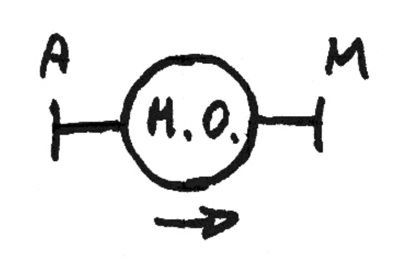
Lezione 5

Generalità sulle Macchine Operatrici

Prevalenza



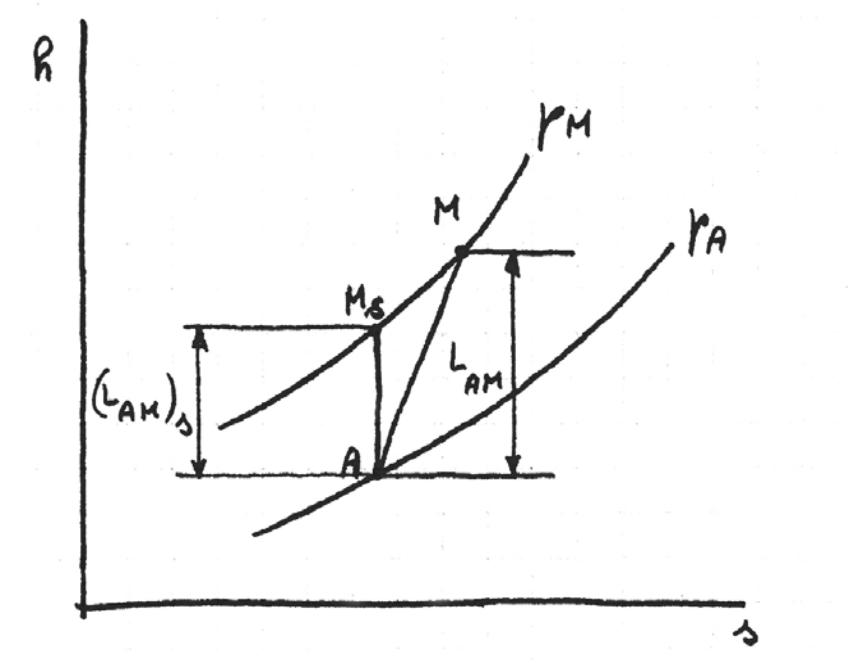
- Si chiama prevalenza *Y* l'incremento di energia meccanica del fluido fra A ed M, al netto delle perdite

$$\frac{c_M^2 - c_A^2}{2} + g\left(z_M - z_A\right) = L'_{AM} - \int_A^M v\,dp - \mathcal{L}_{aAM}$$

$$Y = L'_{AM} - \mathcal{L}_{aAM}$$

Fluidi comprimibili

$$\mathcal{L}_{aAM} = \left(q_{eAM}\right)_y - \left(\int_A^M T\,ds_e\right)_y + \int_A^M T\,ds_s$$

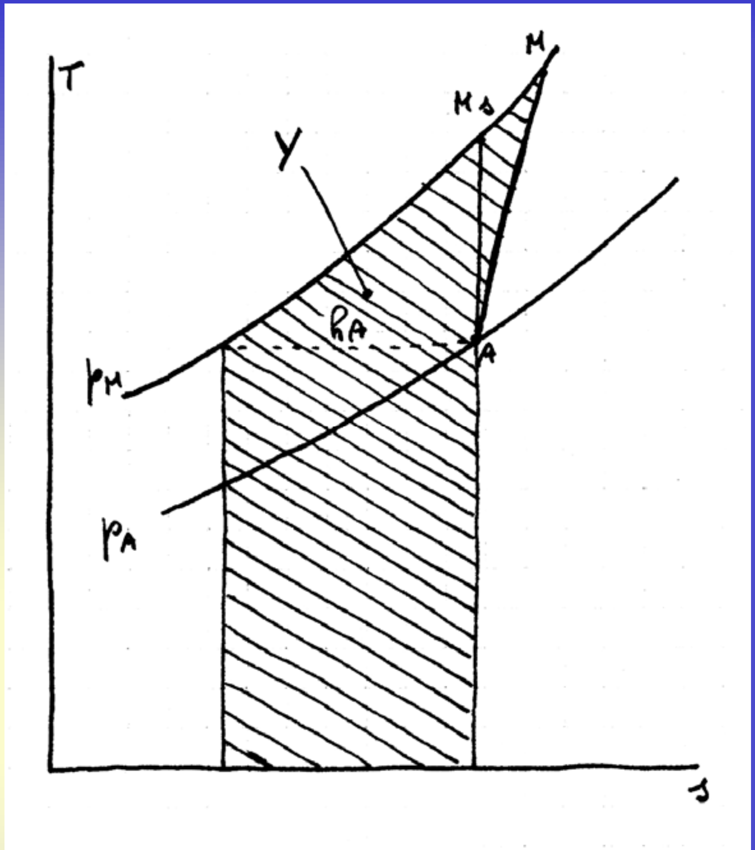


$$h_M - h_A = L'_{AM} = \left(L'_{AM}\right)_y + \left(q_{eAM}\right)_y$$

$$h_{Ms} - h_A = \left(L'_{AM}\right)_s = L'_{AM} - \mathcal{L}_{aAM} - \left(\int_A^M v\,dp - \int_A^{M_s} v\,dp\right)$$

$$Y \simeq \left(L'_{AM}\right)_y$$

$$Y \simeq L'_{AM}\,\eta_c$$



Fluidi incomprimibili

$$Y = L'_{AM} - \mathscr{L}_{aAM}$$

$$H = \frac{L'_{AM}}{g} - \left(\mathscr{K}_p\right)_{AM}$$

$$Y = gH$$

Prevalenza totale, geodetica, manometrica, cinetica

$$\frac{c_M^2 - c_A^2}{2} + g\left(z_M - z_A\right) = L'_{AM} - \int_A^M v\,dp - \mathscr{L}_{aAM}$$

