Propagating Wave (1A)

- 1-D Propagating Wave

Please send corrections (or suggestions) to youngwlim@hotmail.com.

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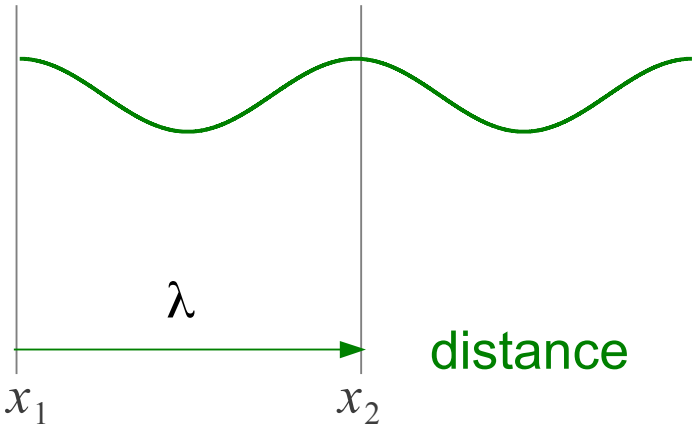
Wave Equation

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

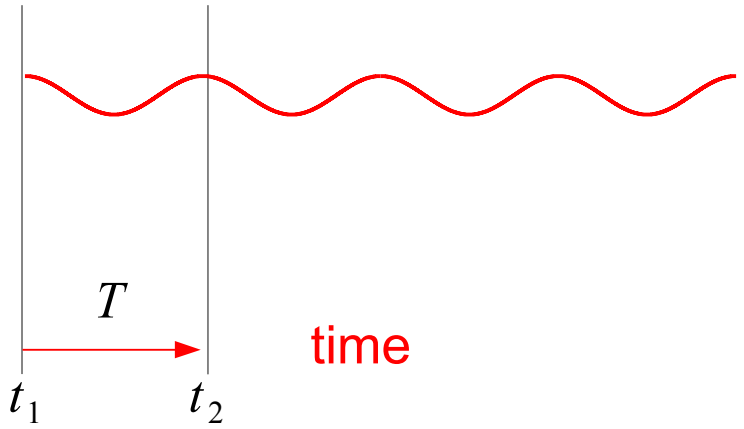
$A_0\cos(k\,x\ -\ \omega t_0)$

At the snapshot of the time t_0



$A_0\cos(k\,x_0\ -\ \omega\,t)$

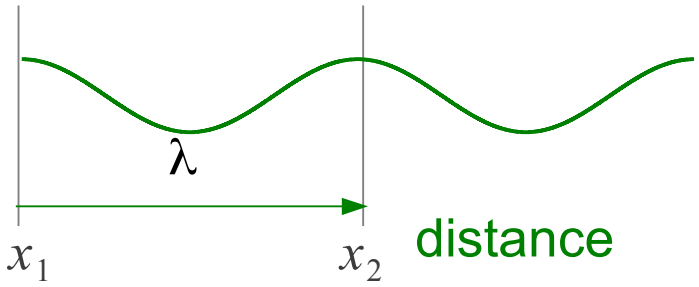
At the fixed site of the distance x_0



Wavelength, Frequency

$$A_0 \cos(k x - \omega t_0)$$

At the snapshot of the time t_0

