Problem 1.

$$\frac{f(t+dt, x) - f(t-dt, x)}{2dt} = -v \frac{f(t, x+dx) - f(t, x-dx)}{2dx} \Bigg\} \Rightarrow \xi^2 - 1 = 2i\xi \frac{vdt}{dx} \sin k\,dx$$

$$f(x,t) = \xi^t \exp(ikx)$$

$\downarrow$ solution

$$\xi = -i \frac{vdt}{dx} \sin k\,dx \pm \sqrt{1 - \left(\frac{vdt}{dx} \sin k\,dx\right)^2}$$

$$\text{for } vdt \leq dx \quad |\xi|^2 = 1$$

$\uparrow$

no amplitude dissipation $\Rightarrow$ energy preserved