Complete Block Dig of LFC of a single area system — A single area power system or isolated power system comprises of turbine, generator, load and governor. The fig. (11) gives a complete block dig of LFC of a single area system.

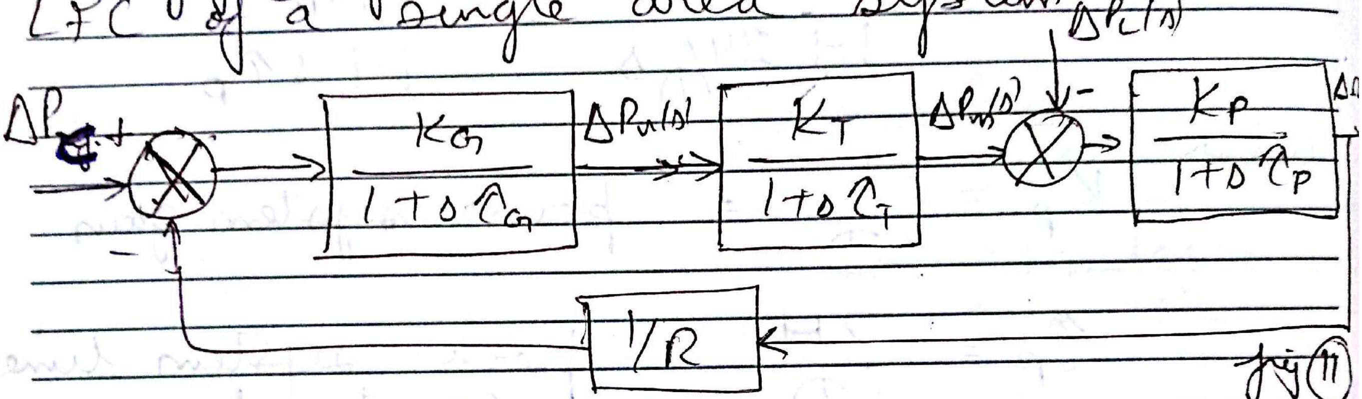


fig (11)

Using block reduction technique the above fig. gets modified as

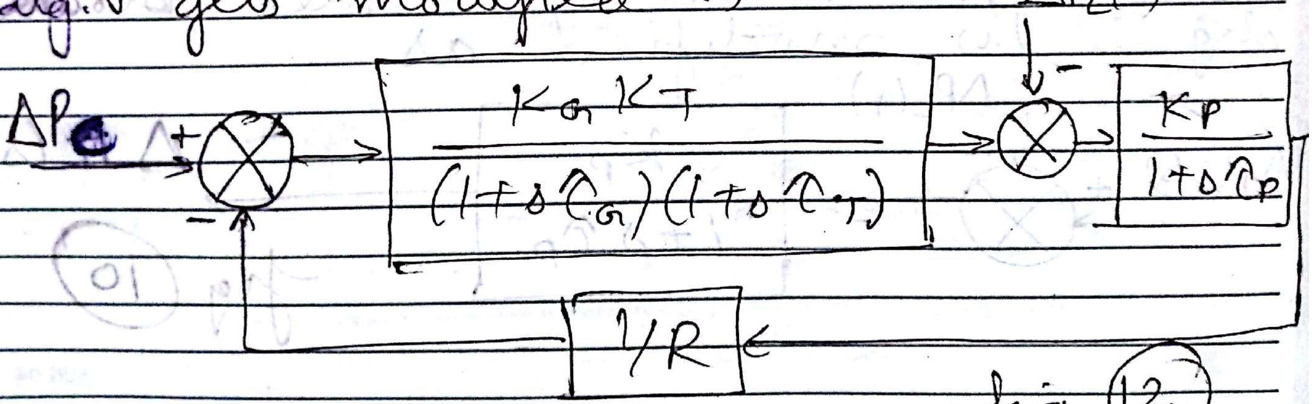


fig (12)

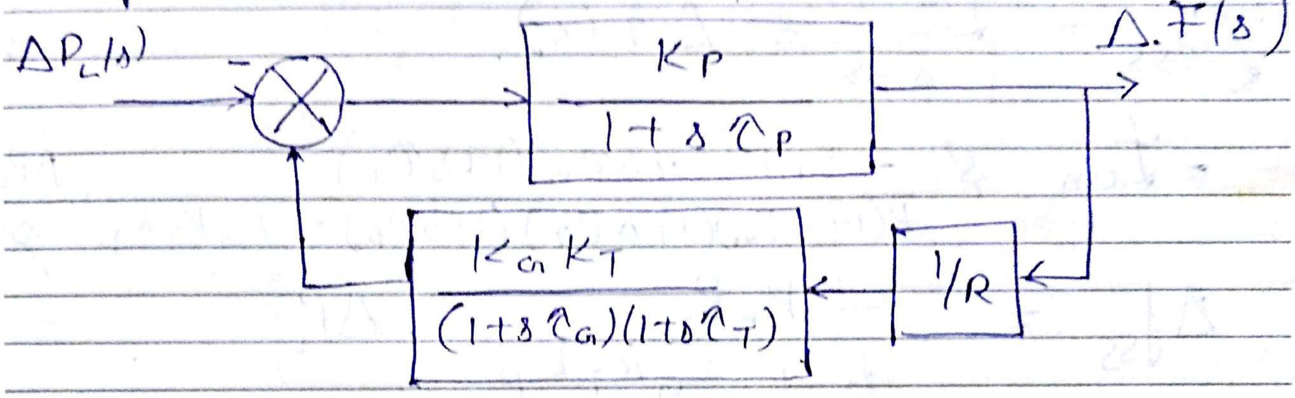
As can be seen from fig (12) that there are two important incremental inputs to the load frequency control system