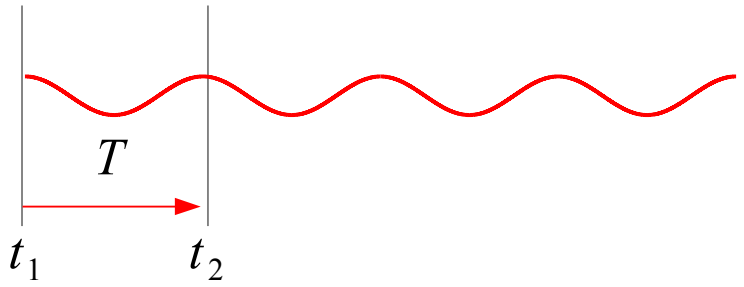


wavelength $\lambda = \frac{2\pi}{k}$

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

$$A_0 \cos(k x_0 - \omega t)$$

At the fixed site of the distance x_0



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

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

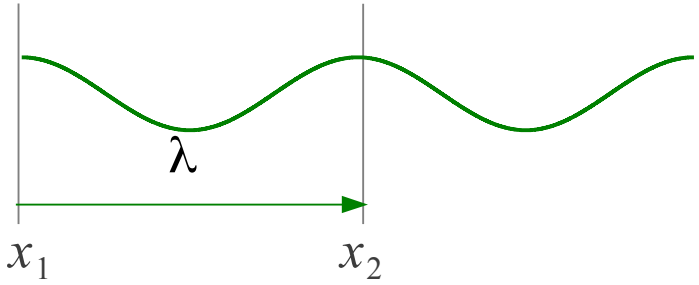
angular frequency $\omega = 2\pi f$

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

Wave Number, Angular Frequency

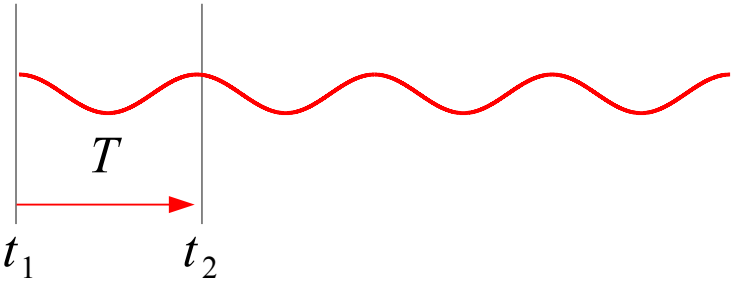
$$A_0 \cos(k x - \omega t_0)$$

