

# Propagating Wave (1A)

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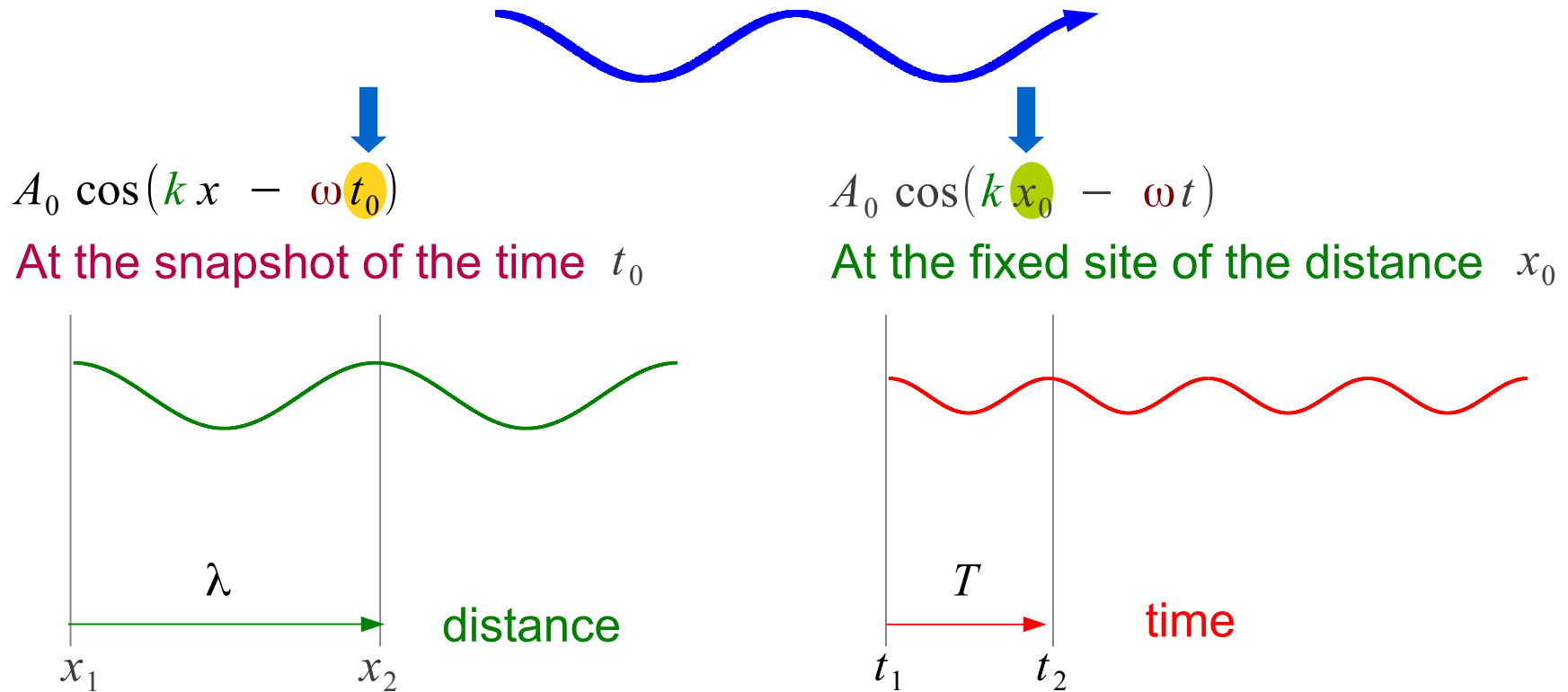
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# Wave Equation

