

Propagating Wave (1A)

- 1-D Propagating Wave

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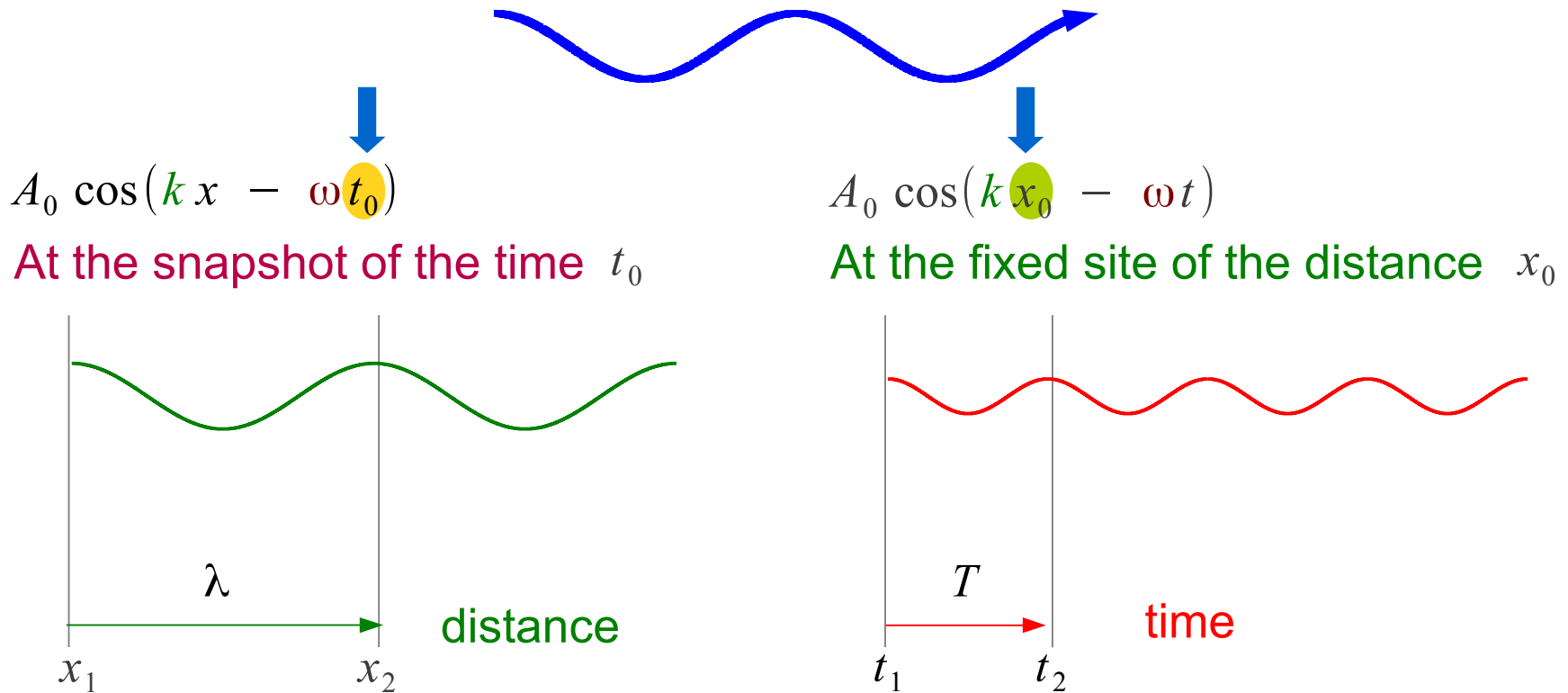
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Wave Equation

