King Saud University
Department of Electrical Engineering
Power Systems Operation and Control (EE 585)

First Semester 1435/1436 | Final Exam | Time Limit: 2.0 hours

الرقم: | الاسم:

Question 1:

A) Four generating units having characteristics as follows:-

Unit	Rated Power (MW)	Output Power (MW)	Speed Regulation (%)
1	500	450	4
2	400	350	5
3	300	250	6
4	200	150	8

The four units are operating in parallel at 60 Hz to supply the loads as shown in Fig 1. If the breaker *B* suddenly opens, determine the new frequency and the new power output of each unit.

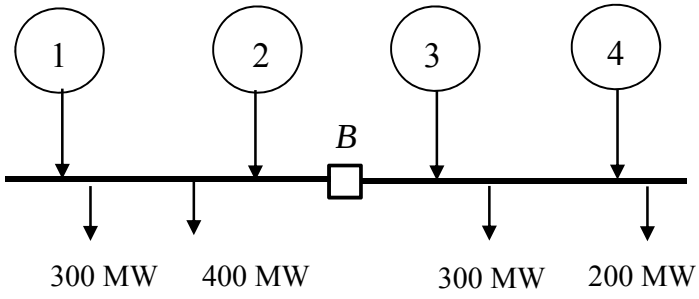


Fig. 1

B) Four thermal units with incremental fuel cost (IFC) as follows:-

$IFC_1 = 0.009\ Pg_1 + 7.0$
$IFC_2 = 0.008\ Pg_2 + 8.0$
$IFC_3 = 0.007\ pg_3 + 9.0$
$IFC_4 = 0.006\ pg_4 + 11.0$

Determine Pg_1, Pg_2, Pg_3, and Pg_4 for economic operation to supply a total demand of 1200 MW. Neglect system losses.

Question 2:

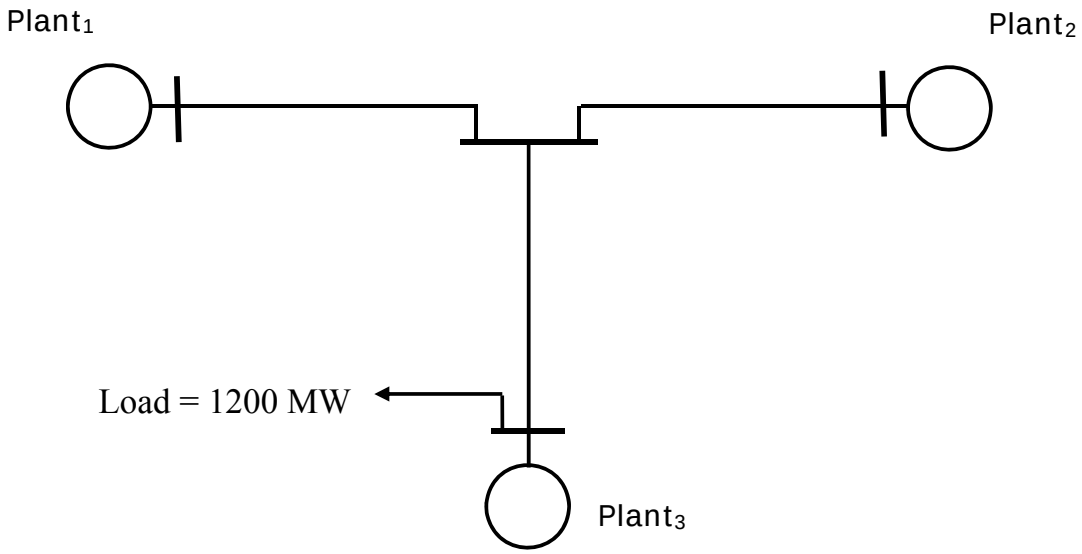


Fig. 2

A power system consists of 3 plants with output power P_1, P_2, and P_3 as shown in Fig. 2, and incremental fuel cost (IFC) as follows:-

IFC of Plant$_1$ = 11 + 0.08 P_1 \$/MW-h

IFC of Plant$_2$ = 13 + 0.12 P_2 \$/MW-h.

IFC of Plant$_3$ = 15 + 0.04 P_3 \$/MW-h.

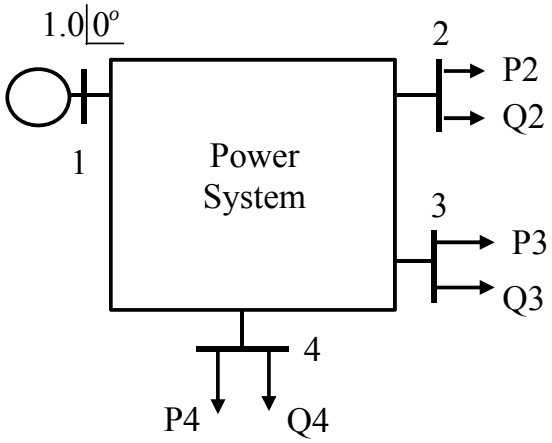
Losses in any transmission line is given by $\beta \times P^2$, where $\beta = 10^{-4}$, and P is the sending-end power of that transmission line (MW).

