CMR INSTITUTE OF TECHNOLOGY	USN	

Internal Assesment Test 1 – March-2023

Sub:	Power System operation & Control							Code:	18EE81
Date:	11/03/2023	Duration:	90 mins	Max Marks:	50	Sem:	7	Section:	A & B

Note: Answer any **FIVE FULL** Questions

Sketch neat figures wherever necessary. Answer to the point. **Good luck!**

		Marks	OBE CO	OBE RBT
1.	Explain in brief the components of RTU for power system SCADA	[10]	CO1	L2
2.	Explain the operating states of power system, with a neat diagram showing the transition between the states	[10]	CO1	L2
3.	a)Two prime mover generator sets are paralleled .Both have 4 % droop. The frequency is 50 Hz on full load .Plot the speed droop characteristics and comment on the load sharing if one generator A has a rating of 500 MW and another B 300 MW and the load to be shared is 400 MW. b)What are the functions of AGC?	[10]	CO2	L3
4.	Draw the diagram of steam turbine governing system and explain the functions of its various components	[10]	CO2	L3

5	Two generators rated 200 MW and 400 MW are operating in parallel. The droop characteristics of their governors are 4% and 5 % respectively from no load to full load. The speed set points are such that the generators operate at 50 Hz when sharing the full load of 600 MW in proportion to their ratings, (i) If the load reduces to 400 MW, how is it shared? At what frequency will system operate? (ii) If now the speed changers are reset so that the load of 400 MW is shared at 50 Hz in proportion to their rating. What are the no load frequencies now?	[10]	CO2	L4
6	With a neat diagram ,explain the general configuration and major components of SCADA	[10]	CO1	L2

Solutions

1)RTUs for power system SCADA

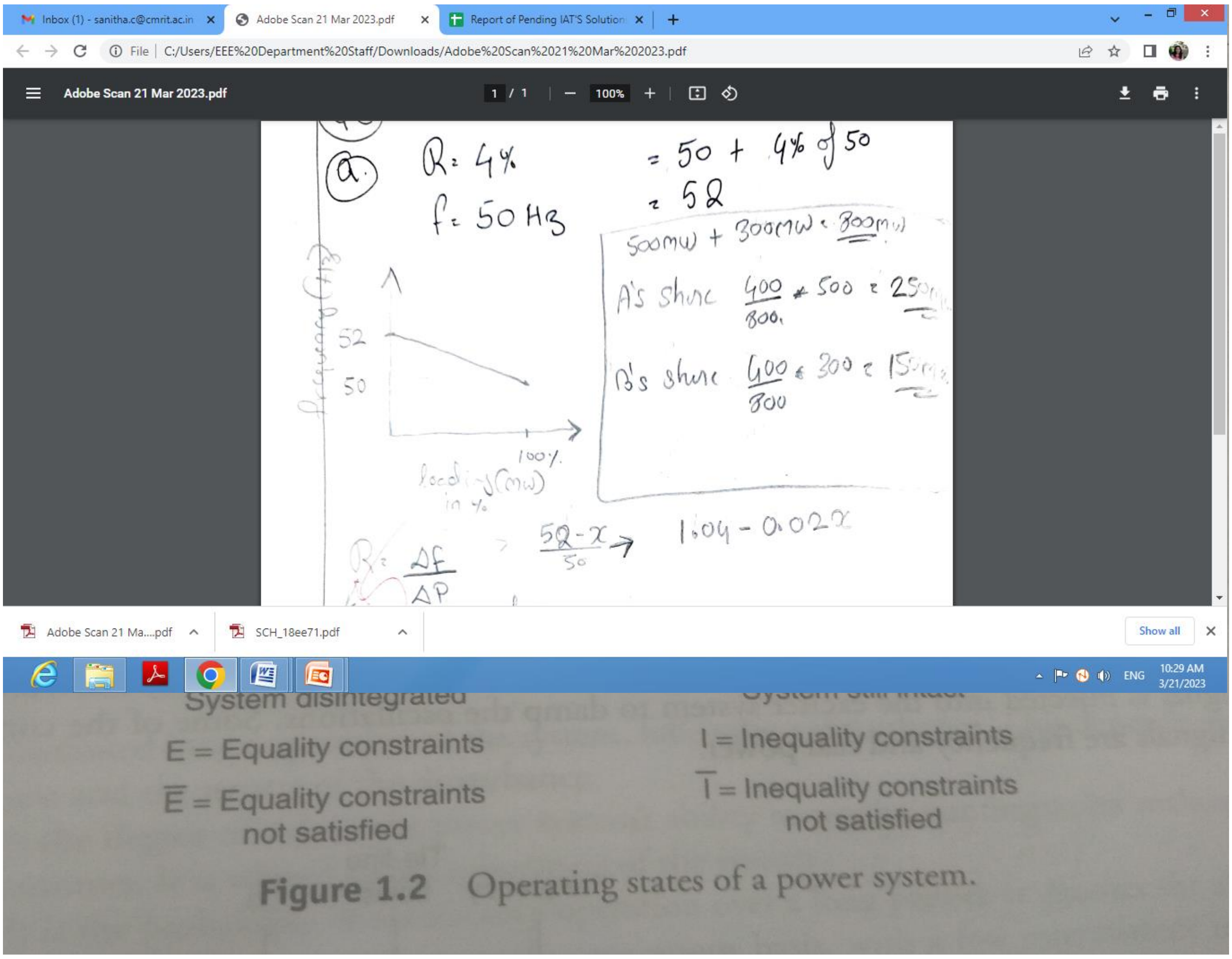
- Analog input card
- Status input card
- Control input card
- Central processing unit

