Alternate way for acoustic eq.

$$\frac{\partial u'}{\partial t} + \bar{u}\frac{\partial u'}{\partial x} + \frac{1}{\bar{\rho}}\frac{\partial p'}{\partial x} = 0$$

$$\frac{\partial p'}{\partial t} + \bar{u}\frac{\partial p'}{\partial x} + \frac{c_p}{c_v}\bar{p}\frac{\partial u'}{\partial x} = 0$$

$$u' = A\exp[i(kx-\omega t)] \quad ; \quad p' = B\exp[i(kx-\omega t)]$$

$$(-i\omega + \bar{u}ik)A + \frac{1}{\bar{\rho}}ik\,B = 0$$

$$(-i\omega + \bar{u}ik)B + \frac{c_p}{c_v}\bar{p}ik\,A = 0$$

$$\begin{vmatrix} (-i\omega+\bar{u}ik) & \frac{1}{\bar{\rho}}ik \\ \frac{c_p}{c_v}\bar{p}ik & (-i\omega+\bar{u}ik) \end{vmatrix} = 0 \qquad -i\begin{vmatrix} (\omega-\bar{u}k) & -\frac{k}{\bar{\rho}} \\ -\frac{c_p}{c_v}\bar{p}k & (\omega-\bar{u}k) \end{vmatrix} = 0$$

$$(\omega-\bar{u}k)^2 = \frac{c_p}{c_v}\frac{\bar{p}}{\bar{\rho}}k^2$$

$$\therefore \boxed{\omega = \bar{u}k \pm \sqrt{\frac{c_p}{c_v}\frac{\bar{p}}{\bar{\rho}}}k}$$

EASIER