At the snapshot of the time t_0



$$A_0 \cos(k x_0 - \omega t)$$

At the fixed site of the distance x_0



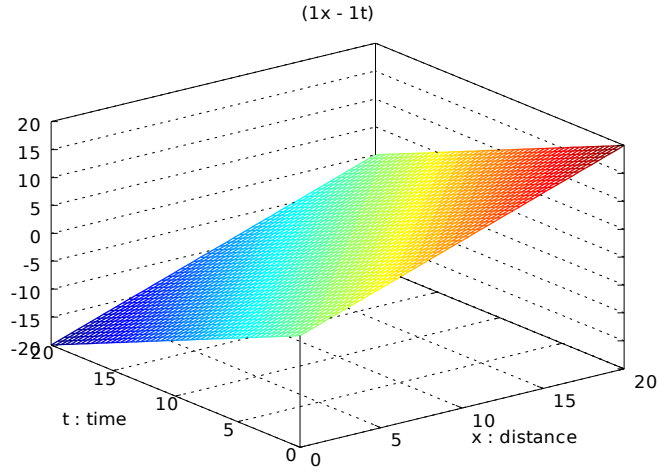
wave number $k = \frac{2\pi}{\lambda}$

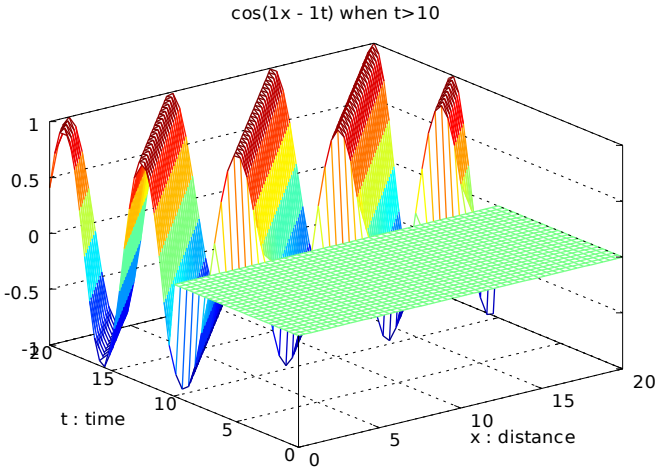
radians per unit distance

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

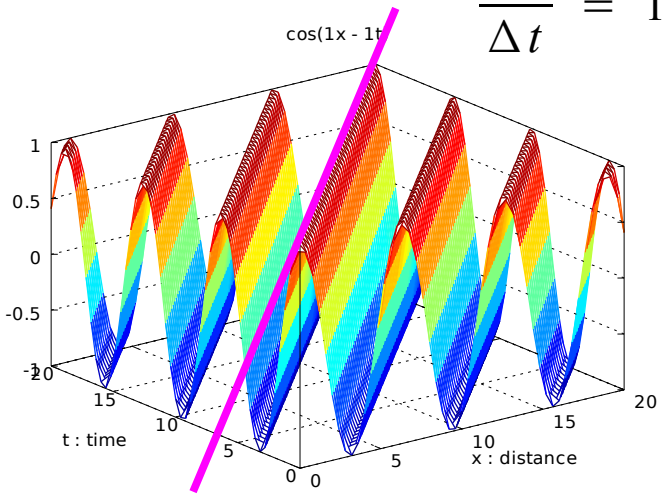
radians per unit time

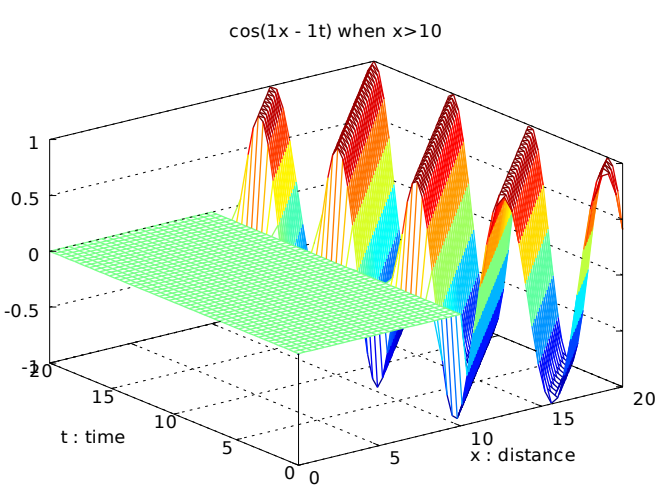
COS(x-t) Example (1)



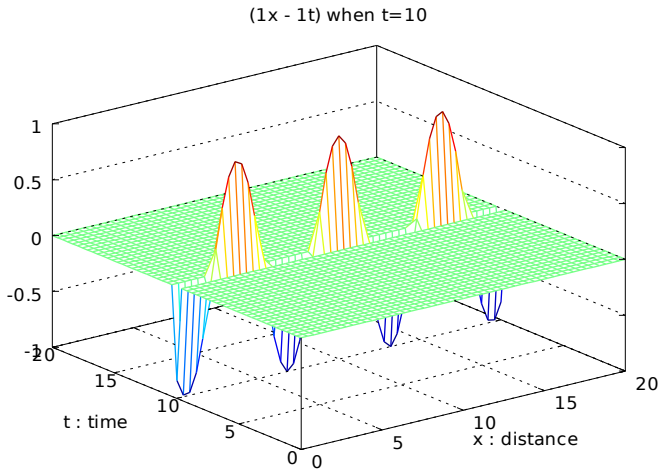


$$\frac{\Delta x}{\Delta t} = 1$$





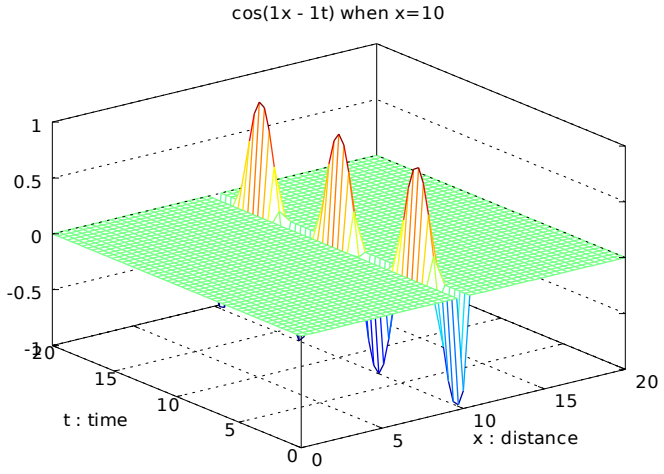
COS(x-t) Example (2)