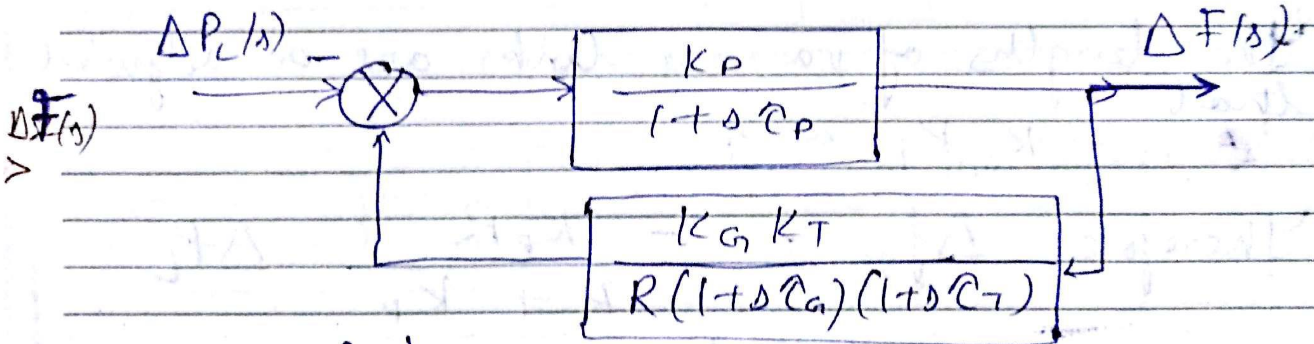
ΔP_C i.e. the change in speed changer setting

ΔP_L i.e. the change in load demand

Let us consider two cases

Case I — The speed changer setting is fixed i.e. $\Delta P_c = 0$ and the load demand changes i.e. $\Delta P_L \neq 0$. This is known as free governor action





$$\left.\frac{\Delta F(s)}{\Delta P_L(s)}\right|_{\Delta P_C(s)=0}$$

$$\frac{\Delta F(s)}{\Delta P_L(s)} = -\frac{\left(K_P/1+s\tau_P\right)}{1+\left(K_P/1+s\tau_P\right)\left\{\dfrac{K_G K_T}{R(1+s\tau_G)(1+s\tau_T)}\right\}}$$

$$\frac{\Delta F(s)}{\Delta P_L(s)} = \frac{K_P R(1+s\tau_G)(1+s\tau_T)}{R(1+s\tau_G)(1+s\tau_T)(1+s\tau_P) + K_G K_T K_P}$$

For a step change in ΔP_L
i.e.

$$\Delta P_L(s) = \frac{\Delta P_L}{s}$$

Hence the steady state change in frequency is given by

$$\Delta f_{ss} = \lim_{s \to 0} s \cdot \Delta F(s)$$

$$= \lim_{s \to 0} s \cdot \frac{-K_P R(1+s\tau_G)(1+s\tau_T)}{R(1+s\tau_G)(1+s\tau_T)(1+s\tau_P) + K_G K_T K_P} \cdot \frac{\Delta P_L}{s}$$

$$\Delta f_{ss} = \frac{-K_P R}{R + K_G K_T K_P} \cdot \Delta P_L$$

The lengths of various links are so adjusted that

$$K_G K_T \approx 1$$

Therefore $$\Delta f_{ss} = \frac{-K_P R}{R + K_P} \Delta P_L$$

$$\Delta f_{ss} = -\frac{K_P}{(1 + K_P/R)} \Delta P_L$$

$$\Delta f_{ss} = -\frac{1}{1/K_P + 1/R} \Delta P_L$$

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$$\boxed{\Delta f_{ss} = -\left(\frac{1}{B + 1/R}\right) \Delta P_L.} \quad \text{—} \; \mathrm{I}$$