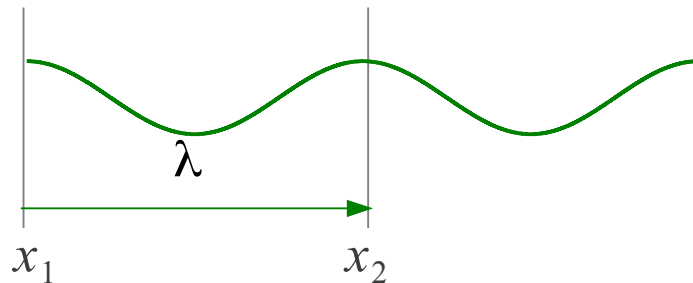
$$A(x, t) = A_0 \cos(kx - \omega t)$$



# Wavelength, Frequency

$$A_0 \cos(kx - \omega t_0)$$

At the snapshot of the time  $t_0$

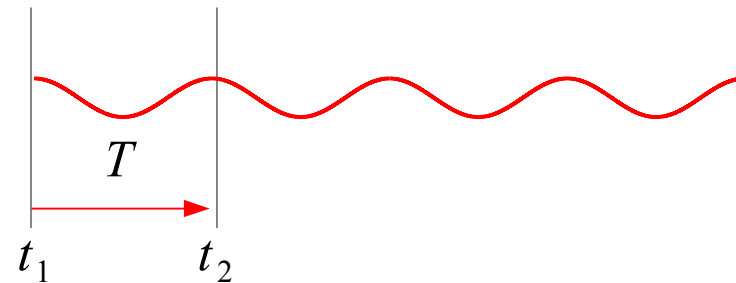


wavelength  $\lambda = \frac{2\pi}{k}$

wave number  $k = \frac{2\pi}{\lambda}$

$$A_0 \cos(kx_0 - \omega t)$$

At the fixed site of the distance  $x_0$



frequency  $f = \frac{\omega}{2\pi}$

period  $T = \frac{2\pi}{\omega}$

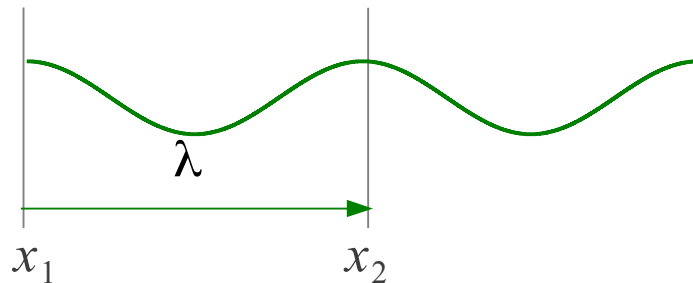
angular frequency  $\omega = 2\pi f$

angular frequency  $\omega = \frac{2\pi}{T}$

# Wave Number, Angular Frequency

$$A_0 \cos(kx - \omega t_0)$$

At the snapshot of the time  $t_0$



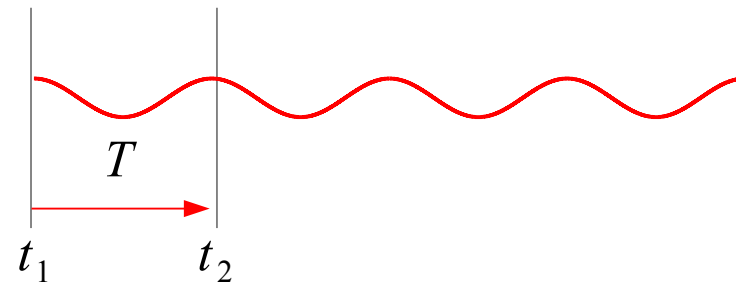
wave number

$$k = \frac{2\pi}{\lambda}$$

*radians per unit distance*

$$A_0 \cos(kx_0 - \omega t)$$

At the fixed site of the distance  $x_0$

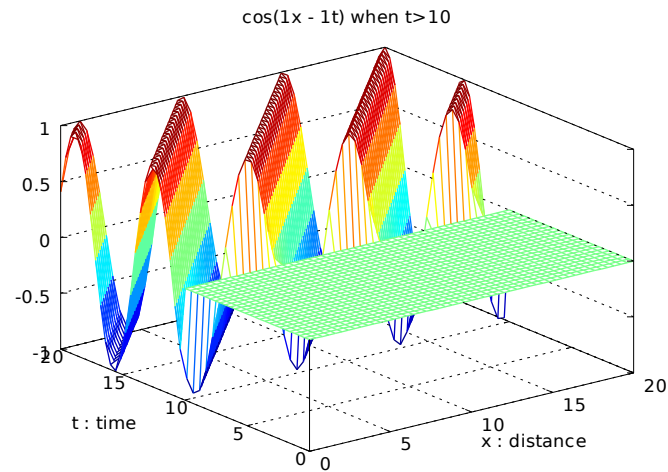
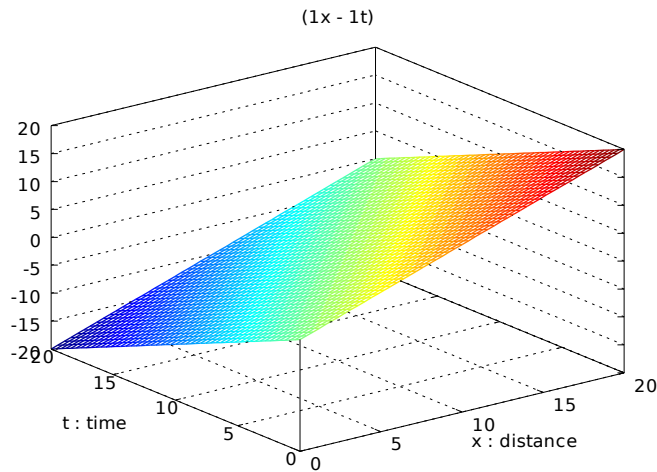