$$\cos(x - 10)$$

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

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

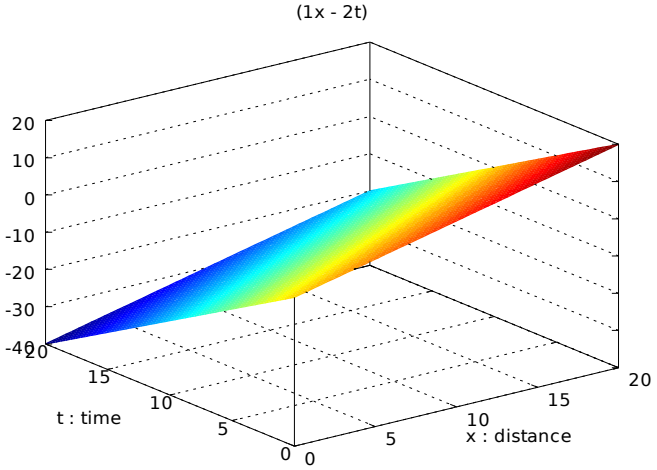


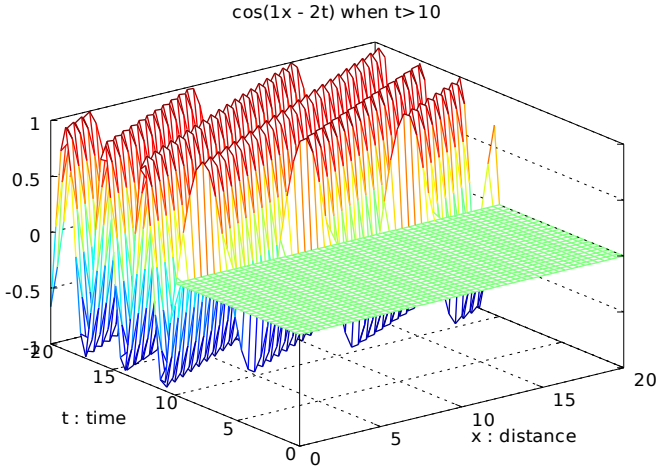
$$\cos(10 - t)$$

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

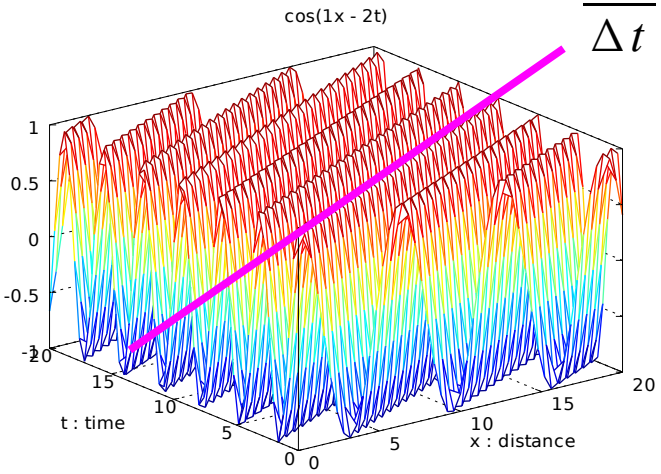
$$\frac{20}{6.28} = 3.18 \ \ cycles$$

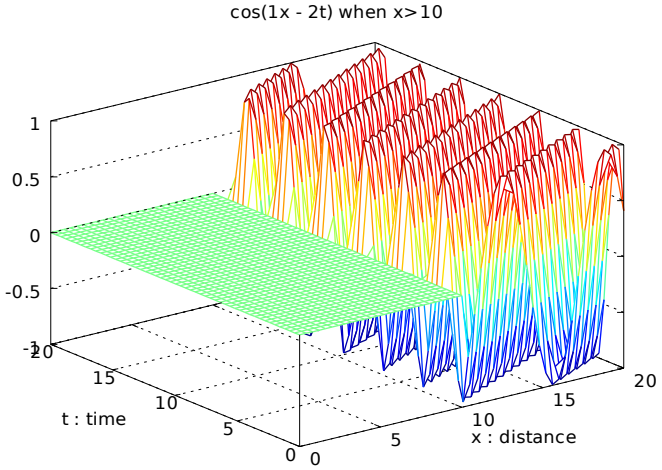
COS(x-2t) Example (1)