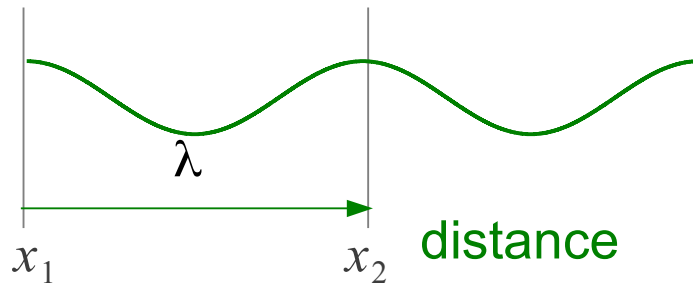
$$A(x, t) = A_0 \cos(kx - \omega t)$$



Wavelength, Frequency

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

At the snapshot of the time t_0



wavelength

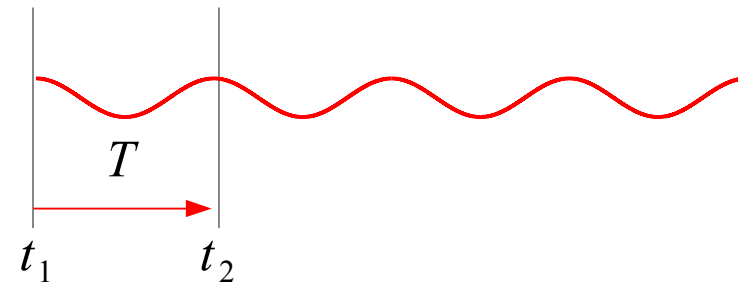
$$\lambda = \frac{2\pi}{k}$$

wave number

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

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

At the fixed site of the distance x_0



frequency

time

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

period

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

angular frequency

$$\omega = 2\pi f$$

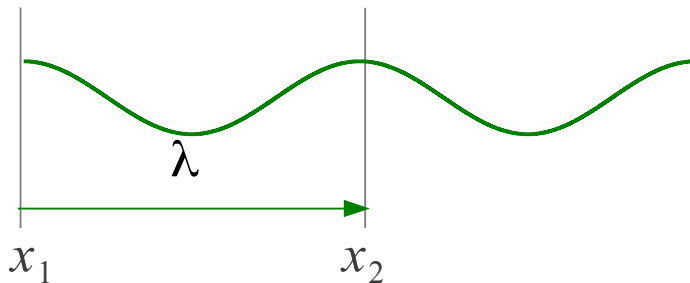
angular frequency

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

Wave Number, Angular Frequency

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

At the snapshot of the time t_0



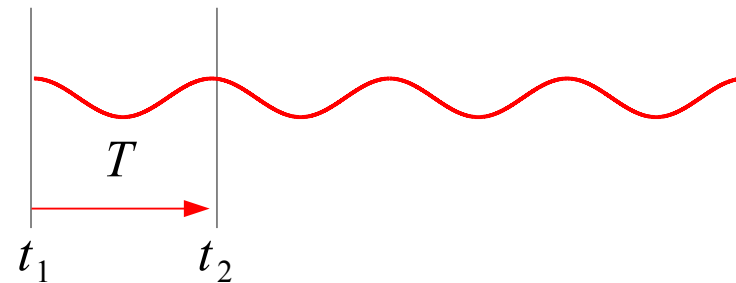
wave number

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

radians per unit distance

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

At the fixed site of the distance x_0

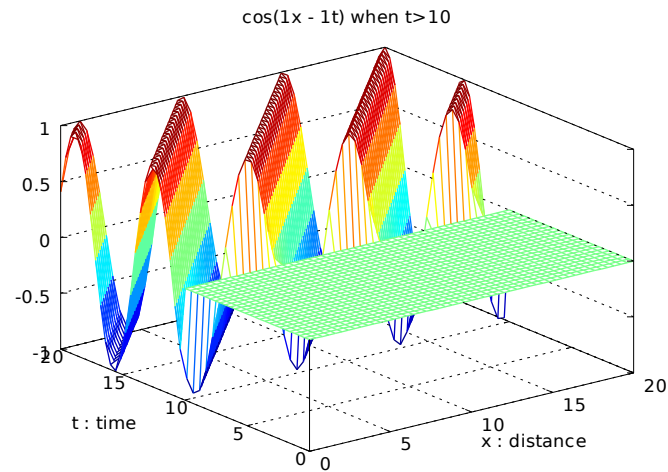
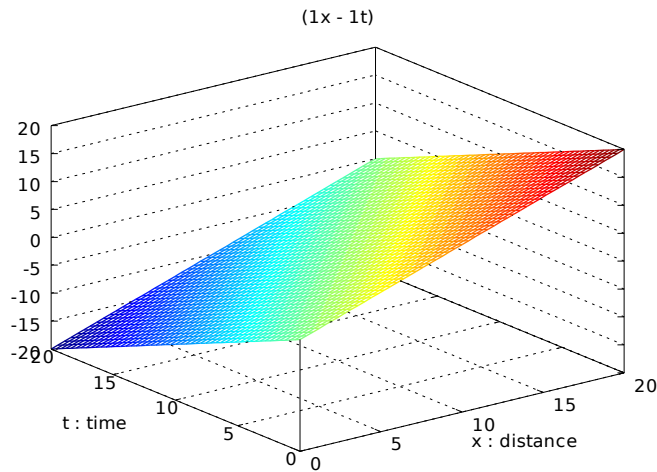


