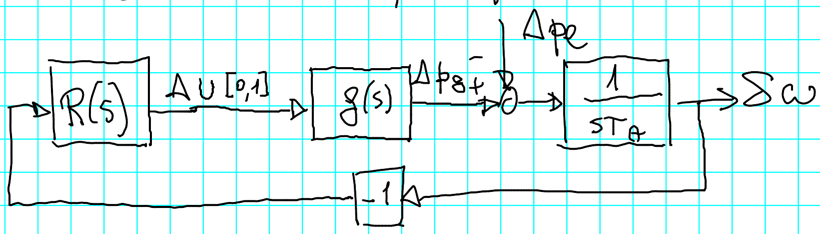
10/04/2019

1

- Islanded generator Pwr/Freq control



- PI vs PID
- Tuning & comments

Simplification for discussion

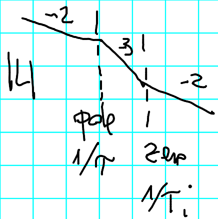
$$g(s) = \frac{1}{1+sT}$$

Loop TF

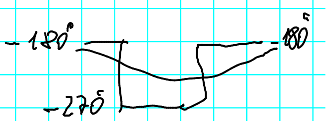
$$L(s) = \underbrace{K\,\frac{1+sT_i}{sT_i}}_{PI}\,\frac{1}{1+s\tau}\,\frac{1}{sT_A} = \frac{K}{s^2T_iT_A}\,\frac{1+sT_i}{1+s\tau}$$

