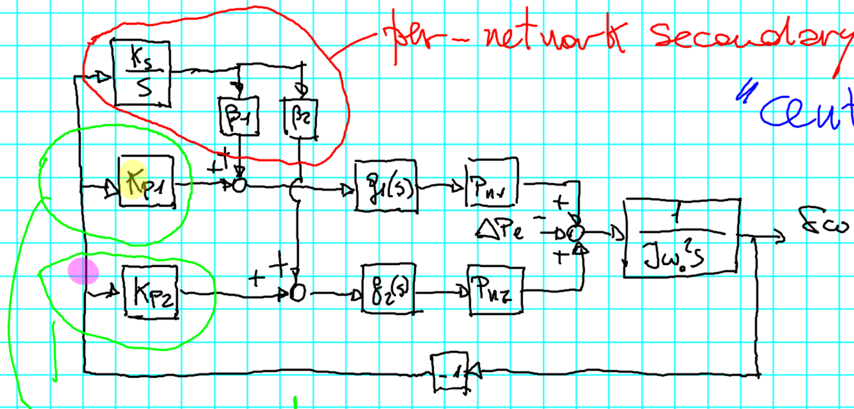
11/04/2019

1

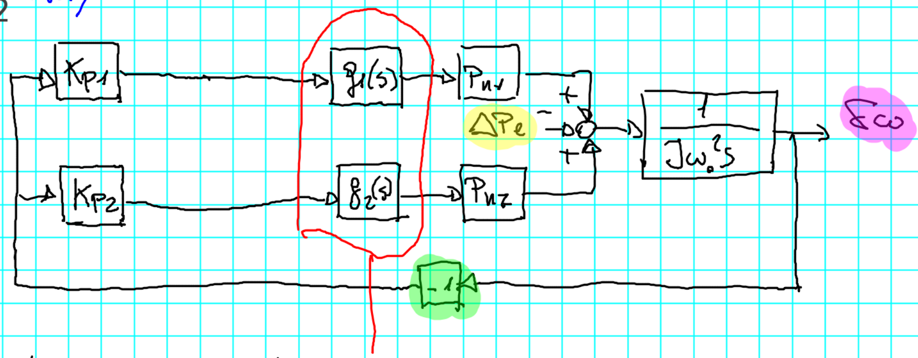
per-network secondary control

"centralised"



per-generator primary control ("K Δf") "distributed"

Primary only



at steady state these are 1

TF: $$\frac{\delta\omega}{\Delta P_e} = \frac{-1/J\omega_0^2 s}{1 + \frac{1}{J\omega_0^2 s}\sum_{i=1}^{2} K_{pi}\, g_i(s)\, P_{ni}} = \frac{-1}{J\omega_0^2 s + \sum_{i=1}^{2} K_{pi}\, g_i(s)\, P_{ni}}$$

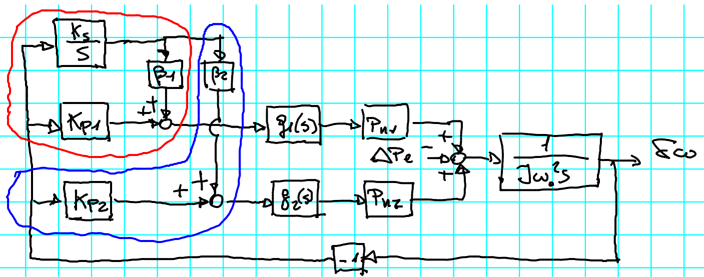
3 Steady-state error with PRI control only: apply a ΔP_e step & use FVT:

$$\delta\omega_\infty = \lim_{s\to 0} \cancel{s}\,\frac{\overline{\Delta P_e}}{\cancel{s}}\;\frac{-1}{\cancel{J\omega_0^2 s} + \sum K_{\varphi i}\,\underbrace{g_i(s)}_{1}\,P_{ni}} = \frac{-\overline{\Delta P_e}}{\sum K_{\varphi i} P_{ni}}$$

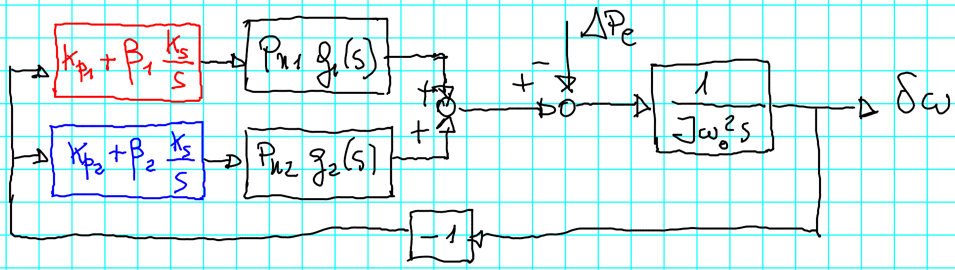
FVT

step of amplitude ΔP_e

4



K_s / s
β_1
β_2
K_{p1}
K_{p2}
$g_1(s)$
$g_2(s)$
P_{n1}
P_{n2}
ΔP_e
$\frac{1}{J\omega_0^2 s}$
$\delta\omega$
-1



$K_{p_1} + \beta_1 \frac{K_s}{s}$
$K_{p_2} + \beta_2 \frac{K_s}{s}$
$P_{n1}\, g_1(s)$
$P_{n2}\, g_2(s)$
ΔP_e
$\frac{1}{J\omega_0^2 s}$
$\delta\omega$
-1