$$Y = L'_{AM} - \mathscr{L}_{aAM}$$

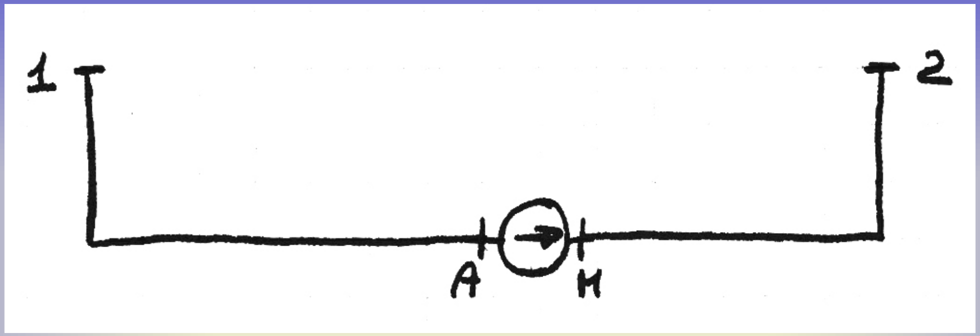
$$Y = g\left(z_M - z_A\right) + \int_A^M \frac{dp}{\rho} + \frac{c_M^2 - c_A^2}{2}$$

$$Y = Y_g + Y_m + Y_c$$

Prevalenza in forme particolari

•Pompa centrifuga	*Ym*
•Elica in vena libera	*Yc*
•Vite d’Archimede	*Yg*

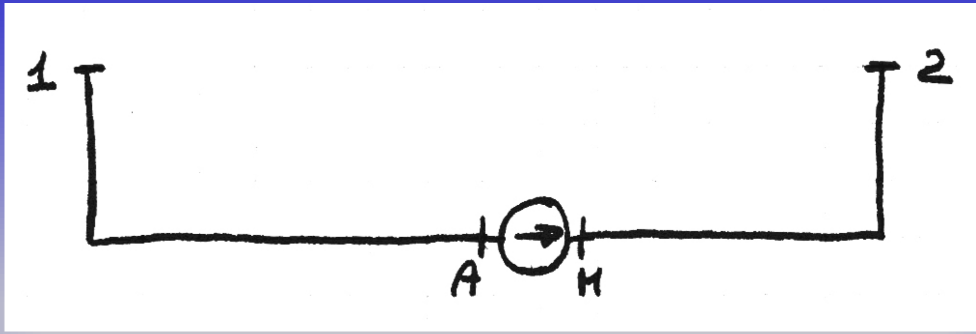
Applicazione ai circuiti



Caso elementare

$$\frac{c_1^2}{2g} + z_1 + \frac{p_1}{\rho g} = \frac{c_2^2}{2g} + z_2 + \frac{p_2}{\rho g} + \frac{\mathscr{L}_{a12}}{g} - \frac{L'_{12}}{g}$$

$$L'_{12} = L'_{AM}$$



Suddivisione delle perdite

$$\mathscr{H}_p = \mathscr{L}_a / g$$

$$\frac{c_1^2}{2g} + z_1 + \frac{p_1}{\rho g} = \frac{c_2^2}{2g} + z_2 + \frac{p_2}{\rho g} + \mathscr{H}_{p1A} + \mathscr{H}_{pM2} - \left(\frac{L'_{12}}{g} - \mathscr{H}_{pAM} \right)$$

$$\mathscr{H}_{pE} = \mathscr{H}_{p1A} + \mathscr{H}_{pM2}$$

Richiesta del circuito

$$\mathcal{H}_{pE} = \mathcal{H}_{p1A} + \mathcal{H}_{pM2}$$

$$H = \left(z_2 - z_1\right) + \frac{p_2 - p_1}{\rho g} + \frac{c_2^2 - c_1^2}{2g} + \mathcal{H}_{pE}$$

Perdite concentrate e distribuite

$$\mathcal{H}_{pE} = \sum_i \mathcal{H}'_{pi} + \sum_j \mathcal{H}''_{pj}$$

$$\mathcal{H}'_{pi} = \zeta_i \frac{c_i^2}{2g}$$

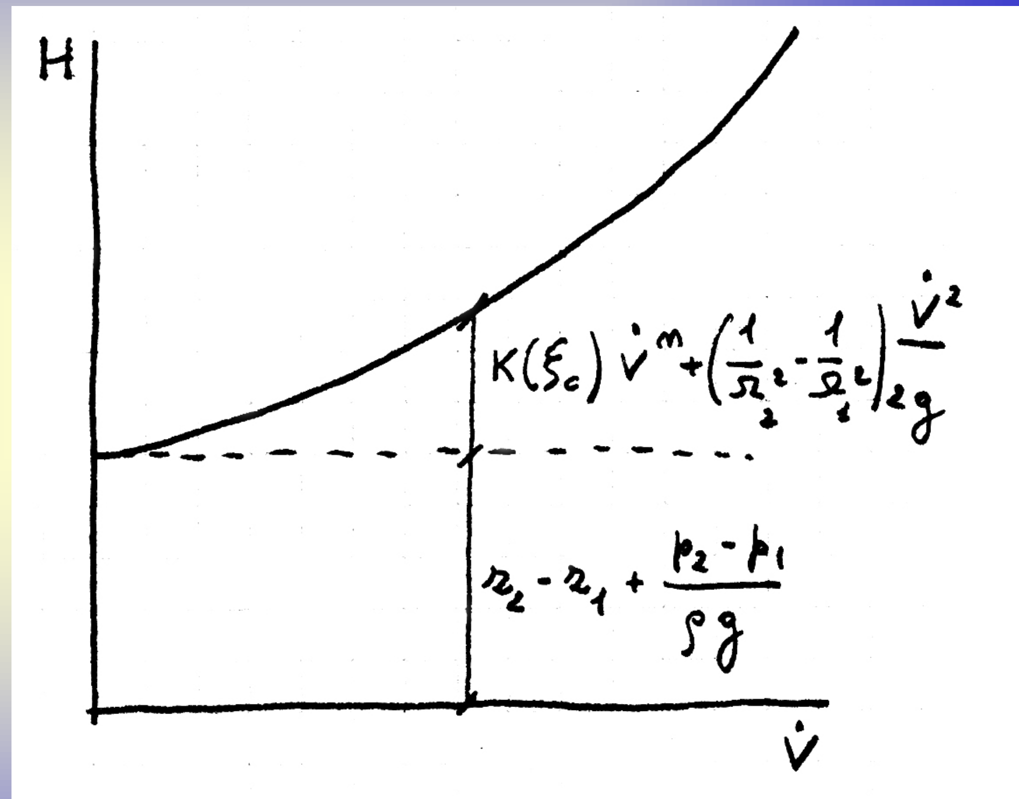
$$\mathcal{H}''_{pj} = \lambda_j \frac{\ell_j}{D_j} \frac{c_j^2}{2g}$$

