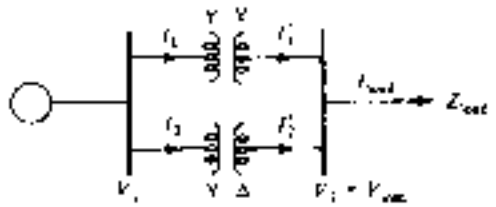

Fig. 4

5. Excitation System Modeling (10%)

The following block diagram represents a simplifted excitation system where a separately excited dc generator is used for supplying the generator field current. Explain the function of the excitation system by describing the meaning of each block, and the meaning of the variables or signals in the block diagram.

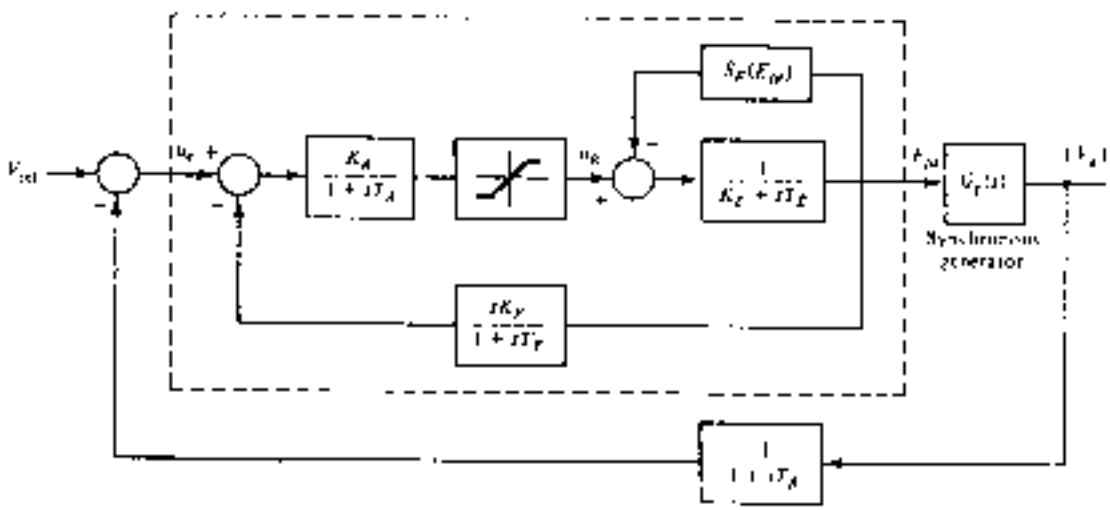

Fig. 5

6. Generator Fault and Transients (12%)

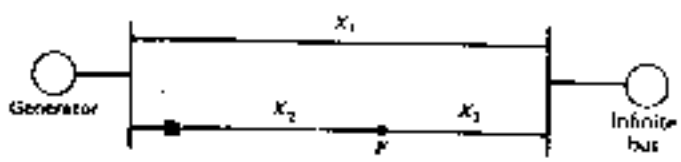

Fig. 6

Consider the system in Figure 6.

X_1=0.4 X_2=0.2 X_3=0.2

E_q'=1.2 P_m=1.5 X_d'=0.2

where X_1, X_2 and X_3 are line reactances, E_q' and X_d' are generator's internal voltage and transient reactance, and P_m is generator's turbine mechanical power.

(a) Suppose the system is operated in equilibrium. Calculate the power angle(δ) with the infinite bus as the reference.

(b) A 3 ϕ fault occurs at location F at time t_1, and the fault is cleared at time t_2. After clearence, the system reaches to a new equilibrium at t_3. For each of the following system variable, compare the RMS value

measured at t_3 with that measured at t_1^-:

E_q', P_m, P_e, δ, V_t

where P_e and V_t refer to generator's power output and terminal voltage respectively.(You are requested to answer "increases", "decreases", "remains unchanged" or "difficult to judge"; you need not give numerical values).

(c) Assume the fault occuring at time t_1 was not a line fault, but a loss-of-excitation fault of the generator.Also, this fault was cleared at t_2. Repeat problem(b) by comparing the same system variables as in problem(b). But the comparison should be made on each variable measured at t_2^- with that measured at t_1^-.

7. Power Distortion and Resonance (8%)

(1)Harmonic current (2)Switching surge
(3)Inrush current (4)Restriking voltage
(5)Voltage dips (6)3 ϕ voltage unbalance
(7)Subsynchronous resonance

For each of the following system operating conditions, select one of the above distortions or resonance. The selected must be a distortion or resonance which can only occur under that operating condition.

(a) Closing a transmission line circuit breaker to restore power supply to a substation main-transformer.
(b) Opening an overhead transmission line circuit breaker to interrupt power supply to a transmission cable.

8. Per Unit and Fault Calculation (10%)

Consider the system in Figure7.

Generator rating: S=25MVA
V_t=14KV
x"=25%

Transformer rating: S=75MVA
14 Δ/69Y KV
x_t=10%

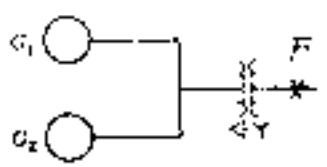

Fig. 7

Both generators have exactly the same design. The generators are connected to the low-voltage side of an unloaded 3 ϕ transformer as shown in Figure7. Before the fault occurs, there is no circulating current between two generators. Find the 3 ϕ short circuit current in per unit at the fault location F(Note: You are requested to select transformer ratings as the per unit bases).

9. Power Flow (10%)

Consider a 3-bus system in Figure 8. Assume the system is under normal operation and the capacitor bank supplies Qc to bus 2.

a. Now switch off the capacitor bank at bus 2. What will happen?
(1)Line loss increases.
(2)Voltage magnitude V_2 decreases.
(3)Voltage angle $|\theta_2|$ lags less.
(4)Generator at bus 3 is closer to underexcitation.
(5)The 3 ϕ -G fault current at bus 3 decreases.
(6)None of (1)–(5).
Give your multiple choices.

b.Decrease load P_2. What will happen?
(1)Voltage angle $|\theta_2|$ lags less.
(2)Voltage magnitude V_2 decreases.
(3)Bus power P_3 increases.
(4)System transient stability worsens.
(5)Bus power P_1 decreases and $P_1 < 0$ may be possible.
(6)None of (1)–(5).
Give your multiple choices.

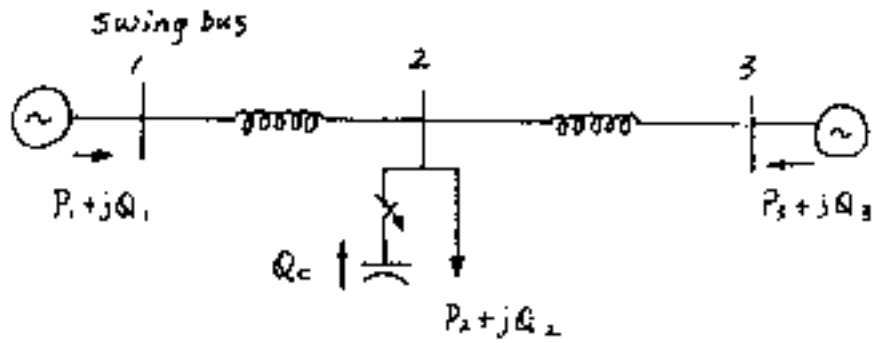

Fig. 8