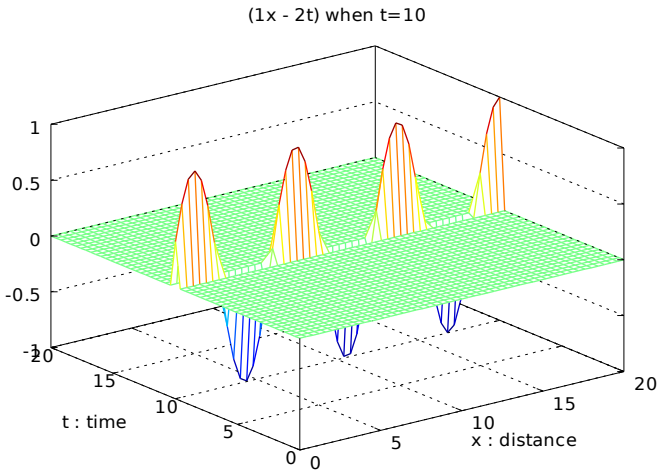


$$\frac{\Delta x}{\Delta t} = 2$$





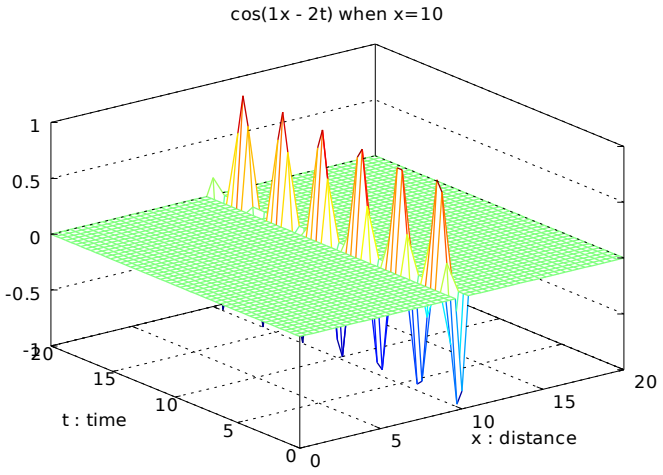
COS(x-2t) Example (2)