Approssimazione

$$\mathcal{H}_{pE} = K\left(\zeta_c\right)\dot{V}^n$$

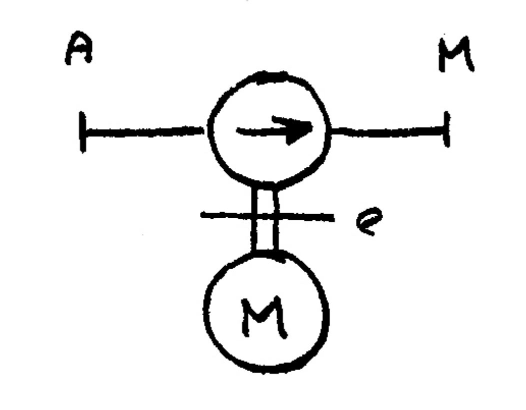
$$H = \left(z_2 - z_1\right) + \frac{p_2 - p_1}{\rho g} + \frac{c_2^2 - c_1^2}{2g} + \mathcal{H}_{pE}$$

Caratteristica esterna

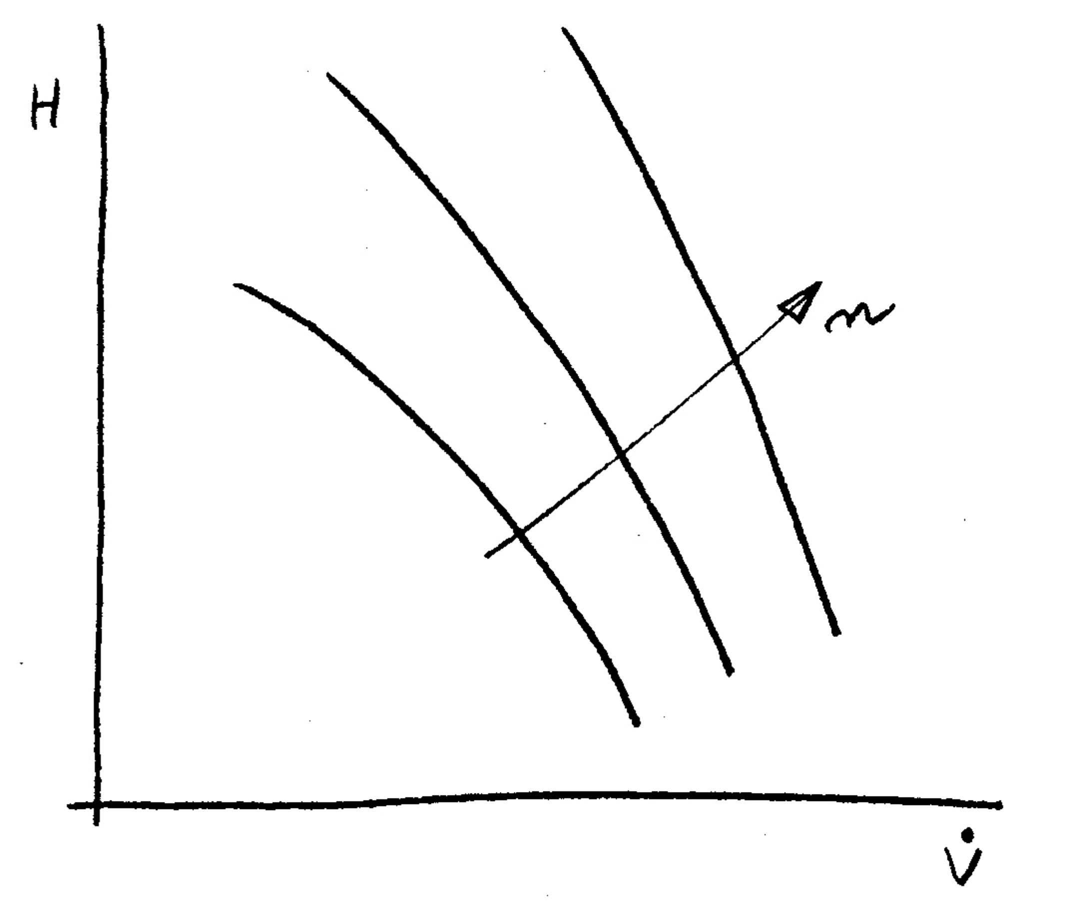


$$H = \left[\left(z_2 - z_1\right) + \frac{p_2 - p_1}{\rho g}\right] + \left[\left(\frac{1}{\Omega_2^2} - \frac{1}{\Omega_1^2}\right)\frac{\dot{V}^2}{2g} + K\left(\zeta_c\right)\dot{V}^n\right]$$

Funzionamento a regime della macchina operatrice



3 interfacce (fluido ; albero)