angular frequency

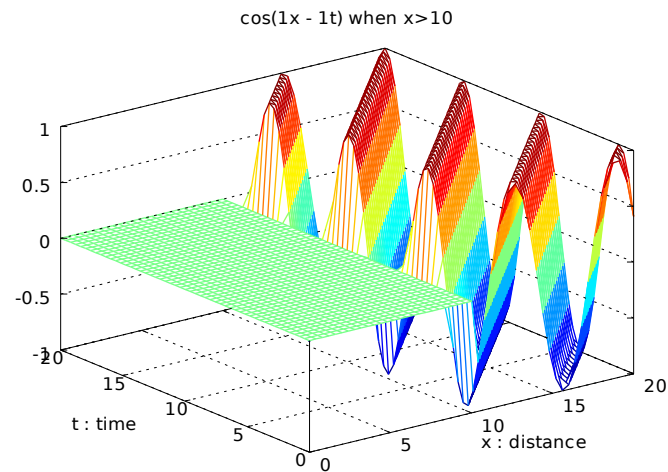
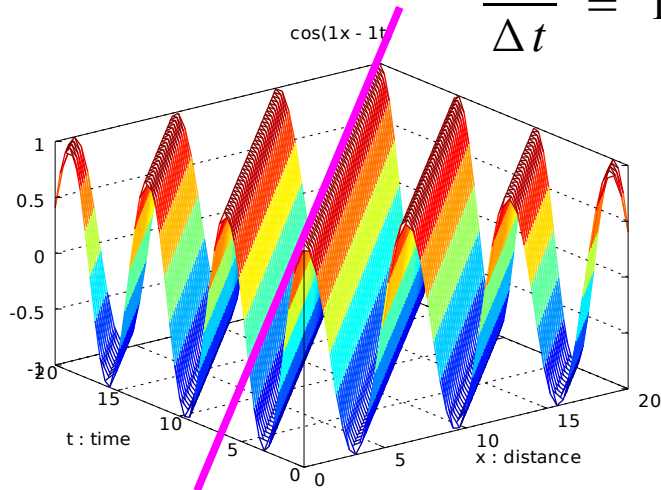
$$\omega = \frac{2\pi}{T}$$

*radians per unit time*

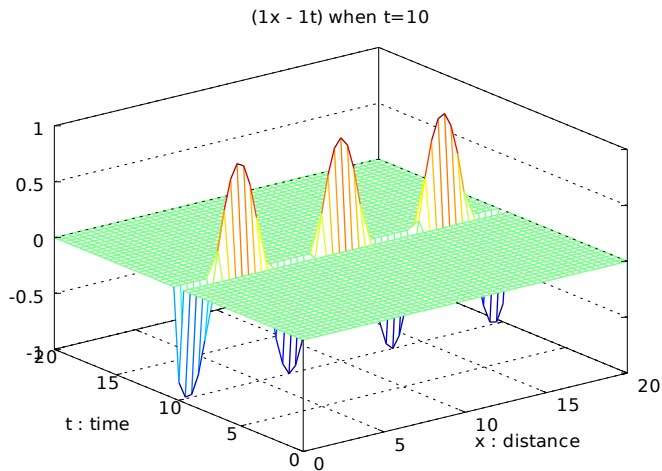
# COS(x-t) Example (1)



$$\frac{\Delta x}{\Delta t} = 1$$



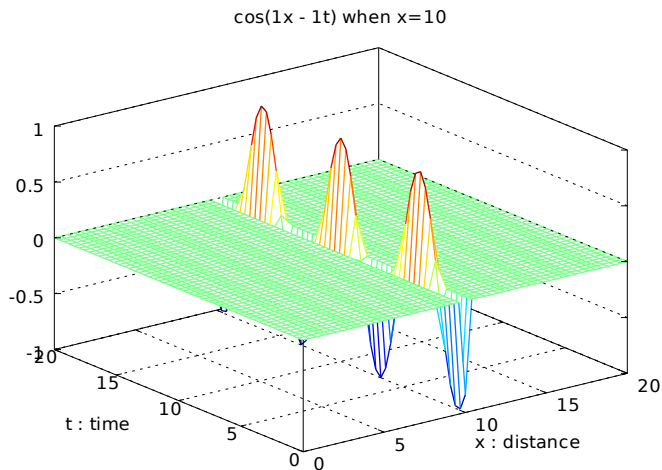
# COS(x-t) Example (2)