$$\cos(x - 20)$$

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

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

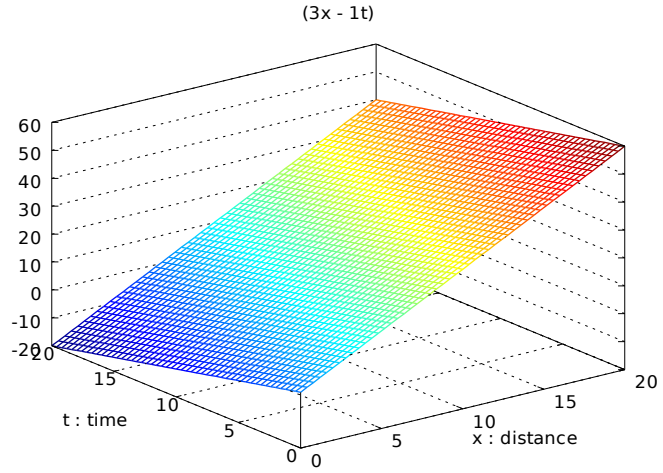


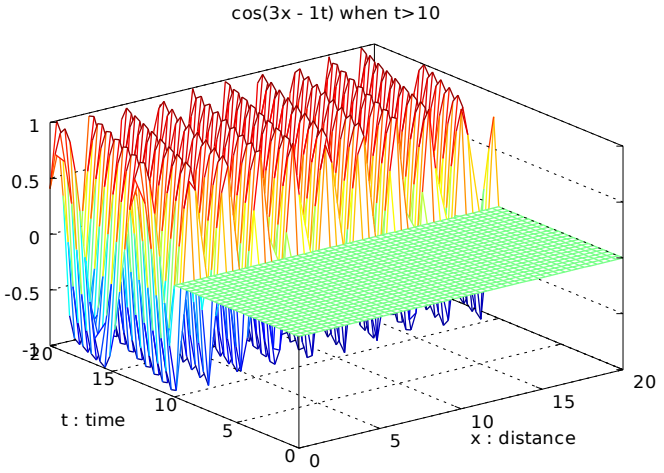
$$\cos(10 - 2t)$$

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

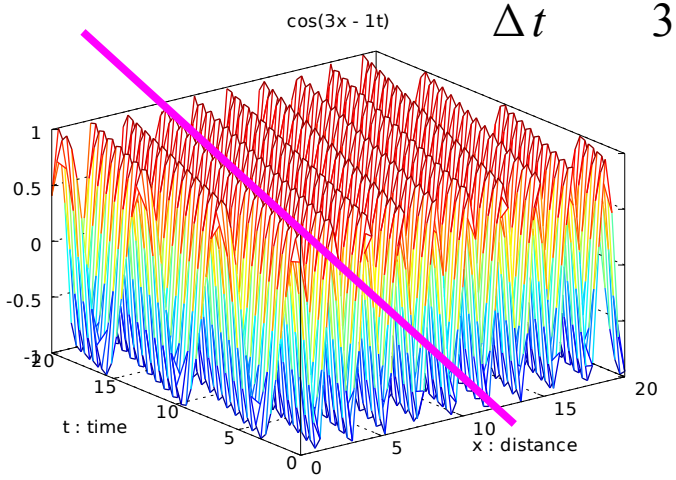
$$\frac{20}{3.14} = 6.37 \ \ cycles$$

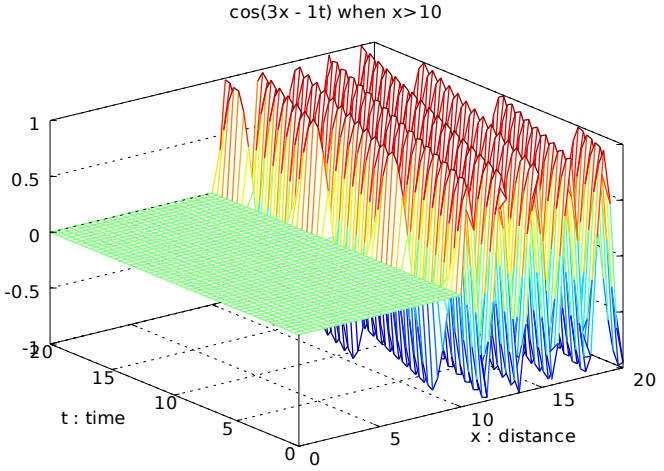
COS(3x-t) Example (1)