angular frequency

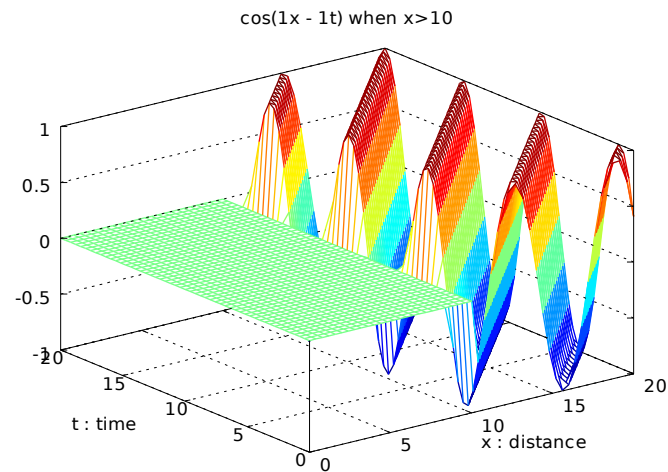
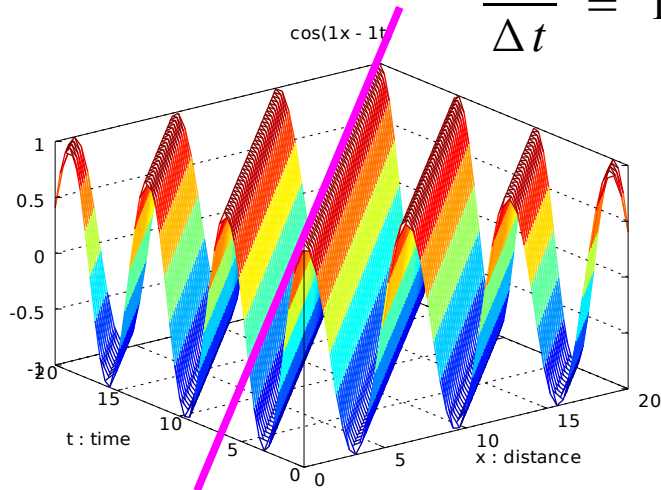
$$\omega = \frac{2\pi}{T}$$

radians per unit time

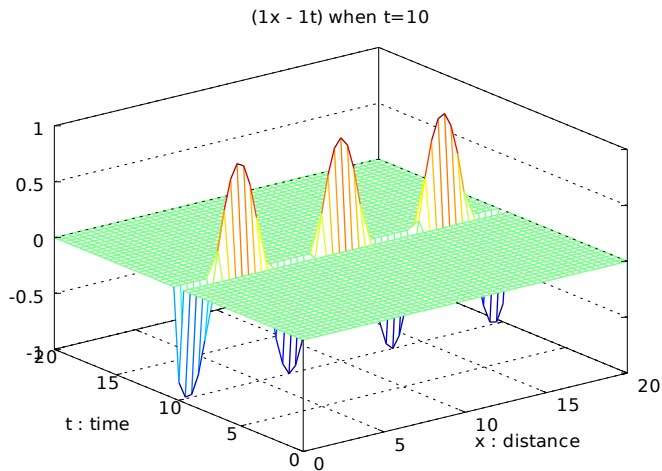
COS(x-t) Example (1)



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



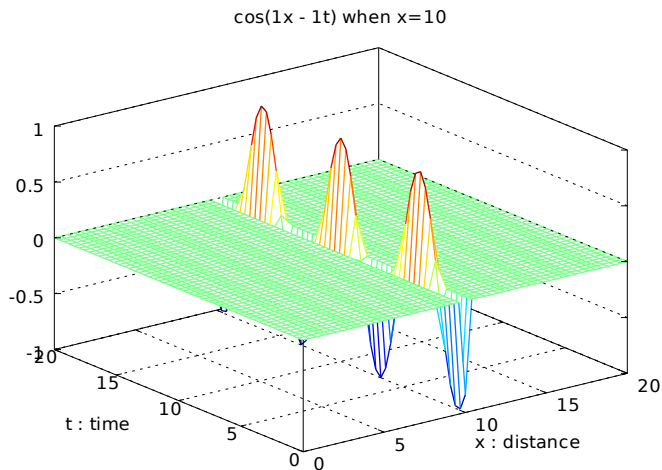
COS(x-t) Example (2)