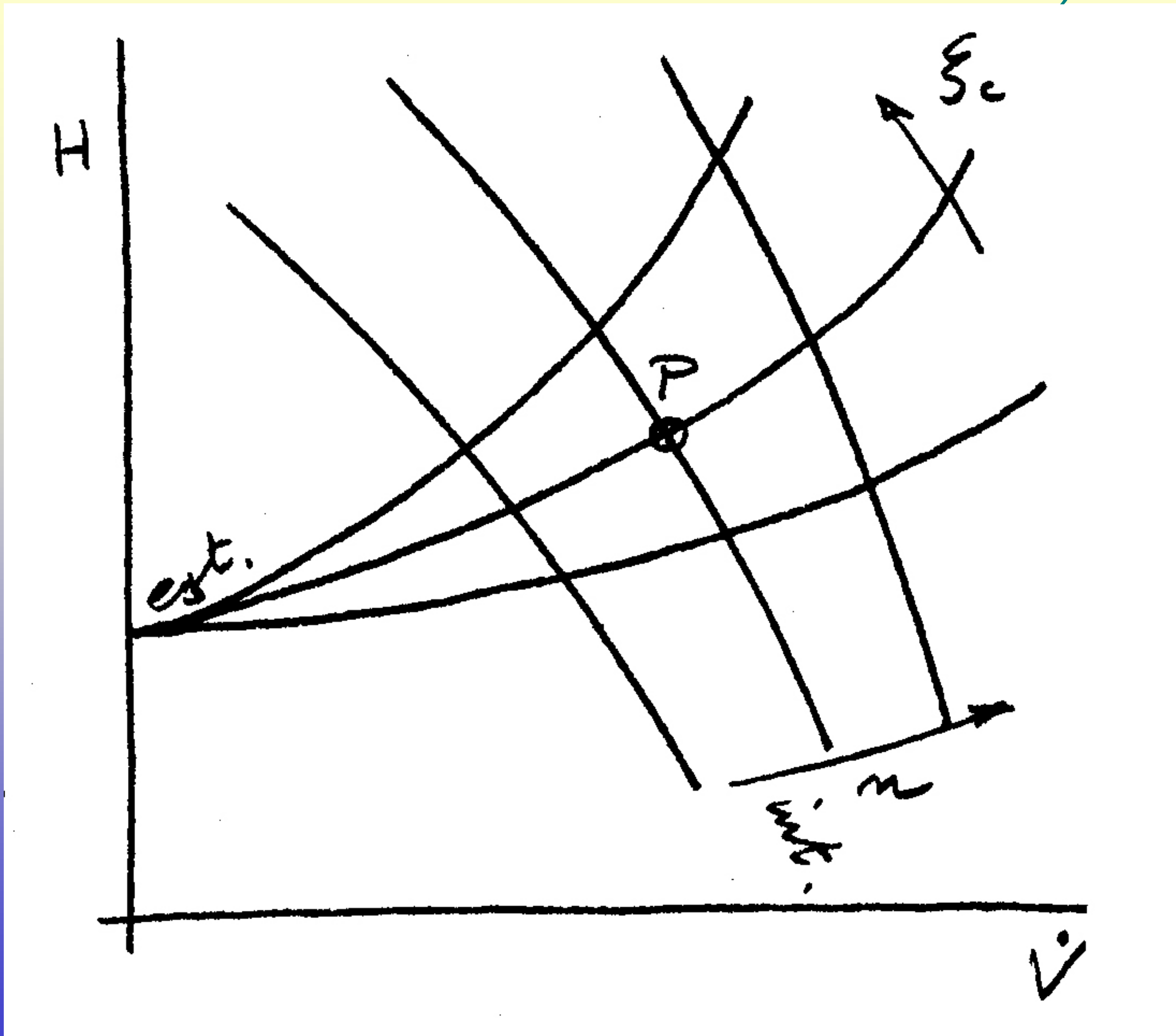
$$P_e = C_e \omega = 2\pi C_e n$$

Caratteristiche interne

Funzionamento in equilibrio (a regime)

Prevalenza fornita = Prevalenza richiesta

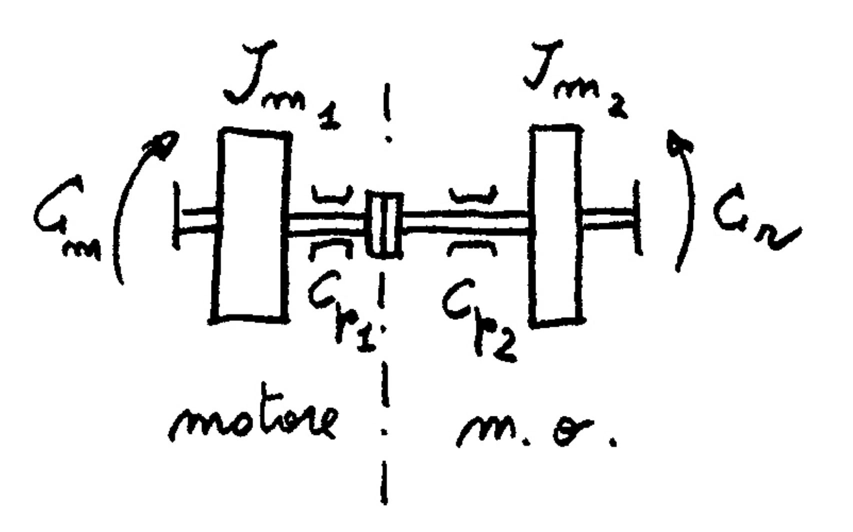
(intersezione caratteristica interna e caratteristica esterna)