$$\cos(x - 10)$$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{1} = 6.28$$

$$\frac{20}{6.28} = 3.18 \text{ cycles}$$

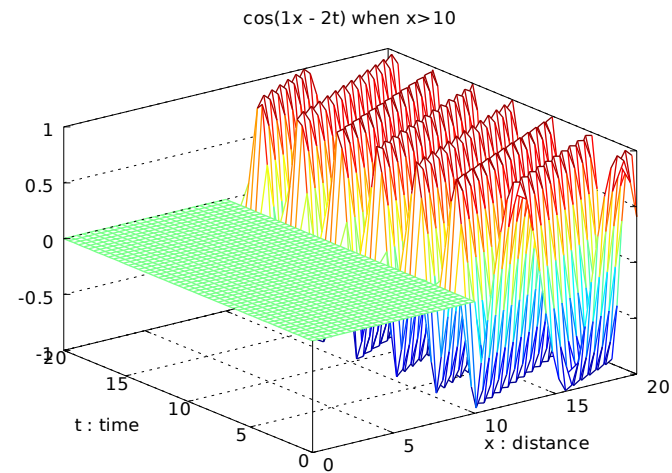
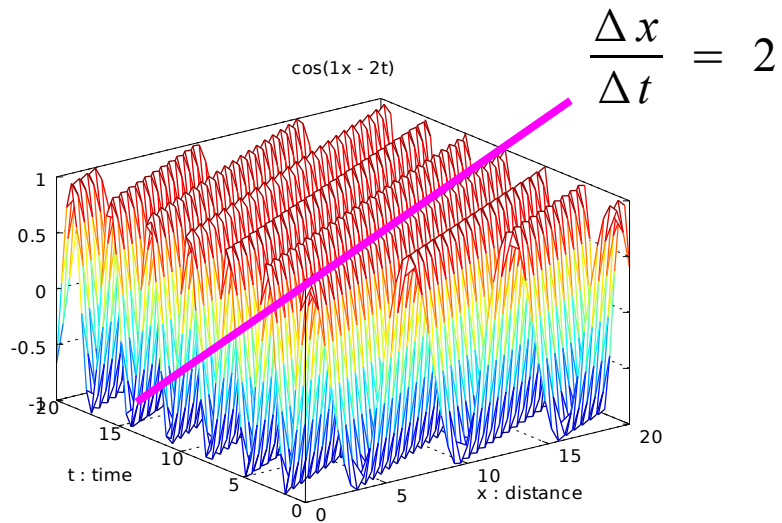
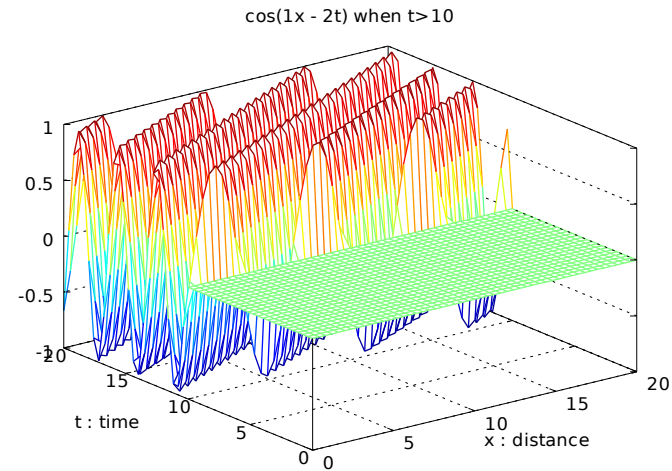
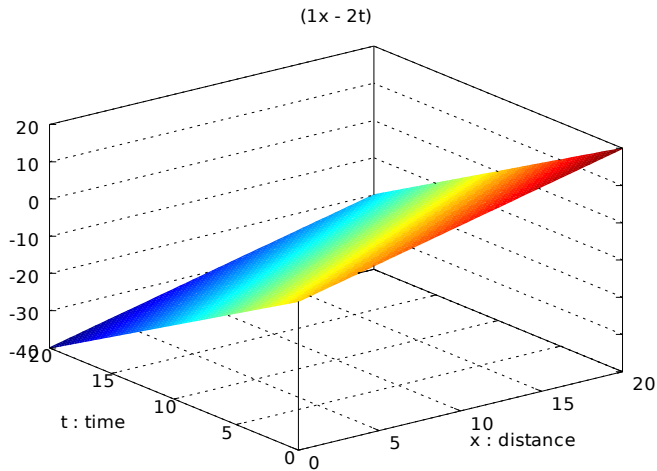