Functions of RTUs

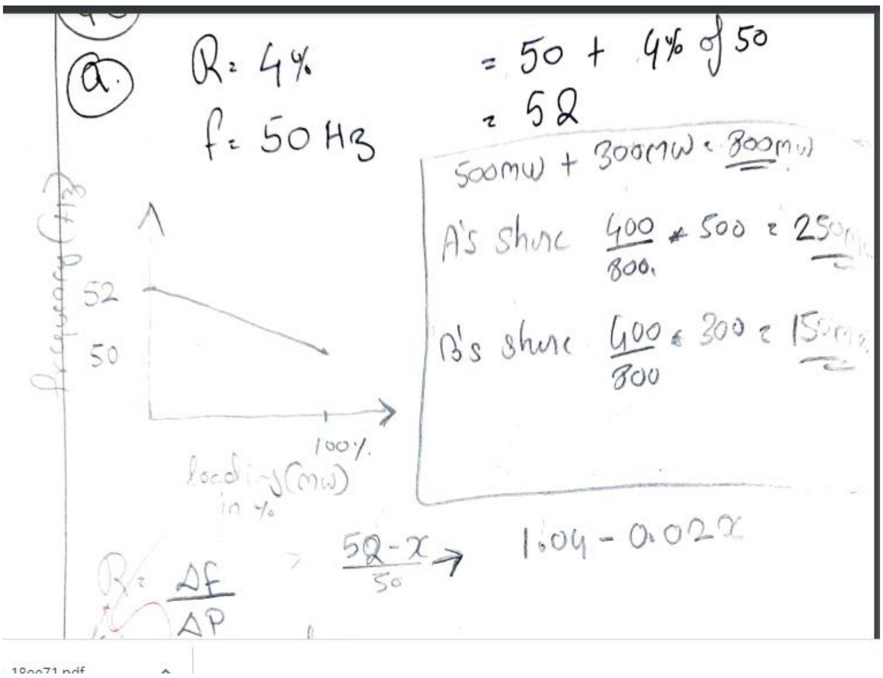
- Time synchronization
- Select before execute
- Reports by exception

2)

- Deals with real & reactive power balance
- Real Power limits
- Reactive power limits
- Voltage constraints
- Transmission line constraints



3a)



3b)

Functions of AGC

- Frequency of various bus voltages to be maintained at scheduled frequency
- Tie line power flows to be maintained at scheduled levels

➢ Total power is shared by all generators economically

4)

