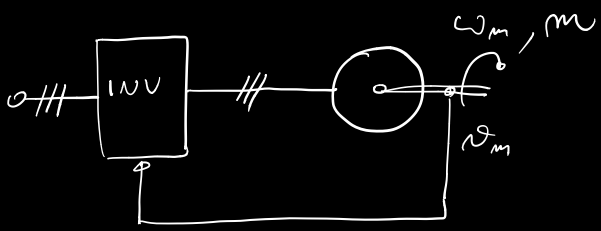
CONTROLLO SENSOR-LESS

SELF-SENSING



Devo conoscere ϑ_m

Anello di corrente : m

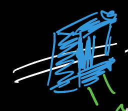
Anello di velocità ω_m

" " posizione ϑ_m

Sensore posizione
- costo 2048 10 000
- ingombro / peso
- possibilità di guasto

Costruisco una stima di ϑ_m^e usando?

MISURE DI CORRENTE
- sonde Hall

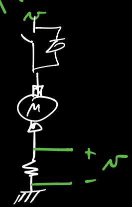


$i_a + i_b + i_c = 0$

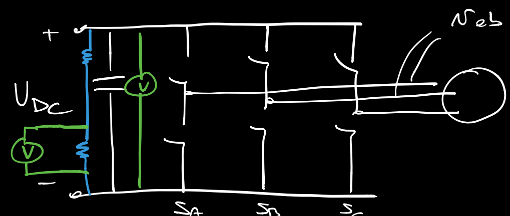
2 correnti!

$i_a = -i_b - i_c$

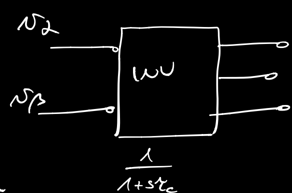
- R. shunt



MISURE DI TENSIONE



v_{ab} v_{bc} v_{ca} → v_{am}, v_{bm}, v_{cm}



Ricostruisco v_a v_b v_c dagli stati dell'inverter oppure posso confondere i riferimenti con i valori reali eventualmente compensando le non idealità dell'inverter!

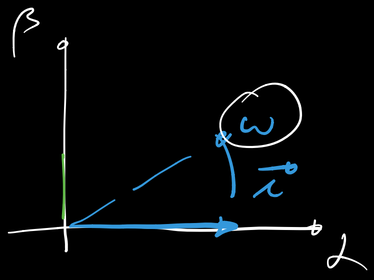
TIPOLOGIA DEL MOTORE < ISOTROPA / ANISOTROPA

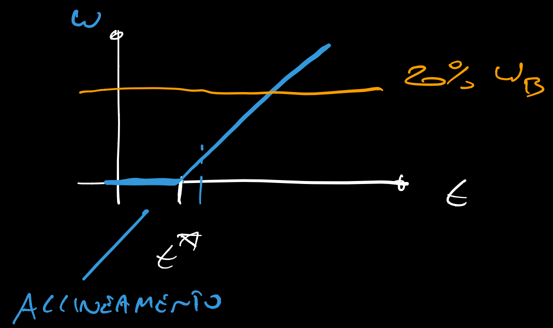
VELOCITÀ DI FUNZIONAMENTO < BASSA / NULLA ; MEDIA / ALTA VELOCITÀ

	BASSA/NULLA VELOCITÀ	ALTA VELOCITÀ
ISOTROPA	NON È POSSIBILE SE NON INTRODUCENDO SPECIFICHE MODIFICHE	λ_m $\frac{d\lambda}{dt}$
ANISOTROPA	SFRUTTO LA SUA SALIENZA	Posso stimare d-

SENSOR-LESS ALTA / VELOCITÀ CON MACCHINA ISOTROPA

MEDIA $\simeq 20\% \, \omega_B$





$$\vartheta_m^e = \int \omega \, dt$$

OLTRE $20\% \, \omega_B$ $\quad \tilde{\vartheta}_m^e \, , \, \tilde{\omega}_m^e$

Quando $|\vartheta_m^e - \tilde{\vartheta}_m^e| < \varepsilon \Rightarrow$ CATENA APERTA

↓

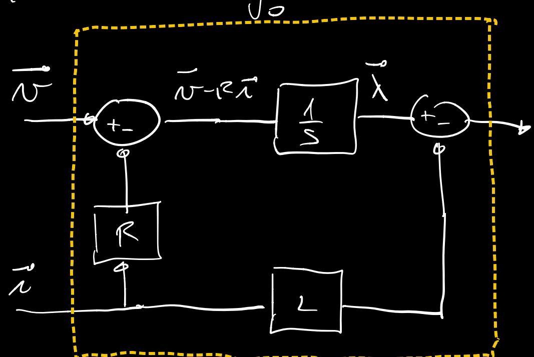
FOC IN CATENA CHIUSA $\tilde{\vartheta}_m^e$