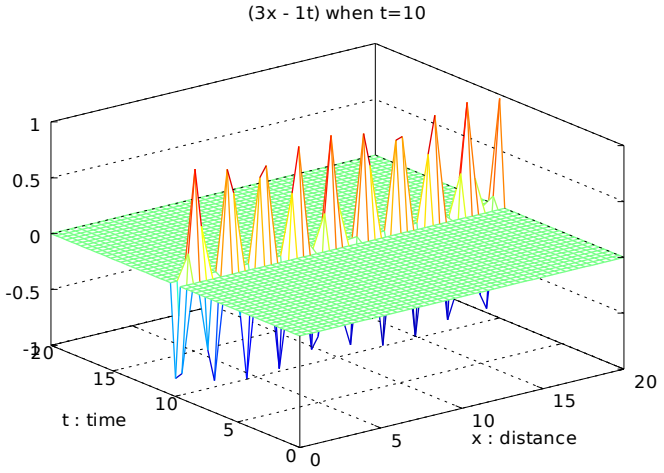


$$\frac{\Delta x}{\Delta t} = \frac{1}{3}$$





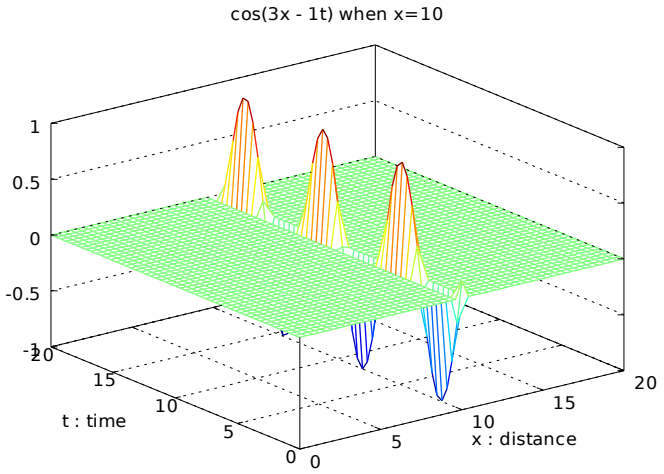
COS(3x-t) Example (2)



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

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

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

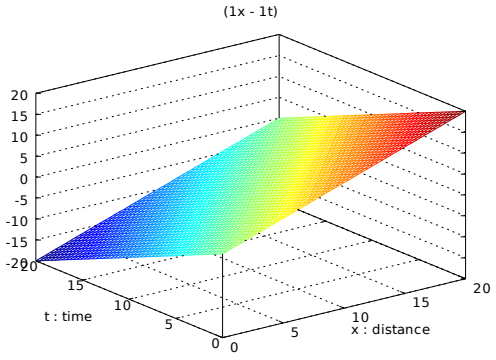


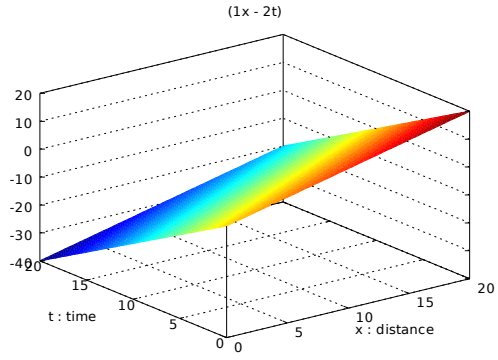
$$\cos(30 - t)$$

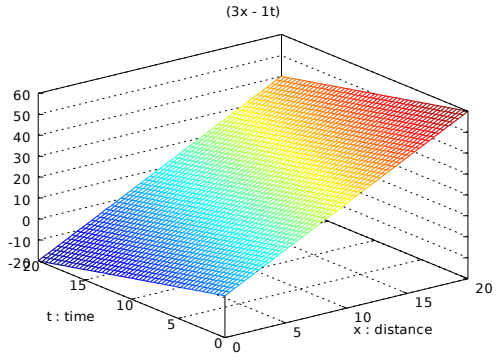
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{1} = 6.28$$

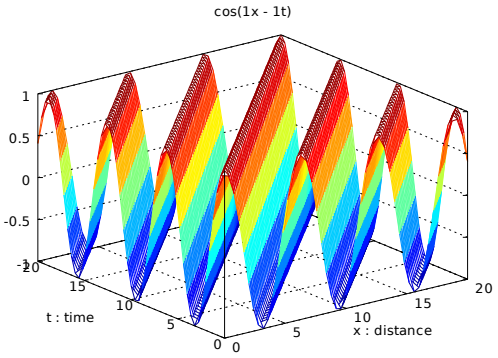
$$\frac{20}{6.28} = 3.18 \ \ cycles$$

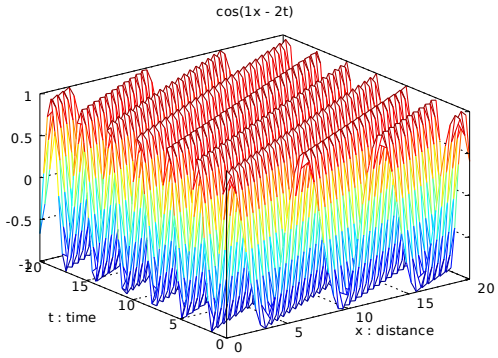
Comparison of Examples (1)