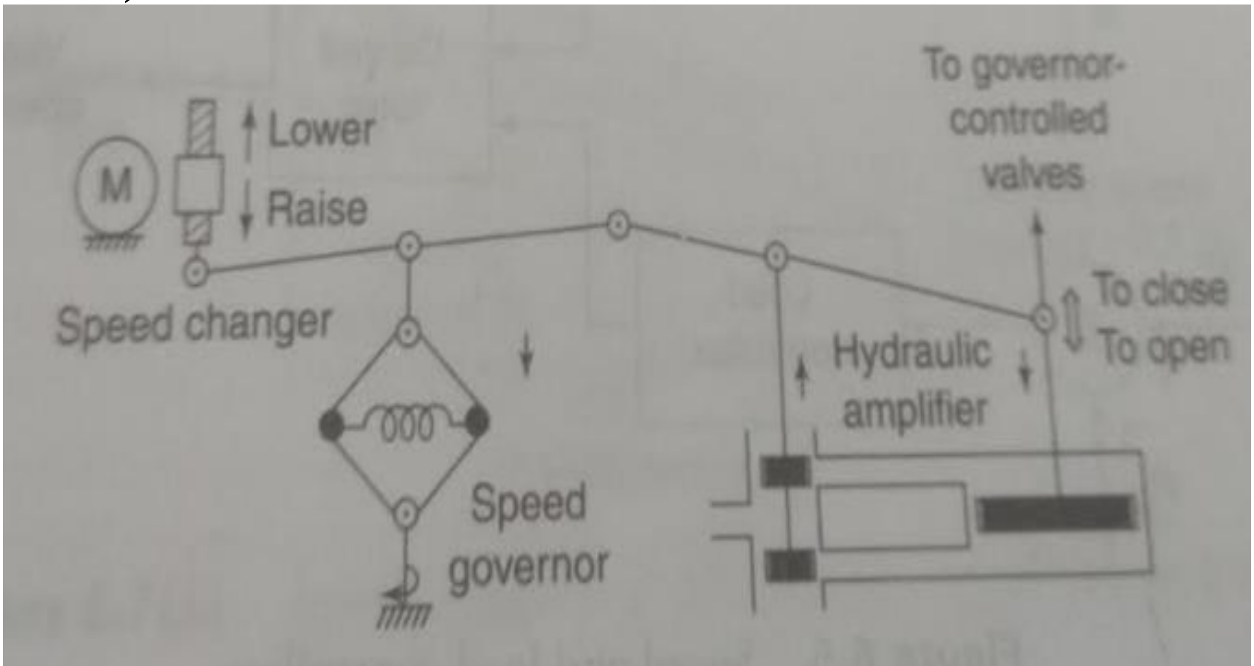


Figure 6.3 Conventional governor.

5)

frequency ... shared at 50 Hz in proportion to their rating.

Solution

(i) The droop characteristics are drawn as in Example 6.4. Since 600 MW is shared in proportion to their rating, unit 1 supplies 200 MW and unit 2 supplies 400 MW, which is their capacity, respectively. Therefore, both the units operate at 100% full-load when supplying 600 MW. We take 100 MW to be the base power. The characteristics are drawn as shown in Fig. 6.12. Unit 1 has a frequency change from 1.04 pu to 1.0 pu from no-load to full-load (2 pu) and unit 2 has a frequency change from 1.05 pu to 1.0 pu from no-load to full-load (4 pu). Thus at $f = 1$ pu, total load is $2 + 4 = 6$ pu. The load now changes to 400 MW. Let x pu be the output of unit 1. Total load is 400 MW = 4 pu. Therefore, the output of unit 2 is $4 - x$ pu. From the figure,

$$\frac{BC}{BO} = \frac{CC_1}{OO_1} \Rightarrow \frac{0.04 - \Delta f}{0.04} = \frac{x}{2} \quad \text{(i)}$$

$$\frac{AC}{AO} = \frac{CC_2}{OO_2} \Rightarrow \frac{0.05 - \Delta f}{0.05} = \frac{4 - x}{4} \quad \text{(ii)}$$