Caratteristiche meccaniche

- equilibrio dinamico

$$\frac{d\omega}{dt} = \frac{C_m - C_r - \sum C_p}{\sum J_m}$$

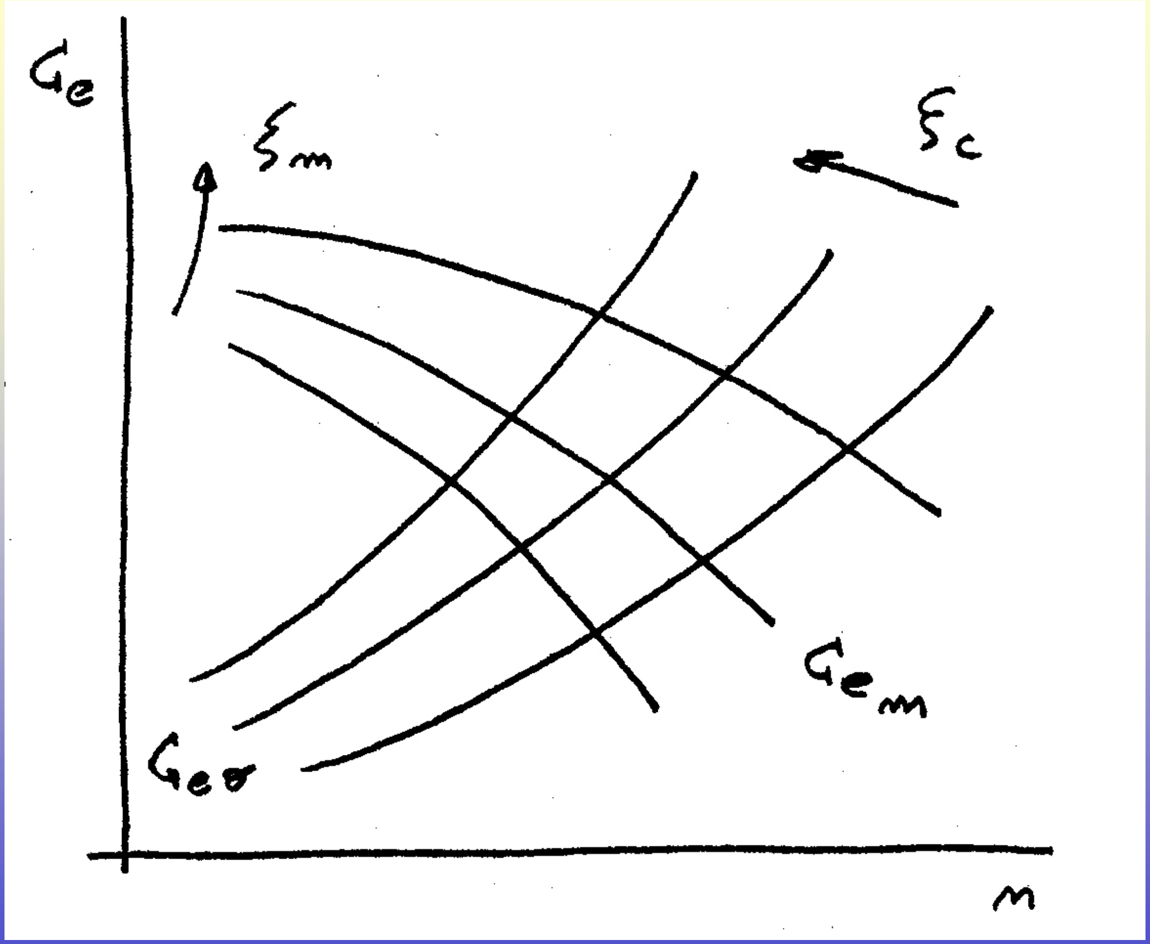


- a regime il I° membro = 0