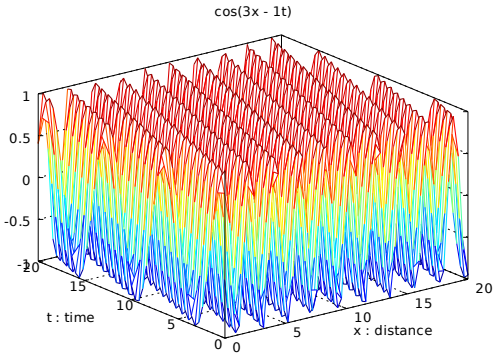




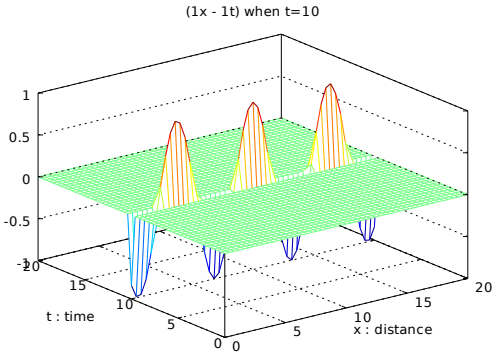


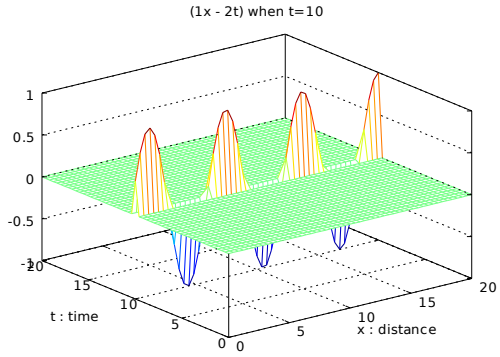


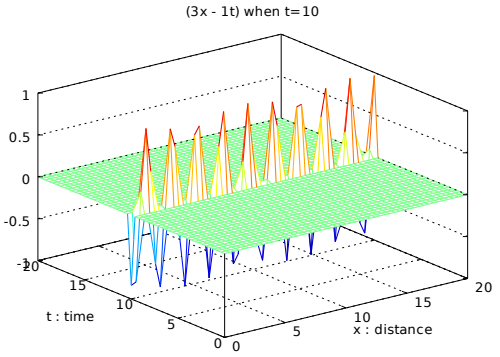


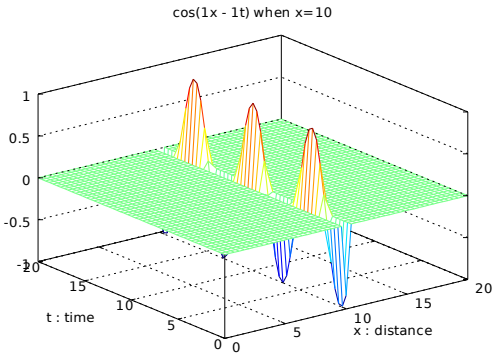


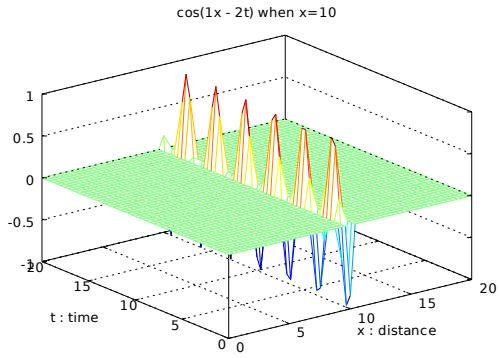
Comparison of Examples (2)

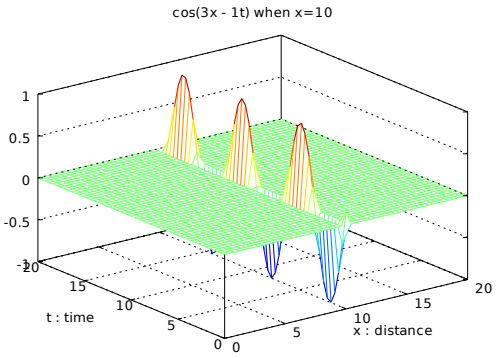












References

[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
[5] P. Hofmann, www.philiphofmann.net/book_material/notes/groupphasevelocity.pdf