$$\cos(10 - t)$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{1} = 6.28$$

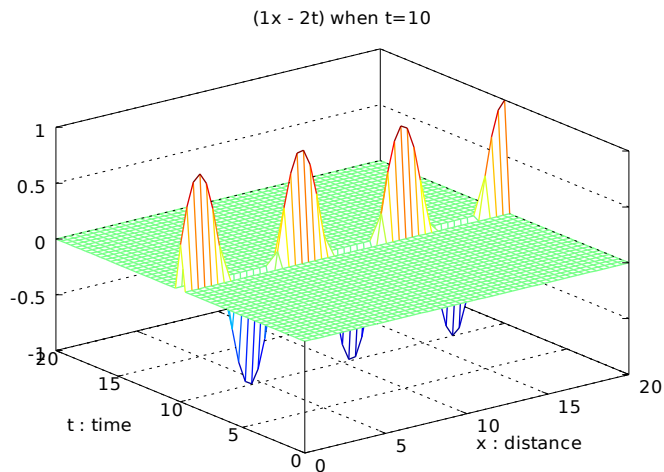
$$\frac{20}{6.28} = 3.18 \text{ cycles}$$

# COS(x-2t) Example (1)





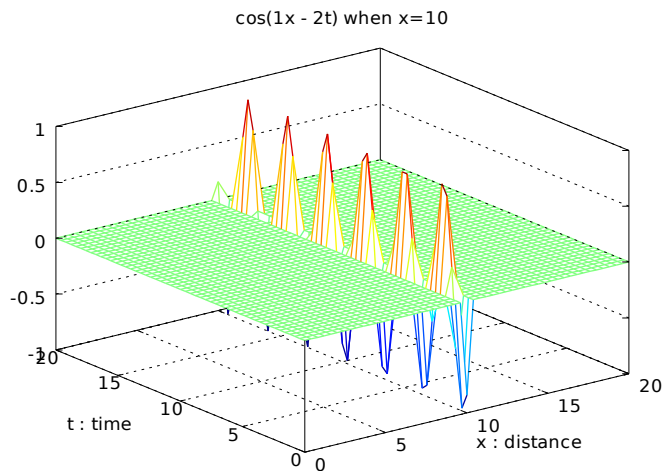
# COS(x-2t) Example (2)



$$\cos(x - 20)$$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{1} = 6.28$$

$$\frac{20}{6.28} = 3.18 \text{ cycles}$$

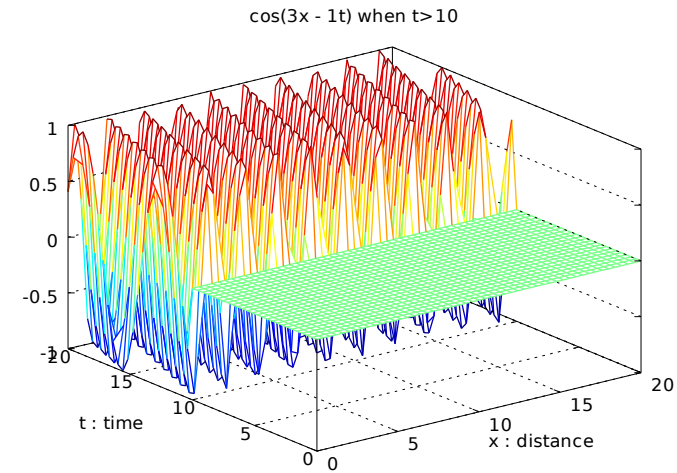
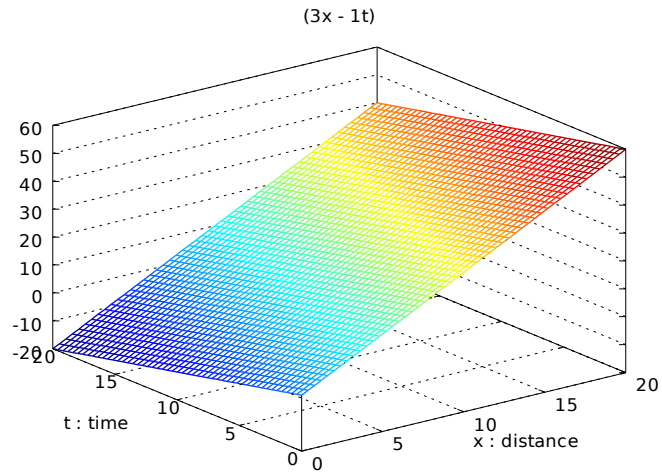


