Total number of printed pages – 7

B. Tech

CPEE 5401

Seventh Semester Examination – 2007

POWER SYSTEM OPERATION AND CONTROL

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any ***five*** *from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (i) Discuss why transient stability limit is lower than steady state stability limit ?

   (ii) How can stability of a system can be improved ?

   (iii) Name the methods used to solve swing equation.

P.T.O.

(iv) How are buses classified ?

(v) What is decoupled load flow method ?

(vi) What is meant by sparsity ?

(vii) With 100% inductive shunt compensation the voltage profile will be flat for what percentage loading of line. Briefly explain your answer.

(viii) The inertia constant of two groups of machines which do not swing together are M_1 and M_2 such that $M_1 > M_2$. It is proposed to add some inertia to one of the two groups of machines for improving the transient stability of the system. To whom it should be added. Explain your answer briefly.

(ix) In load flow analysis, how a load connected to a bus is represented ?

(x) What are the effects of series capacitance compensation ?

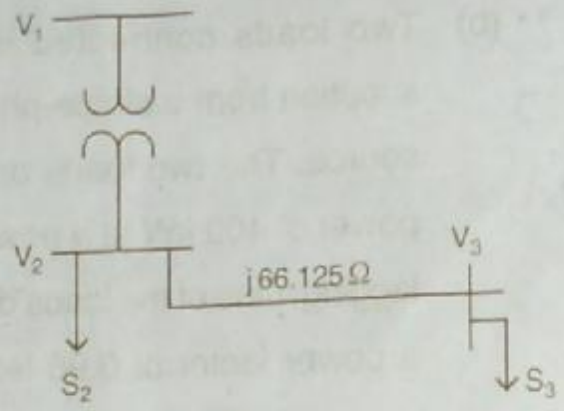
2. (a) What is complex power ? 2

(b) Two loads connected in parallel are supplied from a single-phase 240 V rms source. The two loads draw a total real power of 400 kW at a power factor of 0.8 lagging. One of the loads draws 120 kW at a power factor of 0.96 leading. Find the complex power of the load. 8

3. (a) Explain the use and function of regulating transformer for phase angle control. 3

(b) The one line diagram of a three phase power system is as shown in Fig. 1. The transformer reactance is 20% on a base of 100 MVA, 23/115 kV and the line impedance is $Z = j66.125\ \Omega$. The load at bus 2 is $S_2 = 184.8$ MW $+ j6.6$ Mvar, and at bus 3 is $S_3 = 0$ MW $+ j20$ Mvar. It is required to hold the voltage at bus 3 at $115 < 0°$ kV. Working in per unit, determine

the voltage at buses 2 and 1. 7



(Figure-1)

4. (a) Why shunt reactors are used in transmission line ? Describe how amount of reactor compensation required can be obtained on a transmission line to maintain the receiving end voltage at a specified value. 4

(b) A 3-phase 60 Hz, 500 kV transmission line is 300 km long. The line inductance is 0.97 mH/km per phase and its capacitance is 0.0115 μF/km per phase. Assume a lossless line, (i) Calculate the receiving end voltage when line is terminated in an open circuit and is energized with 500 kV at the

sending end, (ii) determine the reactance and the Mvar of a three phase shunt reactor to be installed at the receiving end to keep the no load receiving end voltage at the rated value. 6

5. (a) Starting from the first principle develop the equations for real and reactive bus powers. 5

(b) A power system has the impedances between various buses

bus 1 to reference j2 Ω
bus 2 to reference j 2 Ω
bus 3 to reference j 2 Ω
bus 1 to bus 3 j 0.2 Ω
bus 2 to bus 3 j 0.4 Ω
bus 1 to bus 4 j 0.2 Ω
bus 2 to bus 4 j 0.2 Ω
bus 3 to bus 4 j 0.1 Ω

Draw a configuration of the system and find bus admittance matrix. 5

6. (a) Draw the schematic diagram of a Load frequency control loop (LFC) and explain the operation. 4

(b) Two generating units rated 250 MW and 400 MW have governor speed regulation of 0.6 and 6.4 percent respectively, from no-load to full load respectively. They are operating in parallel and share a load of 500 MW. Assuming free governor action, determine the load shared by each unit. 6

7. (a) Starting from the first principles, derive swing equation of a synchronous machine. Define inertia constant. 4

(b) A 50 Hz generator of reactance 0.8 pu is connected to an infinite bus through a line of 0.4 pu reactance. E = 1.05 pu, V = 1.0 pu. The inertia constant is 4 MJ/MVA. The generator is loaded to 70% of the maximum power limit. Find the frequency of natural oscillation. 6

8. The fuel cost functions in Rs/h for three thermal plants are given by

$$C_1 = 350 + 7.20\,P_1 + 0.0040\,P_1^2$$

$$C_2 = 500 + 7.30\,P_1 + 0.0025\,P_2^2$$

$$C_3 = 600 + 6.74\,P_1 + 0.0030\,P_3^2$$

Where P_1, P_2 and P_3 are in MW. The governors are set such that generators share the load equally. Neglecting the line losses and generator limits, find the total cost in Rs/h when the total load is

(i) $P_1 = 450$ MW

(ii) $P_2 = 745$ MW

(iii) $P_3 = 1335$ MW. 10