For a total system demand of 1200 MW, determine the power output from each plant for economic operation.

Question 3:

The Y-admittance matrix of a 4-bus power system shown in Fig. 1, (neglecting losses), is given by

$$Y_{BUS} = j\begin{bmatrix} -21 & 7 & 6 & 8 \\ 7 & -24 & 8 & 9 \\ 6 & 8 & -23 & 9 \\ 8 & 9 & 9 & -26 \end{bmatrix} \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \end{matrix}$$



All buses are P-Q type.

a) Perform DC load flow for this system.

b) If a load-flow program gave the following values:-

$$\begin{bmatrix} v_2 \\ v_3 \\ v_4 \end{bmatrix} = \begin{bmatrix} 0.96\angle -20 \\ 0.95\angle -15 \\ 0.94\angle -22 \end{bmatrix}, \text{ determine}$$

$$\begin{bmatrix} P_2 \\ P_3 \\ P_4 \end{bmatrix} \text{ and } \begin{bmatrix} Q_2 \\ Q_3 \\ Q_4 \end{bmatrix}$$

Question 4:

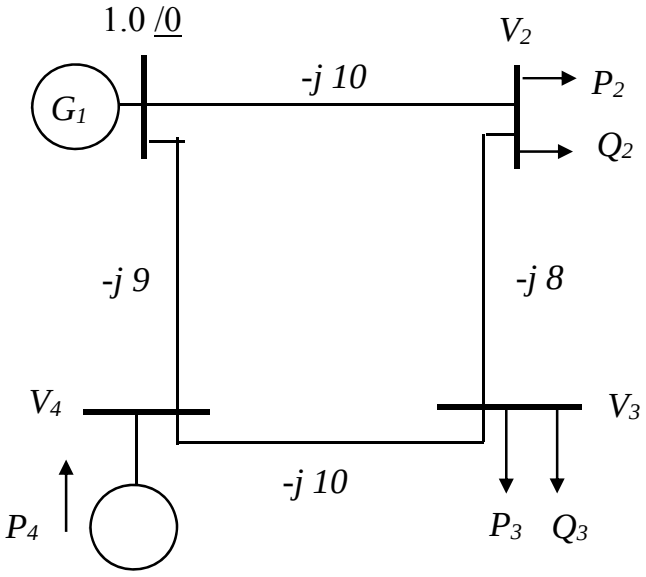


Fig 3.

In the 4-bus power system given in Fig. 4, buses 2, and 3 are load buses, whereas bus 4 is a voltage-control bus (generator bus) bus with $P_4 = 1.5$ pu. Perform fast load flow for this system. Given $P_2 = 2.2$, $P_3 = 2.5$, $P_4 = 1.8$, $Q_2 = 1.3$, $Q_3 = 1.6$, and $Q_4 = 1.4$, all in pu,

Do one iteration only starting with initial guess values.

Question 5:

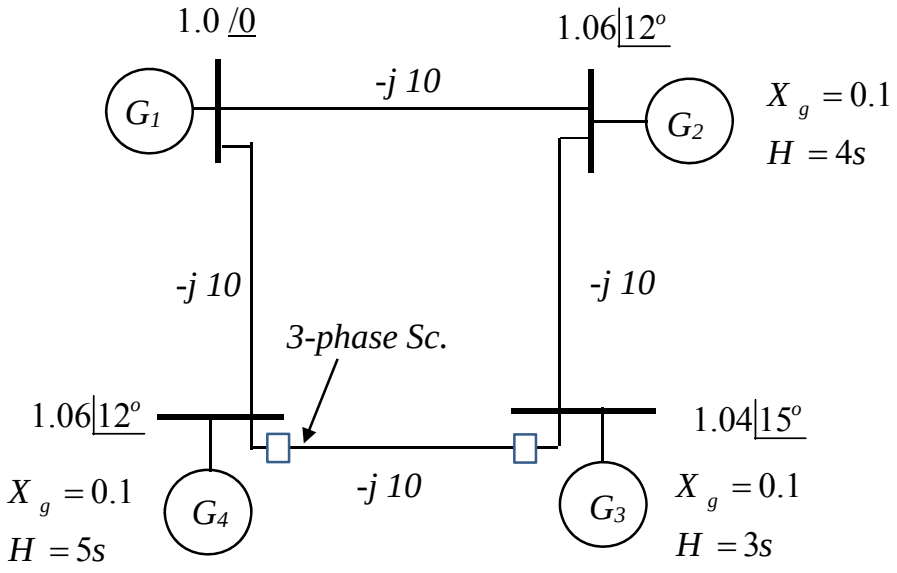


Fig. 5

The 4-bus system in Fig. 5 was operating at steady-state when at t=0, a 3-phase short circuit occurred at the location shown and it was cleared at t=0.04 seconds.

Study stability of this system. Assume damping coefficient D = 2 for all machines.