$T_i = \tau \Rightarrow \dfrac{K}{s^2T_iT_A}$ $\qquad \varphi_m = 0^\circ$

$T_i < \tau \Rightarrow$ $|L|$

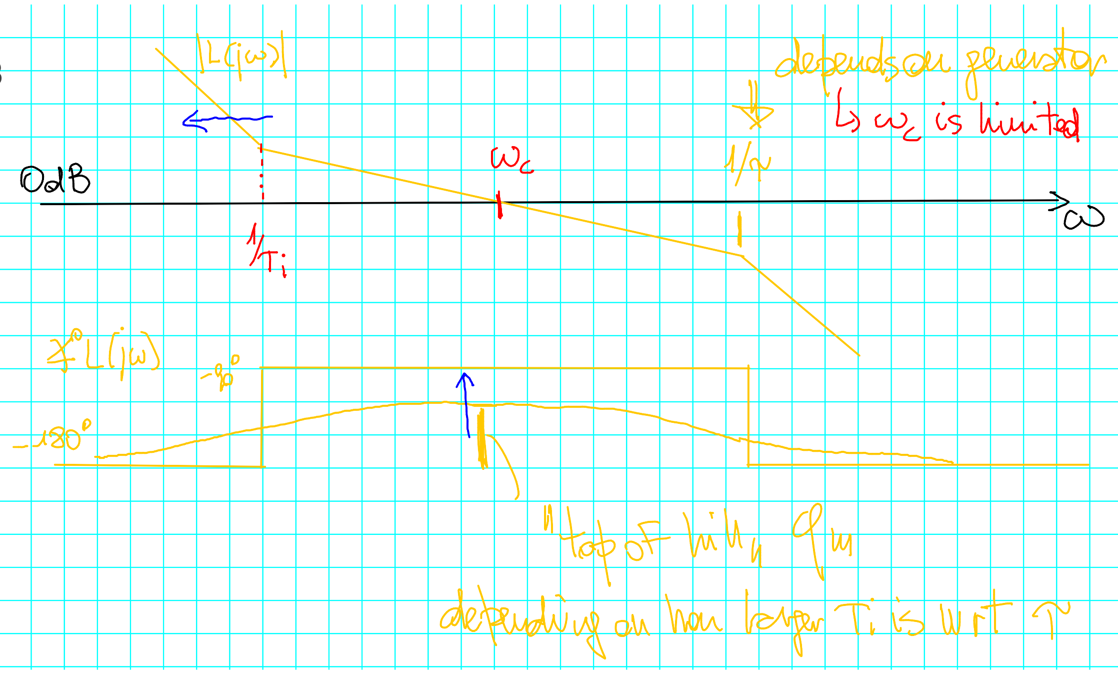


$\measuredangle^\circ L$

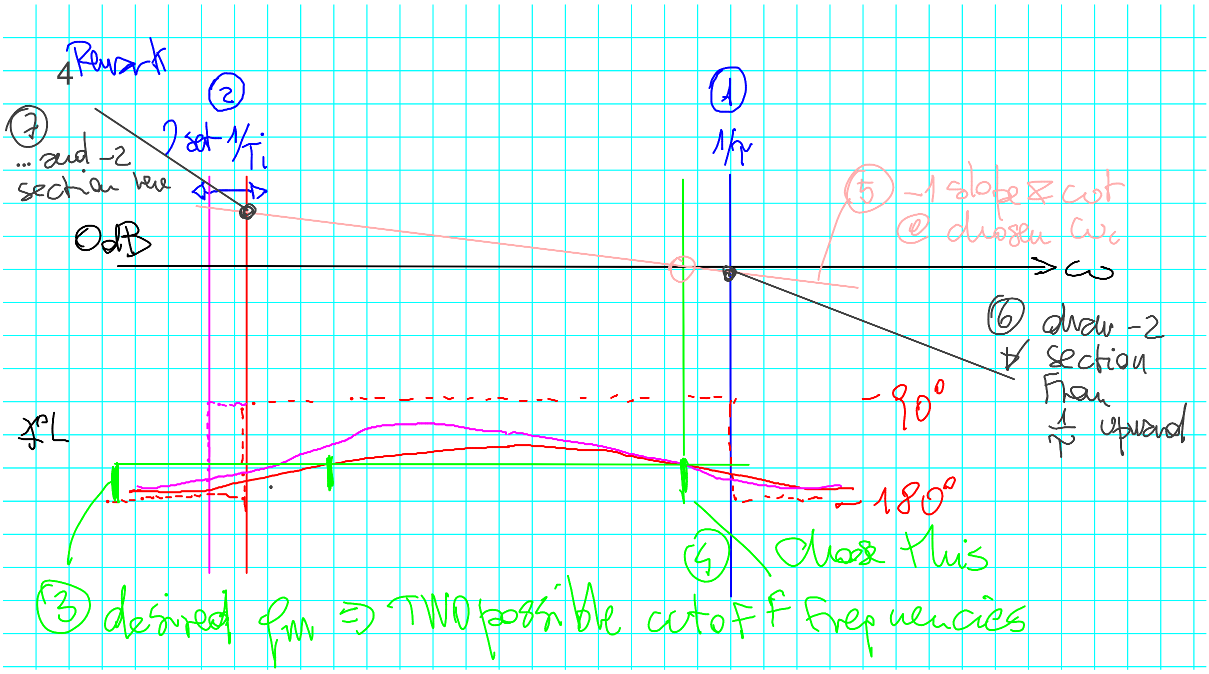


Hence we MUST set $T_i > \tau \Rightarrow$ response speed limit

3



|L(jω)|
depends on generator
↳ ωc is limited
ωc
1/τ
0dB
ω
1/Ti
∡ L(jω)
-90°
-180°
"top of hill" φm
depending on how larger Ti is wrt τ

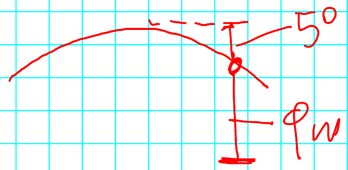

Remark
(7) ... and −2 section here
(2) set 1/Ti
(1) 1/τ
(5) −1 slope & cut @ chosen ωc
0dB
ω
(6) draw −2 section from 1/τ upward
∠L
−90°
−180°
(4) choose this
(3) desired φm ⇒ TWO possible cutoff frequencies

Es. 1

$$g(s) = \frac{1}{1+10s} \qquad T_A = 5$$

Tune a PI for the islanded generator aiming at $\varphi_m = 40°$ with the maximum achievable ω_c compatible with a phase slack of 5° over φ_m

phase hill



$\Rightarrow$ log paper

E2)

$$g(s) = \frac{1}{1+s/2} \qquad T_A = 4$$

Tune PI control for $\omega_c = 0.5$ and $\varphi_m = 45°$

Why could a PID be useful

"process" $\dfrac{1}{1+s\tau} \; \dfrac{1}{sT_A}$

with a PI we cannot cancel the pole ⇒ speed limit

With a REAL PID

$$R(s) = K \frac{(1+sT_1)(1+sT_2)}{s(1+sT_p)}$$

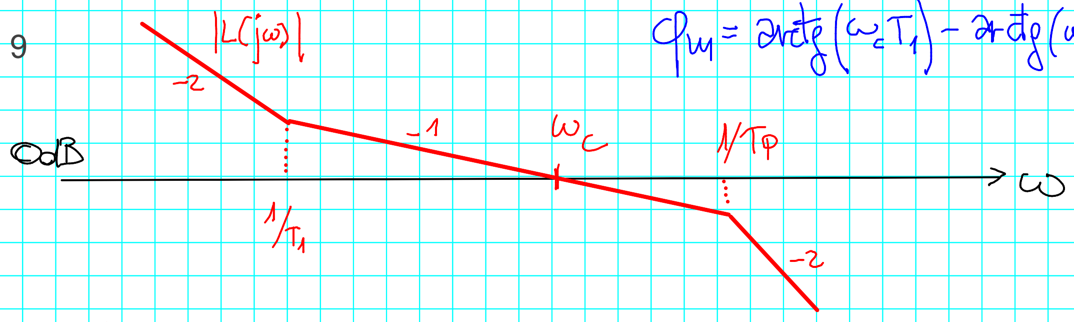
We can use one zero (say that with t. constant T_2) to cancel the process pole

8 $$L(s) = K \frac{(1+sT_1)\cancel{(1+s\tau)}}{s(1+sT_p)} \frac{1}{\cancel{1+s\tau}} \frac{1}{sT_A}$$

$$= \frac{K}{s^2 T_A} \underbrace{\frac{1+sT_1}{1+sT_p}}$$

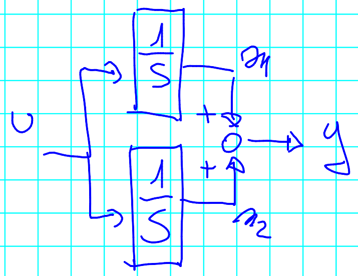
Full control on pole & zero of L

$$\varphi_m = \arctan(\omega_c T_1) - \arctan(\omega_c T_p)$$



Clue: once ω_c is selected
choose T_1 and T_p to yield the required φ_m
and as close as possible to one another

Also remember low-freq controller zeroes mean
slow disturbance rejection (in general) & SP response kicks



$$\frac{Y}{U} = \frac{2}{s}$$

PRIMARY + SECONDARY control