$$\cos(10 - 2t)$$

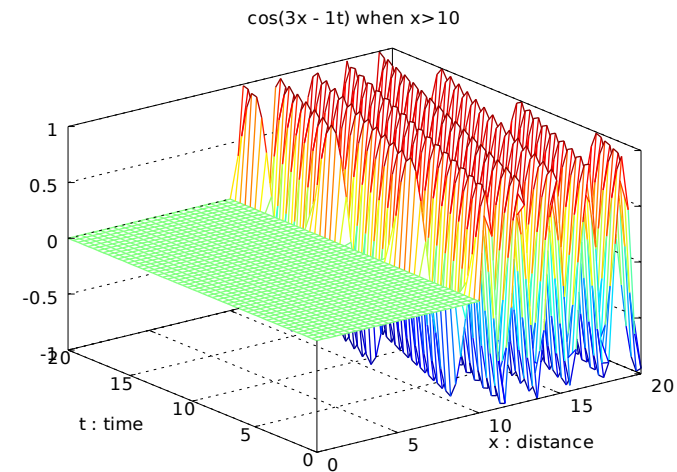
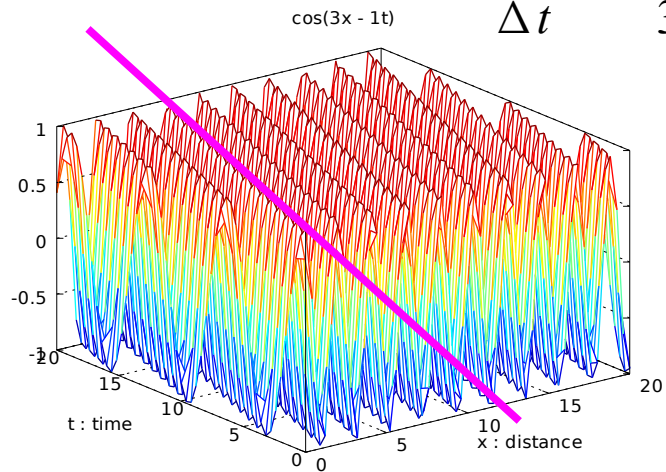
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = 3.14$$

$$\frac{20}{3.14} = 6.37 \text{ cycles}$$

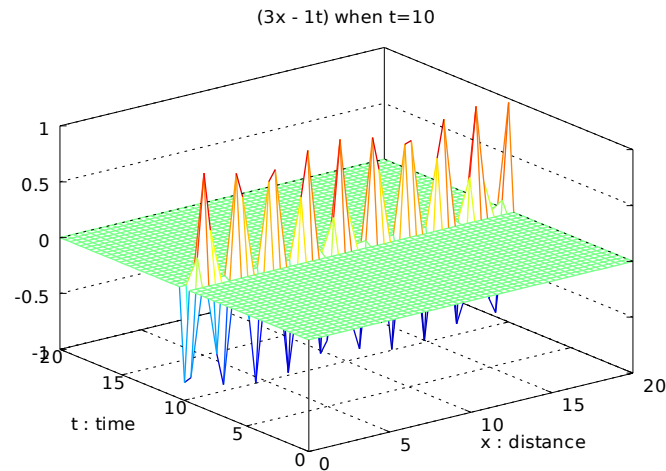
# COS(3x-t) Example (1)