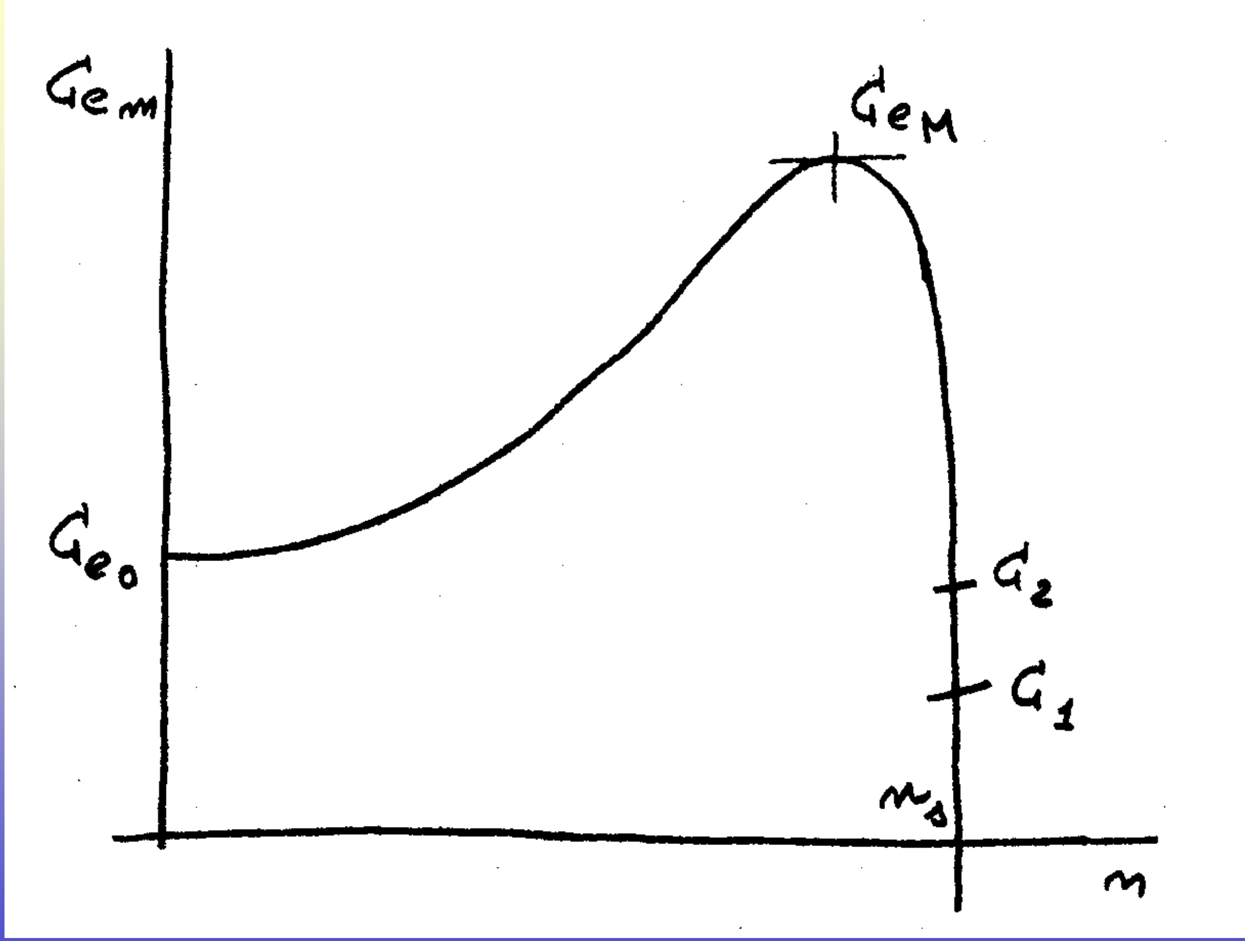
$$C_{em} = C_m - C_{p1}$$

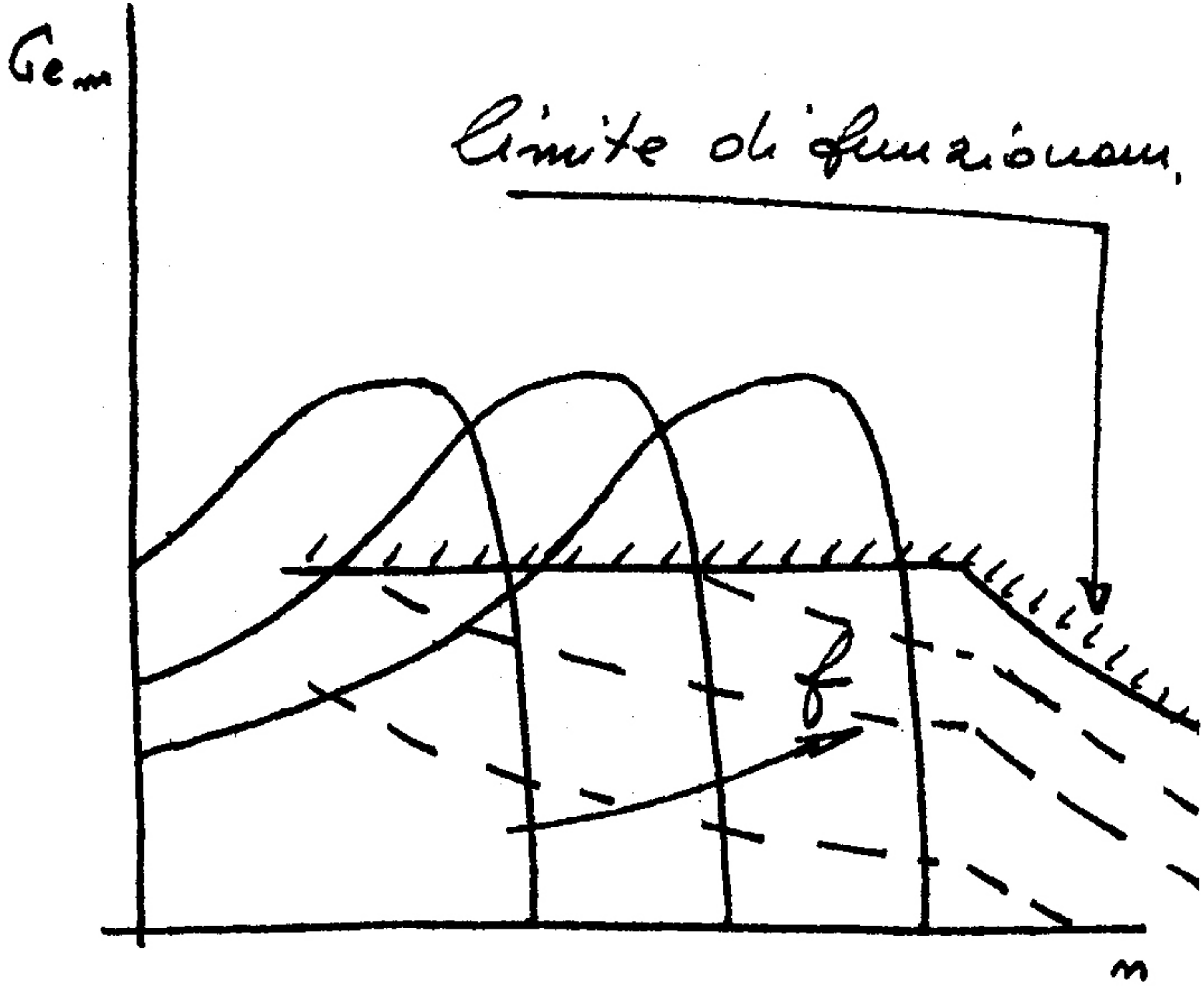
$$C_{eO} = C_r + C_{p2}$$

Rappresentazione grafica dell'equilibrio dei momenti sull'albero

