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.

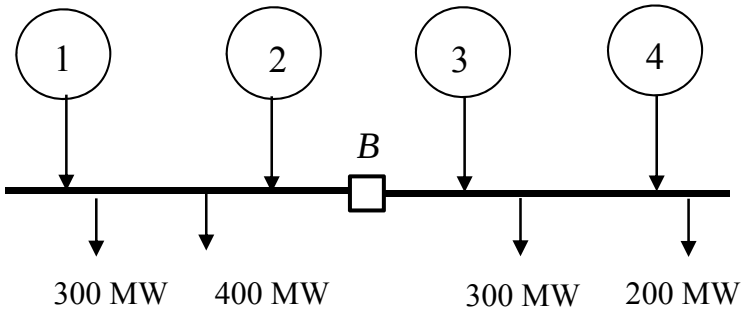


Fig. 1

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:

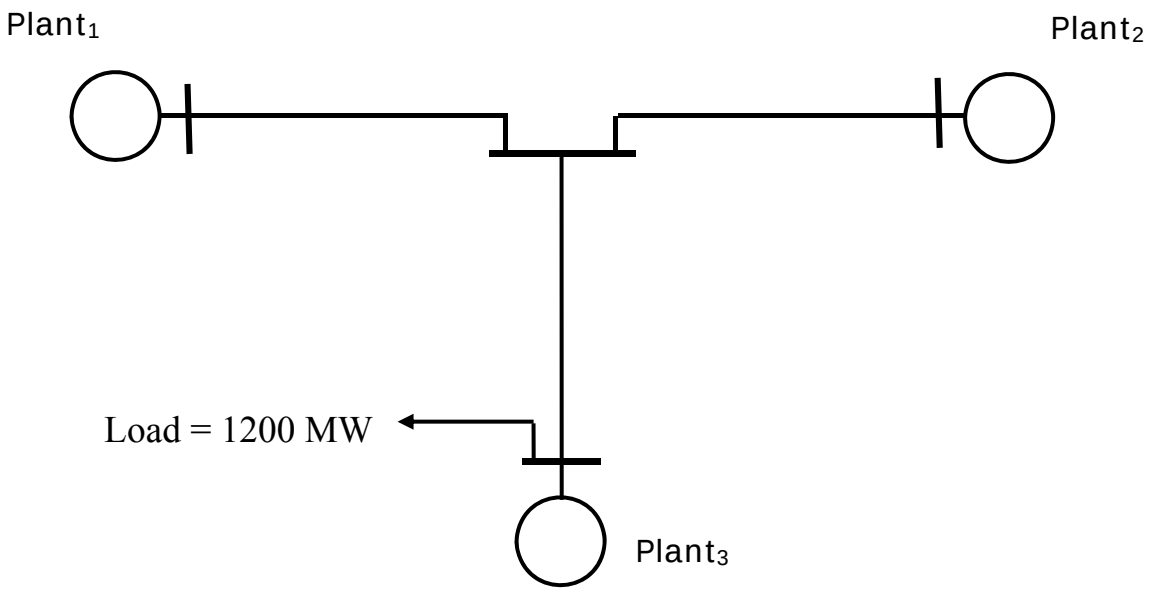


Fig. 2

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:

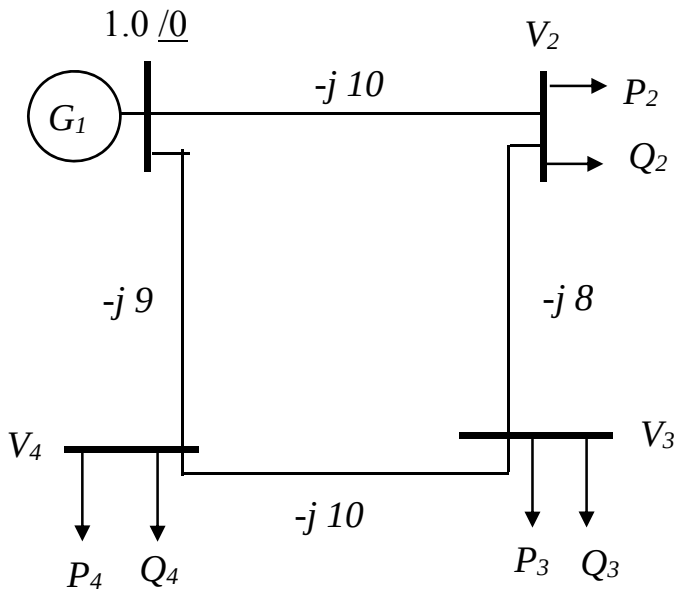


Fig 3.