From (i) $$\frac{\Delta f}{0.04} = 1 - 0.5x \quad \text{(iii)}$$

From (ii) $$\frac{\Delta f}{0.05} = 0.25x \quad \text{(iv)}$$

$$\text{solving we get } \frac{0.05}{0.04} = \frac{1-0.5x}{0.25x}$$

$$\text{or } 0.0125x = 0.04 - 0.02x$$

$$x = 1.23077 \text{ pu}$$

$$= 123.077 \text{ MW}$$

$$4 - x = 2.7692 \text{ pu} = 276.923 \text{ MW}$$

$$\Delta f = (0.25x)0.05 = 0.01538 \text{ pu}$$

$$\text{Frequency } f_1 = 1 + \Delta f = 1.01538 \text{ pu}$$

$$= 50.769 \text{ Hz}$$

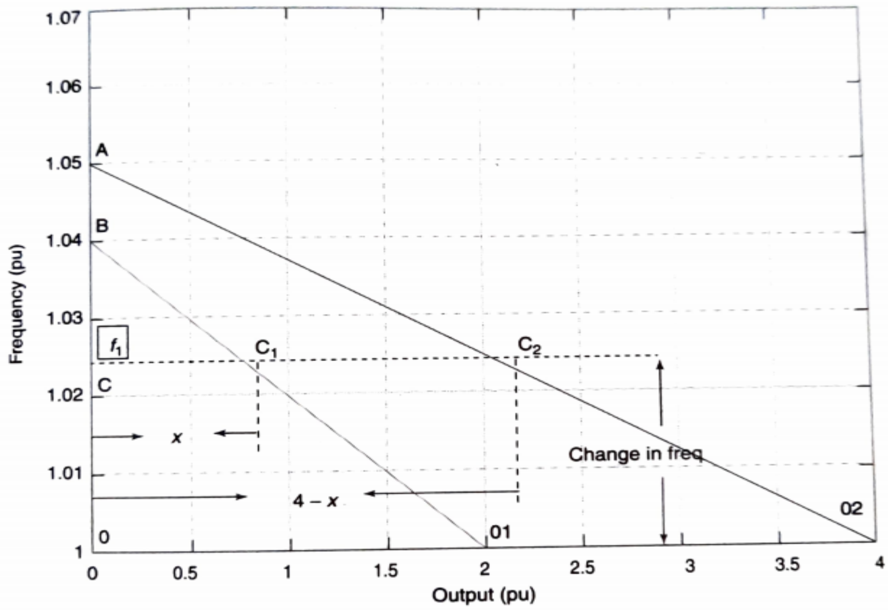


Figure 6.12 Example 6.5, case (i).

ii) Now the governor settings are changed such that they share 400 MW in proportion to their rating at 50 Hz.

ii) Now the governor settings are changed such that they share 400 MW in proportion to their rating at 50 Hz.

$$\therefore \text{ Output of unit } 1 = 400 \times \frac{2}{6} = 133.33 \text{ MW}$$

$$= 1.3333 \text{ pu}$$

$$\text{Output of unit } 2 = 266.67 \text{ MW}$$

$$= 2.6667 \text{ pu}$$

The characteristics are as shown in Fig. 6.13.

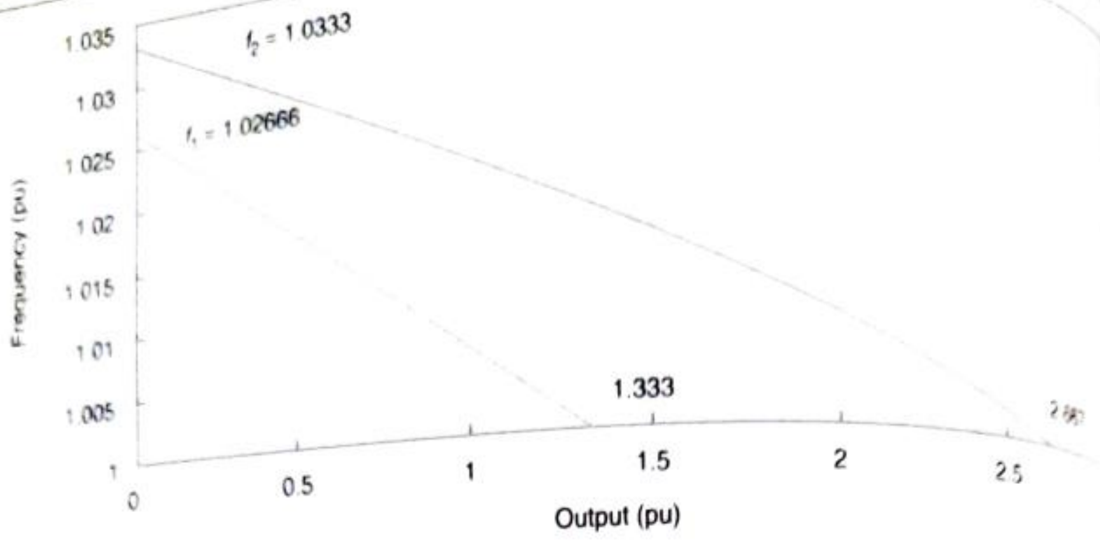


Figure 6.13 Example 6.5, case (ii).

Here, the frequency is 1 pu at the load = 4 pu. We now plot the droop characteristics with same slope and 5% as shown in Fig. 6.13. From the graph, the intercepts are

$$f_1 = 1.02666 \text{ pu} = 51.33 \text{ Hz and } f_2 = 1.0333 \text{ pu} = 51.665 \text{ Hz}$$

We can also calculate the frequencies as follows:

$$\text{Slope of unit } 1 = \frac{0.04}{2} = \frac{\Delta f_1}{1.333}$$

$$\Delta f_1 = 0.02666 \text{ pu (no load frequency of unit 1)}$$

$$f_1 = 1 + 0.02666 = 1.02666 \text{ pu} = 51.33 \text{ Hz}$$

$$\text{Slope of unit } 2 = \frac{0.05}{4} = \frac{\Delta f_2}{2.6667}$$

$$\Delta f_2 = 0.03333 \text{ pu (no load frequency of unit 2)}$$

$$f_2 = 1 + 0.0333 = 1.0333 \text{ pu} = 51.665 \text{ Hz}$$

6)