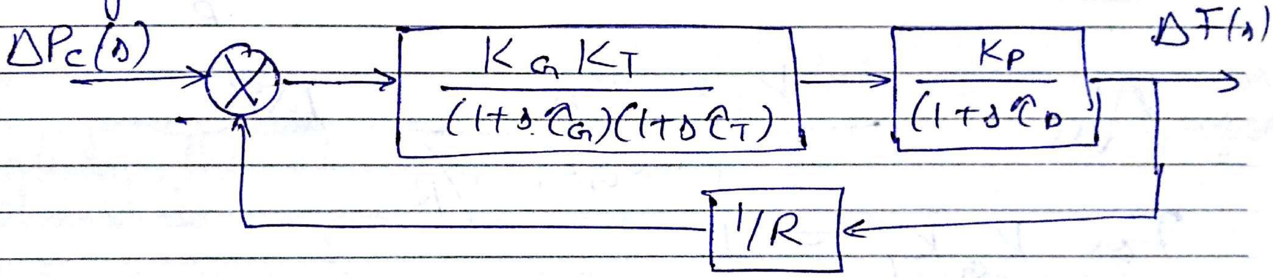
S	✧	11	25
M	✧	12	26
T	✧	13	27
W	✧	14	28
T	01	15	29
F	02	16	30
S	03	17	
S	04	18	
M	05	19	
T	06	20	
W	07	21	
T	08	22	
F	09	23	
S	10	24	

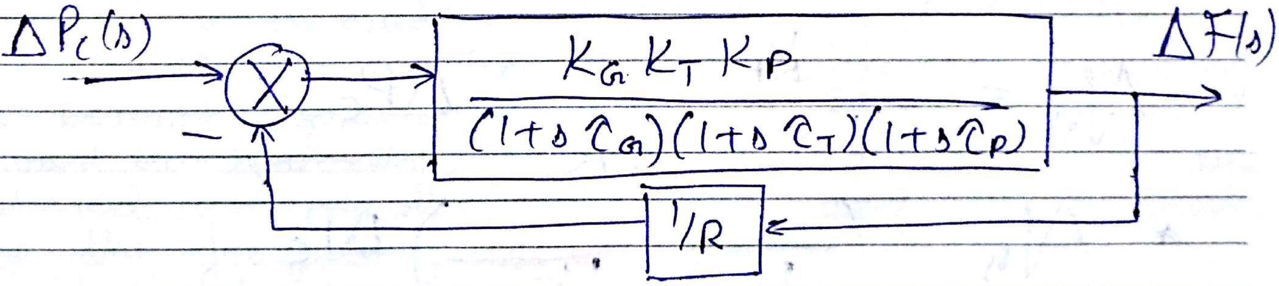
JUN 2000

where $B = 1/K_p$

The eq (I) thus gives the steady state changes in frequency caused by changes in load demand. The speed regulation is so adjusted that changes in frequency are small.

Case II – The load is constant but the speed changer setting position is changed i.e. $\Delta P_L(s) = 0$





$$\left.\frac{\Delta F(s)}{\Delta P_C(s)}\right|_{\Delta P_L(s)=0} = \frac{\left(\dfrac{K_G K_T K_P}{(1+s\tau_G)(1+s\tau_T)(1+s\tau_P)}\right)}{1 + \dfrac{1}{R}\dfrac{K_G K_T K_P}{(1+s\tau_G)(1+s\tau_T)(1+s\tau_P)}}$$

$$\Delta F(s) = \frac{K_G K_T K_P}{(1+s\tau_G)(1+s\tau_T)(1+s\tau_P) + \dfrac{K_G K_T K_P}{R}} \, \Delta P_C(s)$$

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The steady state error in frequency for a step change in ΔP_C is given by $\Delta P_C(s) = \frac{\Delta P_C}{s}$

$$\Delta f_{ss} = \lim_{s \to 0} s \cdot \Delta F(s)$$

$$\Delta f_{ss} = \lim_{s \to 0} \cancel{s} \frac{K_G K_T K_P}{(1+s\tau_G)(1+s\tau_T)(1+s\tau_P) + \frac{K_G K_T K_P}{R}} \cdot \frac{\Delta P_C}{\cancel{s}}$$

$$\Delta f_{ss} = \frac{K_G K_T K_P}{1 + K_G K_T K_P / R} \cdot \Delta P_C$$

For $K_G K_T = 1$

$$\Delta f_{ss} = \frac{K_P}{1 + K_P / R} \Delta P_C$$

$$\Delta f_{ss} = \left(\frac{1}{1/K_P + 1/R} \right) \Delta P_C$$

$$\boxed{\Delta f_{ss} = \left(\frac{1}{B + 1/R} \right) \Delta P_C} \longleftarrow \text{II}$$

REMIND ME

S	✧	11	25
M	✧	12	26
T	✧	13	27
W	✧	14	28
T	01	15	29
F	02	16	30
S	03	17	
S	04	18	
M	05	19	
T	06	20	
W	07	21	

JUN 2000

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$$\frac{f_1' - 50}{-133} = \frac{2}{-200} = \frac{1}{-100}$$

or $$f_1' - 50 = \frac{-133}{-100}$$

$$f_1' = \frac{133}{100} + 50 = 51.33 \text{ Hz}$$

Similarly

$$\frac{f_2' - 50}{0 - 267} = \frac{52.5 - 50}{0 - 400}$$

or $$f_2' - 50 = \frac{2.5}{-400} \times -267$$

$$f_2' = 1.67 + 50 = 51.67 \text{ Hz}$$