TF from ΔP_e to $\delta\omega$

$$\frac{\delta\omega}{\Delta P_e} = \frac{-1/J\omega_0^2 s}{1+\frac{1}{J\omega_0^2 s}+\sum_{i=1}^{2}\left(K_{pi}+\beta_i\frac{K_s}{s}\right)g_i(s)P_{ni}}$$

Normally in this analysis one sets $\sum\beta_i = 1$, hence

$$\sum \cdots = \sum K_{pi}\, g_i(s) P_{ni} + \frac{K_s}{s}\sum \beta_i\, g_i(s) P_{ni}$$

particularly useful when managing local pools of (quasi) identical generators

6 Addendum

one can sometimes add a P/Z couple to PRI controllers

$$K_{pi} \longrightarrow K_{pi} \frac{1+sT_{zi}}{1+sT_{pi}}$$

Before :

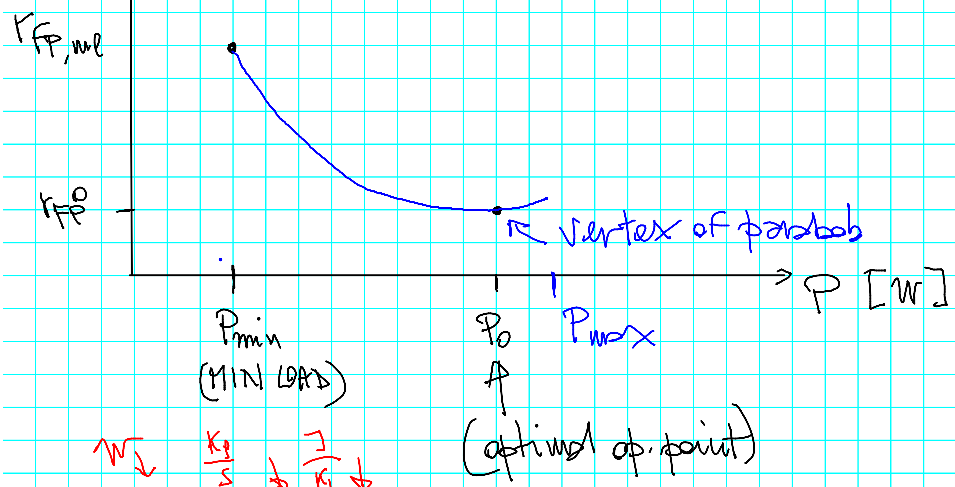
$$\Delta\omega \rightarrow \boxed{K_{pi} + \beta_i \frac{K_S}{s}} \longrightarrow \text{control for local generator}$$

After :

$$K_{pi} + \beta_i \frac{K_S}{s} \frac{1+sT_{zi}}{1+sT_{pi}}$$

				€/W total
1W	3€	cumbte $\rightarrow$	11.5	11.5 / 5
1W	3€		8.5	8.5/4
1W	1.5W		5.5	5.5/3 $<$ 6
1W	2€		4	2
1W	2€		2	2

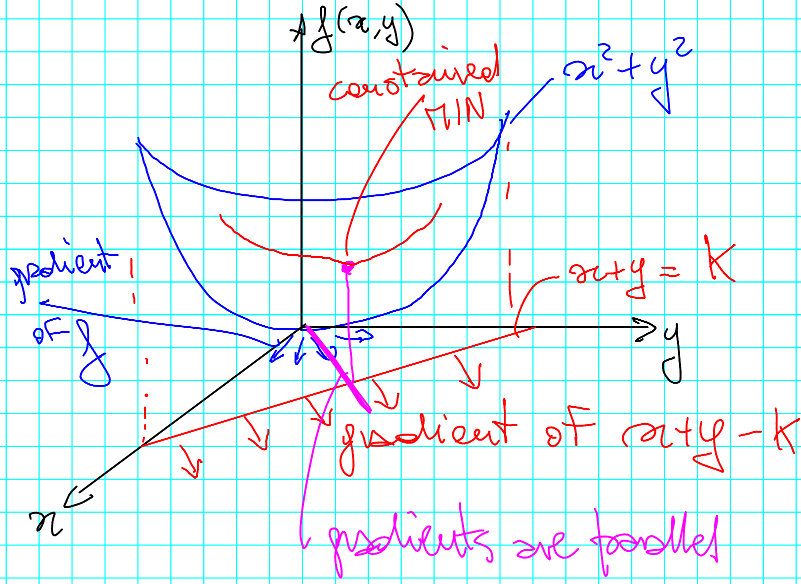
$$r_{FP} = \frac{{}^{*}\text{Power yielded by Fuel}}{\text{generated power}}$$ (inverse of an efficiency)



$$\underset{W}{}\qquad \underset{\frac{kg}{s}}{}\qquad \underset{\frac{J}{kg}}{}$$

* $P_{Fuel} = w_{Fuel}\, HH$, but not all becomes generated power

$$\mathcal{L} = \underbrace{c_1(P_{g1}) + c_2(P_{g2}) + \cdots + c_n(P_{gn})}_{f} + \lambda\left(P_{g1} + P_{g2} + \cdots + P_{gn} - \hat{P}_e\right)$$


$f(x,y)$
constrained MIN
x^2+y^2
gradient of f
$x+y=K$
y
gradient of $x+y-K$
x
gradients are parallel