$$\frac{\Delta x}{\Delta t} = \frac{1}{3}$$



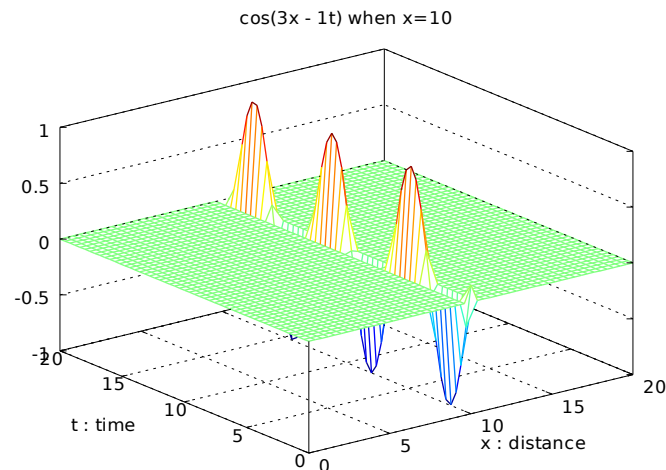
# COS(3x-t) Example (2)



$$\cos(3x - 10)$$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{3} = 2.093$$

$$\frac{20}{6.28} = 9.56 \text{ cycles}$$

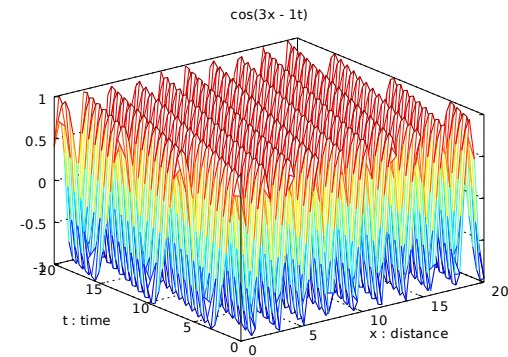
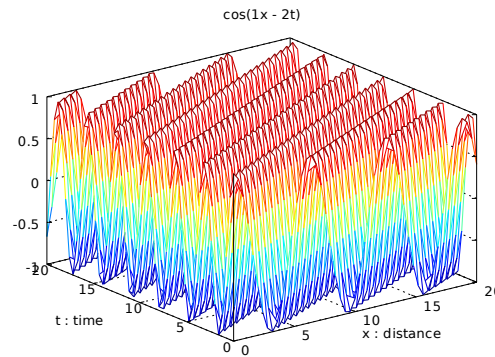
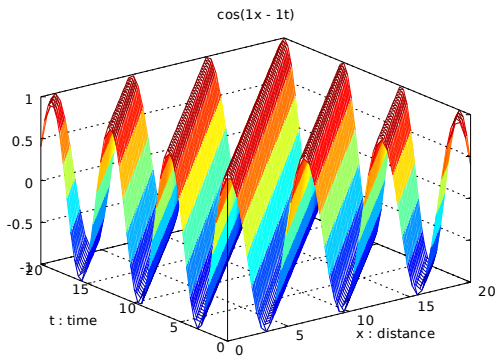
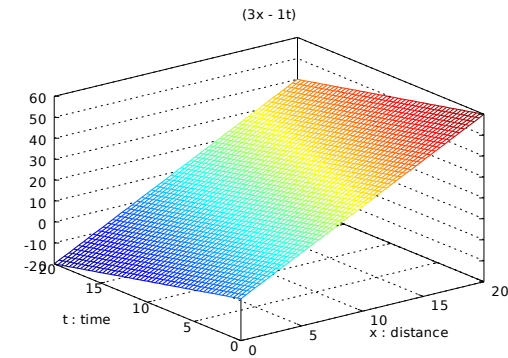
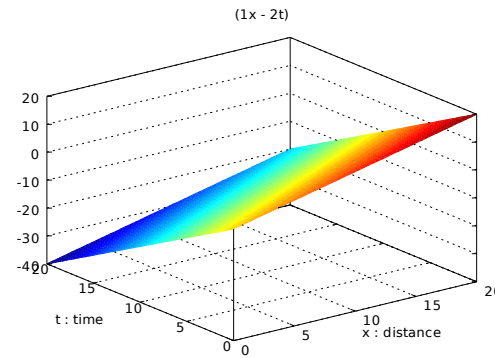
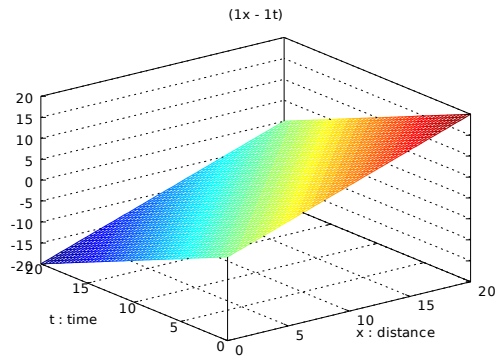