a) For the system shown in Fig 3, determine *Ybus.*
b) Perform DC load flow for this system.
c) Using the equation $[Y][V]=[I]$, use Mathcad to calculate $V_2$, $V_3$, and $V_4$. 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,

## Question 4:

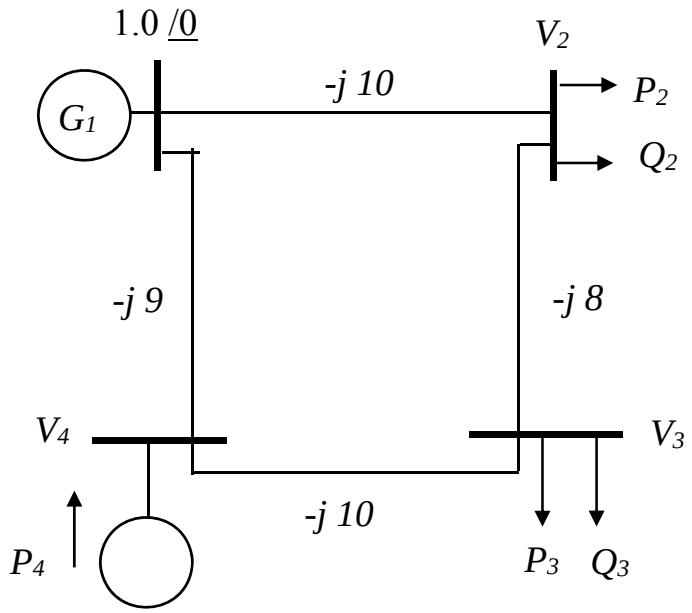


Fig 3.

In the 4-bus power system given in Fig. 4, buses 2, and 3 are load buses with loads as given in $Q_3$, whereas bus 4 is a voltage-control bus (generator bus) bus with $P_4 = 1.5$ pu. Perform fast load flow for this system. Do one iteration only starting with initial guess values.

## Question 5:

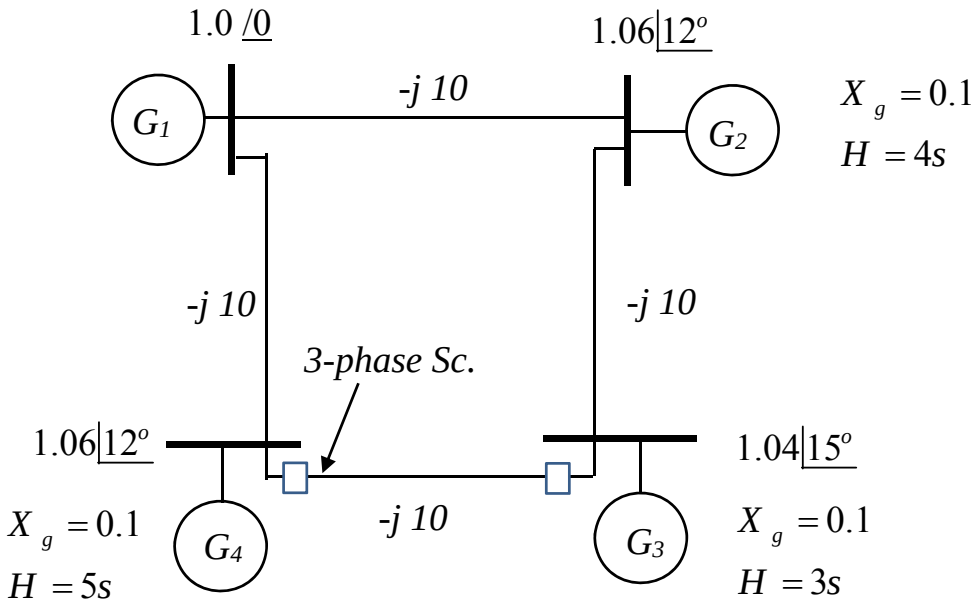


Fig. 5

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.