Let W targmin L(Z,N), Show that Aw-b & dgln).

 $g(n) = -f^*(-A^T n) - \lambda^T b$, where $-f^*(y) = m in f(x) - y^T x$, is the conjugate func.

29(N)= A# f*(-ATA)-b. (Due to subgradiant property).

Next we show that wedft(-ATA).

This is equivalent to LATA & oflw)

Since we argmin Lizin) = argmin f(z)+ NT(Az)-NTb.

Hence. WE argmin flz) + XAZ.

» w € af*(-ATA).

⇒ Aw-b € dgln).

XE Sf*(4)

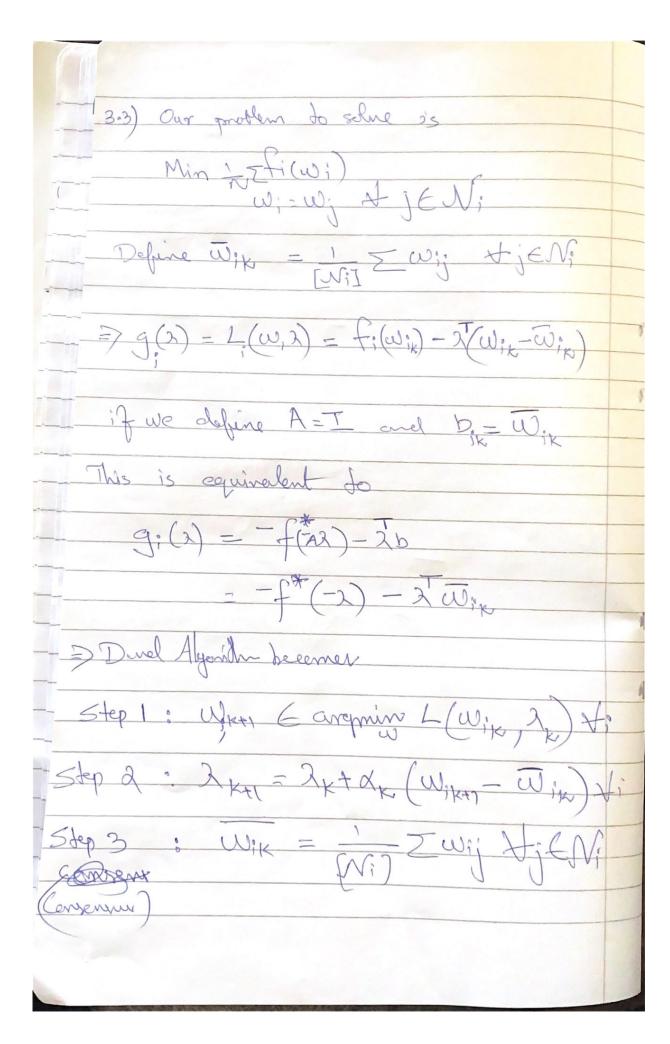
y Edfox)

X Eougmin f (2) - y^T &

Thomas f is 2-smooth = ft is 1/2 strengly convert
Proof: f is Lamouth > 7f is Lipschitz => (Tfcv) - Tfcy) (x-y) 7/ 1/2 | Tfcn - Tfcy) Let y = \(\frac{1}{4}(y)\)

\(\times \times 2\f^*(y)\)
\(\times 2\f^*(y)\)
\(\times \times 7\f^*(y)\) => (u-v) (e-y) > 1/4-v//2 2 ty Eafter, VE afty > The fis 1 strengly convex Thm 2: fis M-strongly convex = ft is 1 -smooth Let 4= Vf(x4), V= Vf(xx) => xy= 7f* (u) = argnin (f(z) - uz) xy - 7f* (v) - aremin (f(2) - 1/2) (Because of dozenew & strong convexity) That is so is the minimizes of the strengthe convex function fcz) - uTZ => fexu)-utxy > f(xy)-utxy + M ||xy-xy|| + xx Now changing the roler of say and say after noting that sex is the minimizes of f(2) - VZ, f(xy)-xxy > f(xy)-vxv + M2 /1xv-xy//2

Adding the two => f(xy) + f(xy) + Vxy - Uxy > f(xy) + f(xy) => M/kv-xu//2 = J(xy-xv) AJ (xy-xy) = (J-VT)(2u-2v -J////xu-xv/ => |(x,-xy) = 1 (u-v) => f* is 1 - smooth Conclusion: Form thm-1 and thm-2 if f is t-smooth of 1-shortylements on the smooth of 1-shortylements Conclusing In gradient dual ascent of f use do the consequence of f use do the should by - convex of Standard convergence results apply \$600 ||xx-x*||2 < 1- 2 || 1/x0-x*||2



The geometric graph converger at Noy Nboy Ec and we know the convergence nel agent asso The combined correspond will be In worst of the fund