Equazione di tensione in α-β

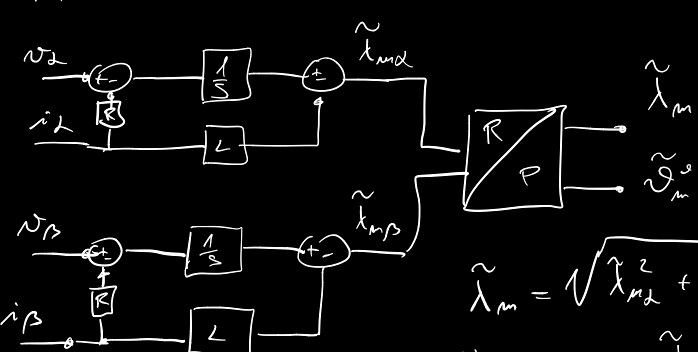
$$\vec{v} = R\vec{i} + \frac{d\vec{\lambda}}{dt} \qquad \vec{\lambda} = \vec{\lambda}_m + L\vec{i}$$

$$\frac{d\vec{\lambda}}{dt} = \vec{v} - R\vec{i} \qquad \vec{\lambda} = \int_0^t \vec{v} - R\vec{i} \, dt$$

$$\vec{\lambda}_m = \vec{\lambda} - L\vec{i} = \int_0^t \vec{v} - R\vec{i} \, dt - L\vec{i}$$



$$\tilde{\vec{\lambda}}_m = \tilde{\lambda}_m e^{j\tilde{\vartheta}_m^e}$$



$$\tilde{\lambda}_m = \sqrt{\tilde{\lambda}_{m\alpha}^2 + \tilde{\lambda}_{m\beta}^2}$$

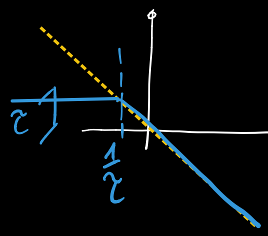
$$\tilde{\vartheta}_m^e = \operatorname{atan} \frac{\tilde{\lambda}_{m\beta}}{\tilde{\lambda}_{m\alpha}}$$

$$\tilde{\omega}_m^e = \frac{d}{dt} \tilde{\vartheta}_m^e$$

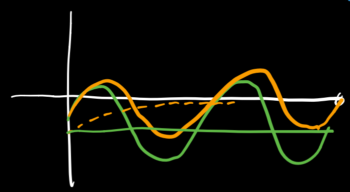
- INTEGRATORE PURO ① OFFSET: VALORE INIZIALE DEL FLUSSO
  ② BIAS NELLE MISURE → SATURAZIONE L'INTEGRATORE "DRIFT"

Sostituisco con un filtro passa basso LPF

$$\frac{1}{s} \simeq \frac{\tau}{1+s\tau}$$



① OFFSET decade come $e^{-\frac{t}{\tau}}$



② Con BIAS δ in ingresso vedo in uscita $\tau\delta$

- Devo conoscere i parametri R/L

$$R = R_0 (1+\alpha \Delta temp)$$

ω_m^e è ≈ 0 $\quad v \approx Ri$ $\quad (\omega\lambda \approx 0)$

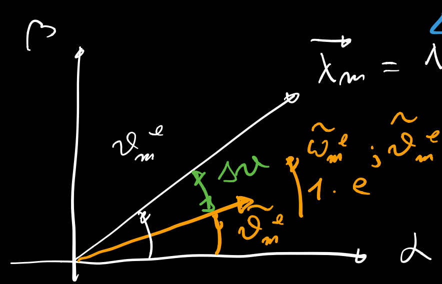
- MISURE / COMPENSAZIONE ACCURATE!
- $\tilde{\omega}_m^e = \frac{d\tilde{\vartheta}_m^e}{dt}$

$$\tilde{\vartheta}_m^e(t) = A \sin(\omega t) + \overbrace{B \sin(100\omega t)}^{\text{RUMORE}}$$

$$\tilde{\omega}_m^e(t) = \underline{\omega A} \cos(\omega t) + \underline{100 B \omega} \cos(100\omega t)$$