$$\cos(30 - t)$$

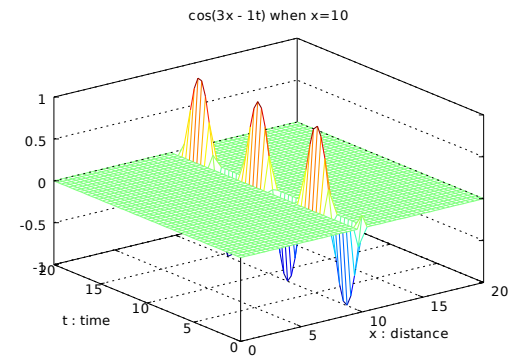
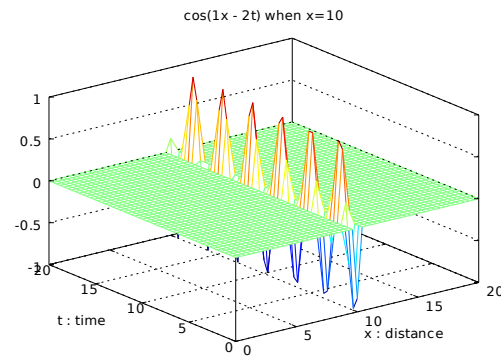
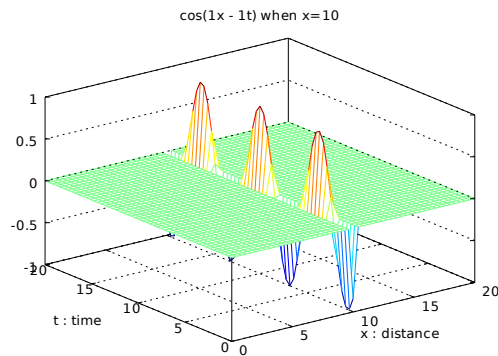
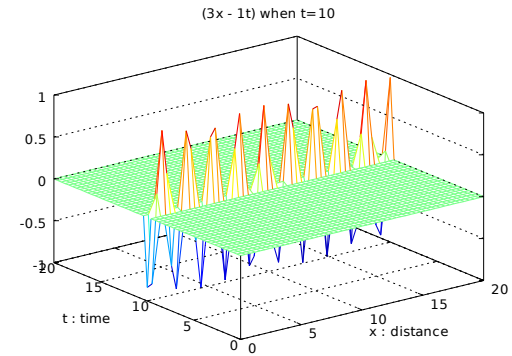
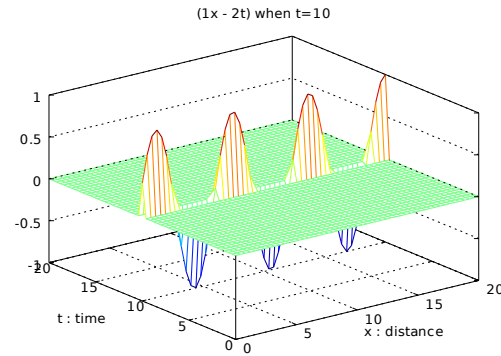
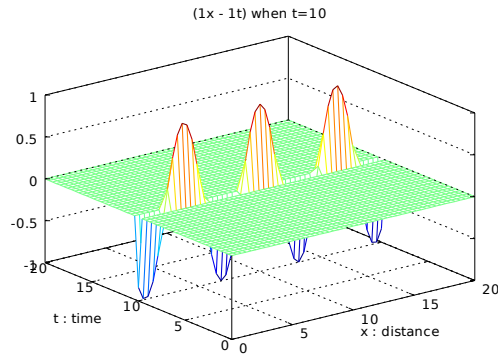
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{1} = 6.28$$

$$\frac{20}{6.28} = 3.18 \text{ cycles}$$

# Comparison of Examples (1)



# Comparison of Examples (2)



## References

- [1] <http://en.wikipedia.org/>
- [2] J.H. McClellan, et al., Signal Processing First, Pearson Prentice Hall, 2003
- [3] <http://www.mathpages.com/>, Phase, Group, and Signal Velocity
- [4] R. Barlow, [www.hep.man.ac.uk/u/roger/PHYS10302/lecture15.pdf](http://www.hep.man.ac.uk/u/roger/PHYS10302/lecture15.pdf)
- [5] P. Hofmann, [www.philiphofmann.net/book\\_material/notes/groupphasevelocity.pdf](http://www.philiphofmann.net/book_material/notes/groupphasevelocity.pdf)