$$\frac{\partial}{\partial y}\left(\bar{P}\bar{t}\,\frac{\partial w}{\partial y}\right) + \frac{\partial}{\partial x}\left(\bar{P}\bar{t}\,\frac{\partial w}{\partial x}\right) + f(x,y,t) = \rho\,\frac{\partial^2 w}{\partial t^2}\,\bar{t}$$

IF $\bar{t} = \text{const}$ $\quad \frac{\partial}{\partial y}\left(\bar{P}\frac{\partial w}{\partial y}\right) + \frac{\partial}{\partial x}\left(\bar{P}\frac{\partial w}{\partial x}\right) + f/\bar{t} = \rho\, w_{tt}$

IF $\bar{P}$ is constant $\Longrightarrow \quad w_{xx} + w_{yy} + f/\bar{t}\bar{P} = \rho/\bar{P}\, w_{tt}$

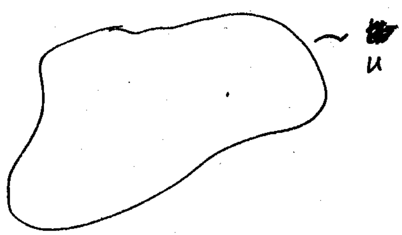
IF $f = 0 \quad \Longrightarrow \quad w_{xx} + w_{yy} = \frac{1}{c^2} w_{tt}$ and $\nabla^2 w = \frac{1}{c^2} w_{tt} \qquad c = \sqrt{\frac{\bar{P}}{\rho}}$

- IF steady state $\frac{\partial}{\partial t} = 0 \Longrightarrow \nabla^2 w = 0$ Elliptic eqn.

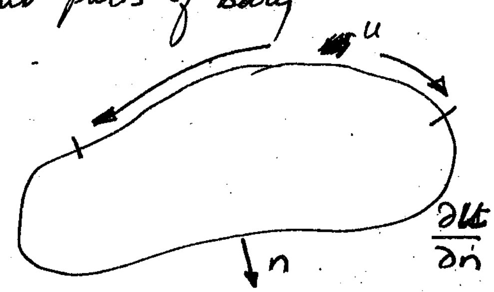
- Boundary Conditions + initial conditions IN GENERAL
  - for each time derivative you need 1 initial condition
  - for each space derivative $\frac{\partial}{\partial x}, \frac{\partial}{\partial y}$ you need 1 boundary condi

- FOR ELLIPTIC TYPE EQNS need to specify value on bdry, or deriv on bdr or value and normal derivative on different parts of bdry

must also satisfy consistency of Neumann $\int \frac{\partial u}{\partial n}\, ds = \iint \nabla^2 u\, dA$ using Divergence theorem.



or



- FOR PARABOLIC TYPE - heat eqn $u_{xx} = a u_t$
  - need 1 initial condition $u(x, t=t_0) = u_0(x)$
  - need value or value + normal deriv on boundary : $\alpha u + \beta u_n$

- FOR HYPERBOLIC - wave eqn
  - need 2 initial conditions $u(x, t=t_0) = u_0(x)$, $\frac{\partial}{\partial t} u(x, t=t_0) = u_1(x)$
  - need value or value + normal deriv on boundary