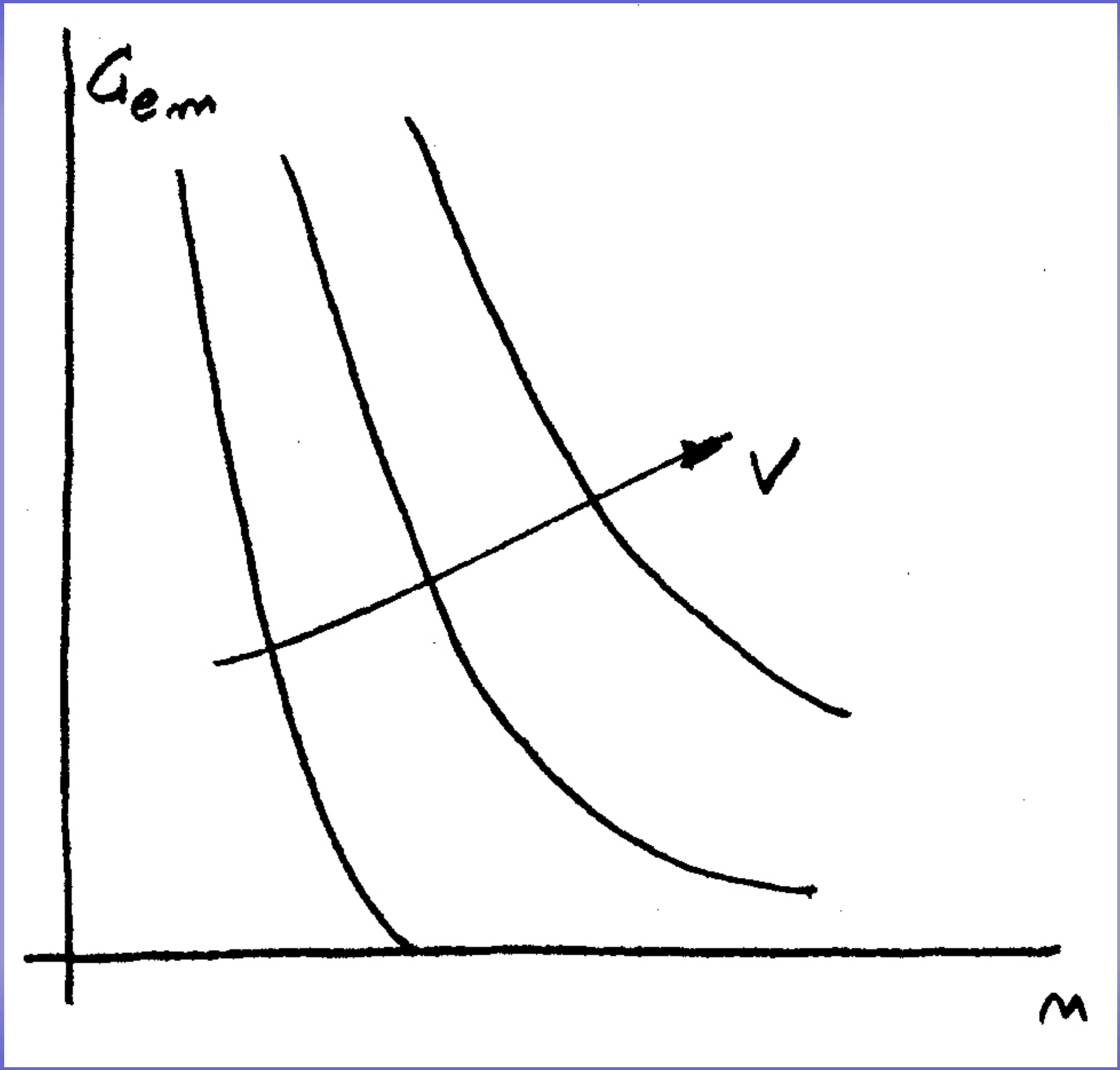


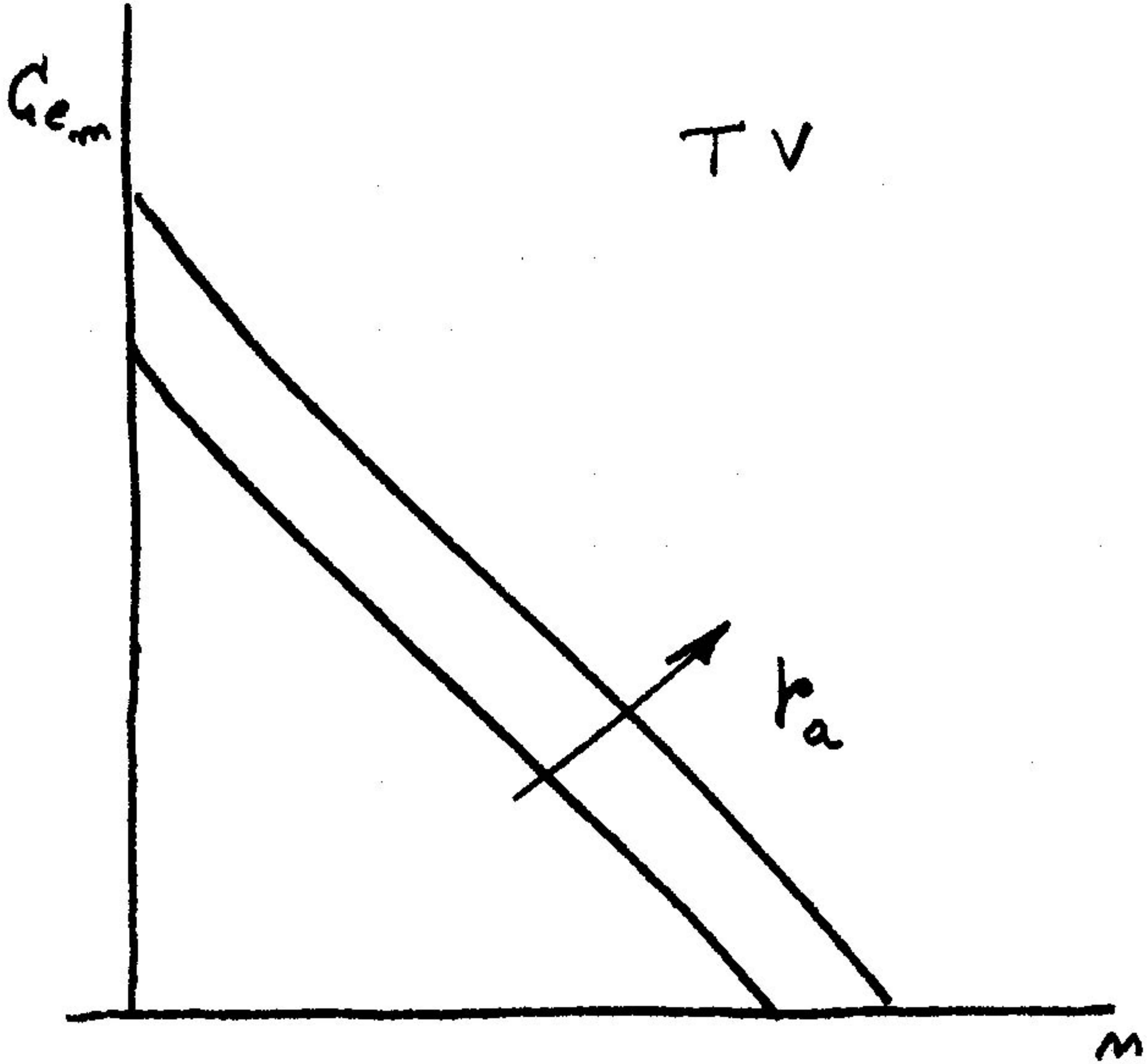
Caratteristiche meccaniche dei motori



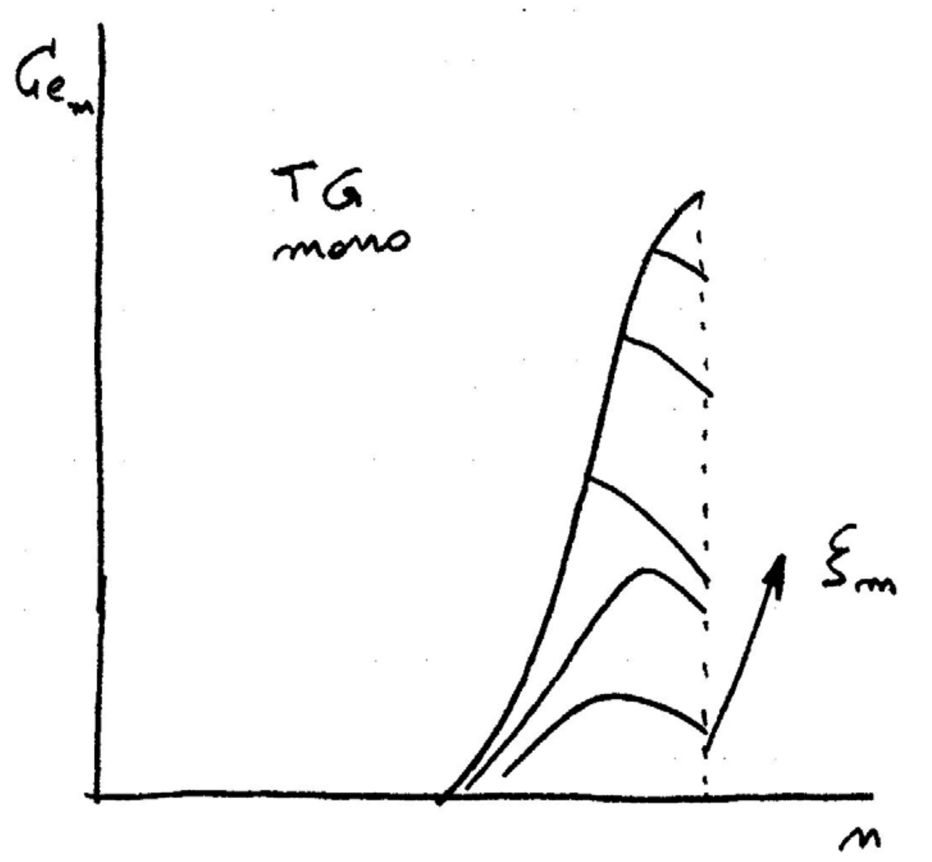


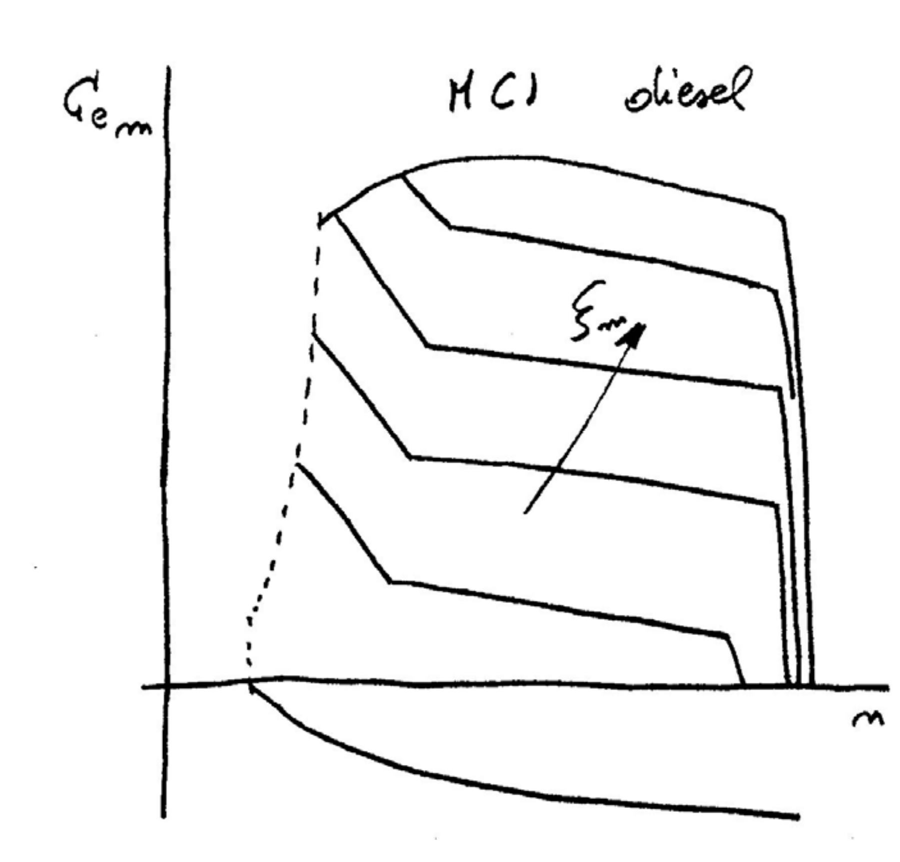
Cem
limite di funzionam.