STIMATORE CON PLL PHASE LOCKED LOOP

$$\Delta\vartheta = \vartheta_m^e - \tilde{\vartheta}_m^e$$



$\Delta\vartheta > 0$ $\quad \tilde{\omega}_m^e$ deve aumentare

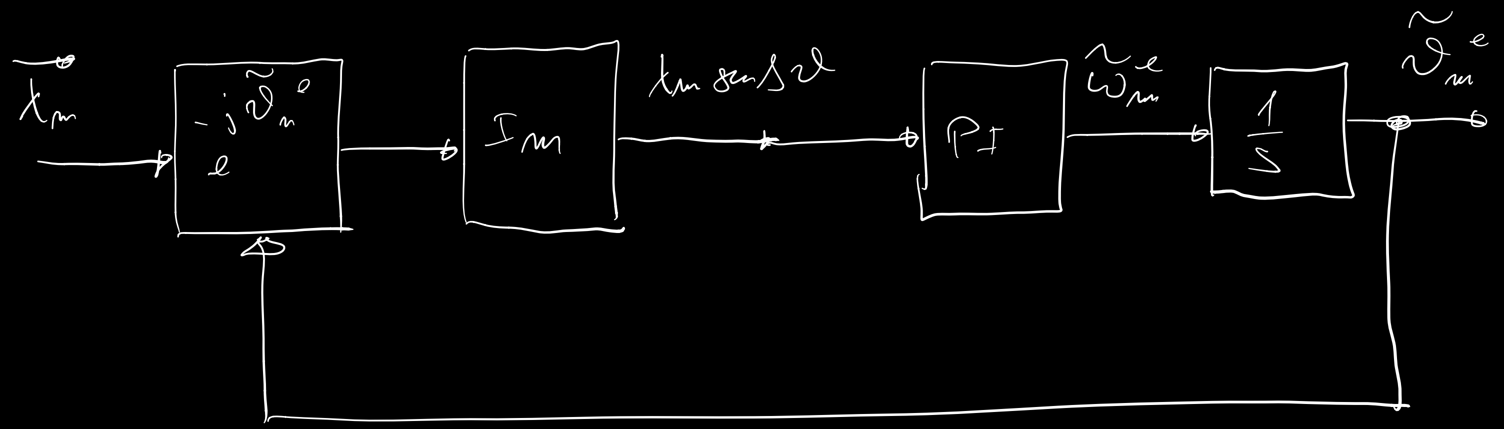
$\Delta\vartheta < 0$ $\quad \tilde{\omega}_m^e$ deve diminuire

$$\vec{\lambda}_m e^{-j\tilde{\vartheta}_m^e} = \lambda_m e^{j\vartheta_m^e} e^{-j\tilde{\vartheta}_m^e} = \lambda_m e^{j\Delta\vartheta}$$

- Re: $\lambda_m \cos\Delta\vartheta$
- Im: $\lambda_m \operatorname{sen}\Delta\vartheta$

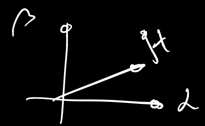
VEDI PRIMA

$\sin\Delta\vartheta \cong \Delta\vartheta$



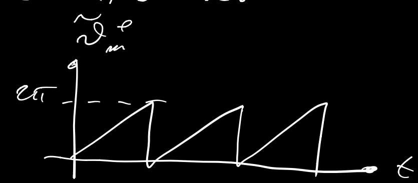
A REGIME

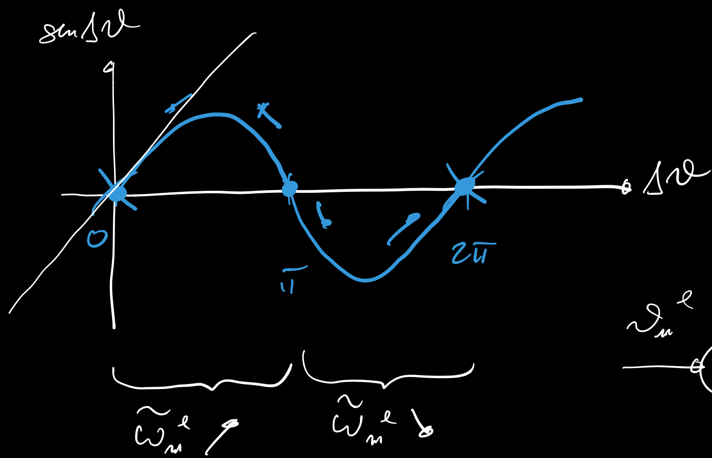
$\vec{\lambda}_m$



$\lambda_{m\alpha}$, $\lambda_{m\beta}$ } sono sinusoidi

$\tilde{\vartheta}_m^e = \vartheta_m^e \quad \Delta\vartheta = 0 \quad \tilde{\omega}_m^e = cost$





$\sin\Delta\vartheta = \Delta\vartheta$