- Components of SCADA
- Field instrumentation
- Remote stations
- Communication network
- Central monitoring station
- Software

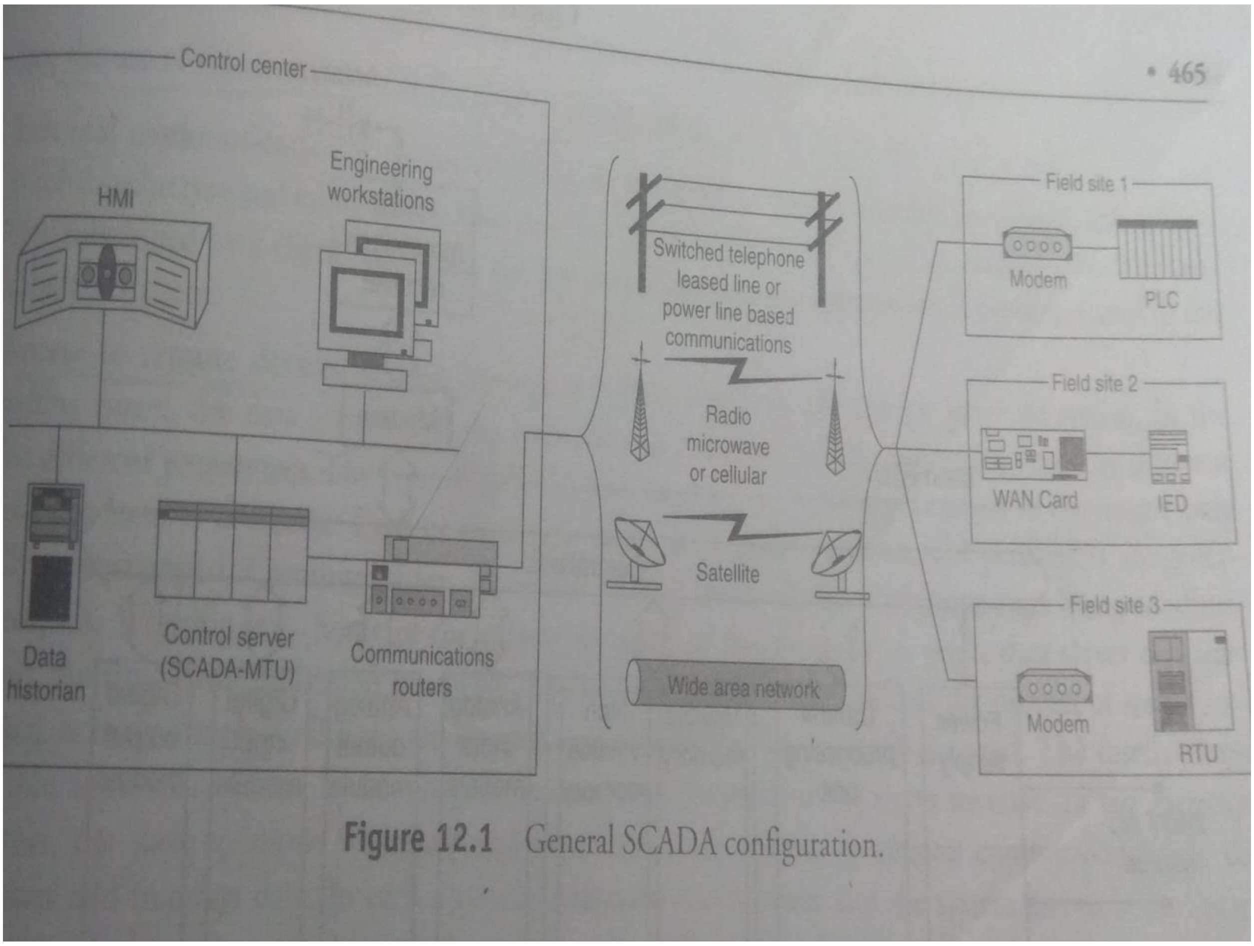


Figure 12.1 General SCADA configuration.

Central monitoring Station

- HMI or MMI
- Mimic diagram of whole system
- Display of RTUs with present I/O reading
- Windows for alarms
- Trending display
- **Software for SCADA**
- Real time data base (RTDB)
- Two types : 1)Proprietary
- -developed by companies to communicate
- with their own hardware
- 2)Open
- -capable of communicating with systems of different vendors

4)