f
n


G_{em}
V
n

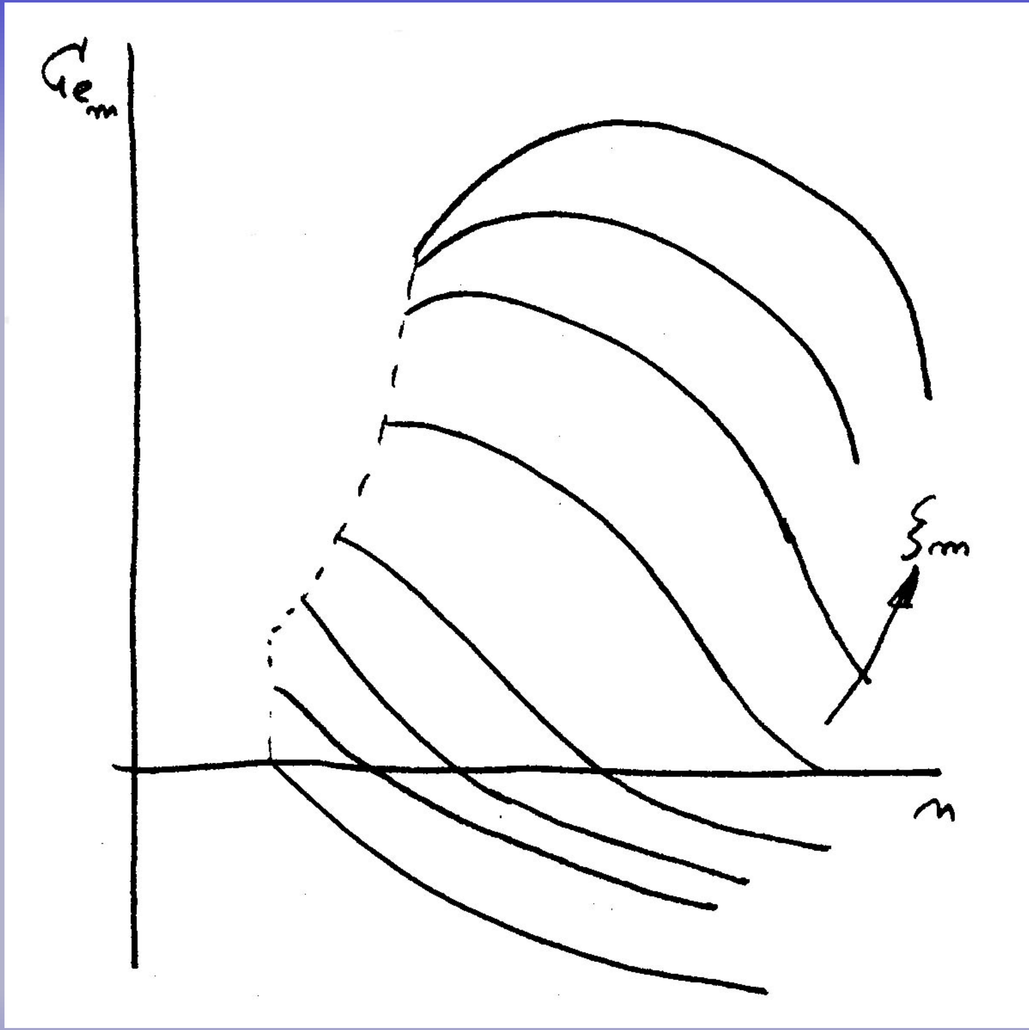


Gem
TV
ra
m





- $$\frac{n_{min}}{n_{max}} \cong 0,5 \div 0,6$$ TG
- $$\frac{n_{min}}{n_{max}} \cong 0,12 \div 0,18$$ MCI



Ge_m
ξ_m
n