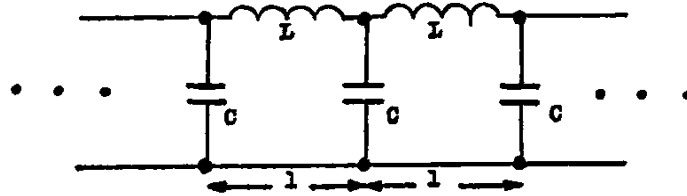


### Problem 3: Infinite LC-grid

When sine waves propagate in an infinite LC-grid (see the figure below) the phase of the ac-voltage across two successive capacitors differs by  $\Phi$ .



- Determine how  $\Phi$  depends on  $\omega$ ,  $L$  and  $C$  ( $\omega$  is the angular frequency of the sine wave).
- Determine the velocity of propagation of the waves if the length of each unit is  $\ell$ .
- State under what conditions the propagation velocity of the waves is almost independent of  $\omega$ . Determine the velocity in this case.
- Suggest a simple mechanical model which is an analogue to the above circuit and derive equations which establish the validity of your model.

**Formulae:**

$$\cos \alpha - \cos \beta = -2 \cdot \sin\left(\frac{\alpha + \beta}{2}\right) \cdot \sin\left(\frac{\alpha - \beta}{2}\right)$$

$$\sin \alpha - \sin \beta = 2 \cdot \cos\left(\frac{\alpha + \beta}{2}\right) \cdot \sin\left(\frac{\alpha - \beta}{2}\right)$$