$$\cos(x - 10)$$

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

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

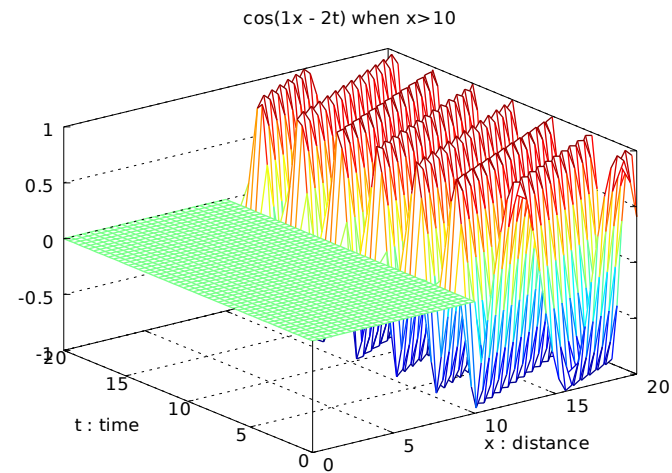
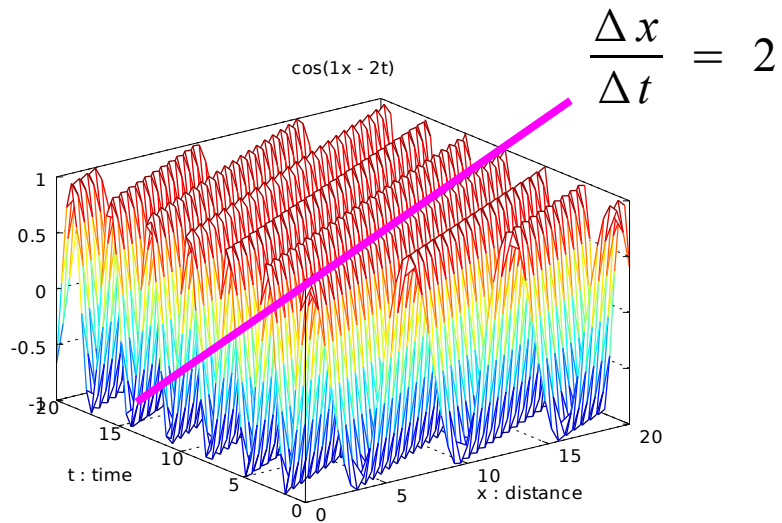
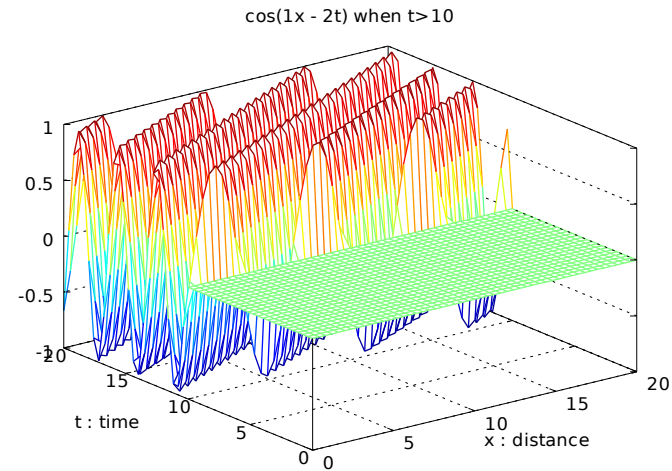
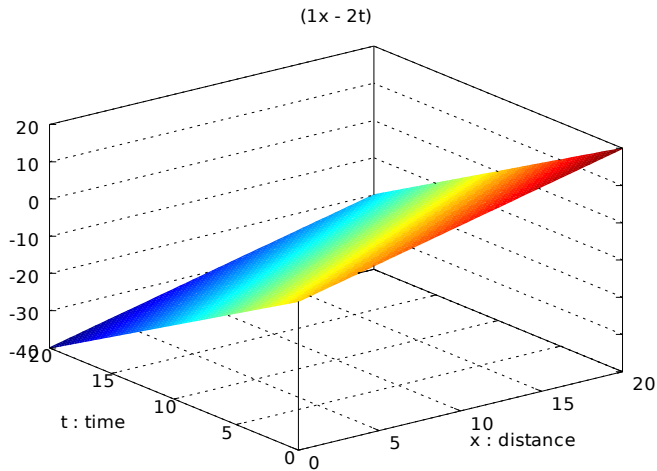


$$\cos(10 - t)$$

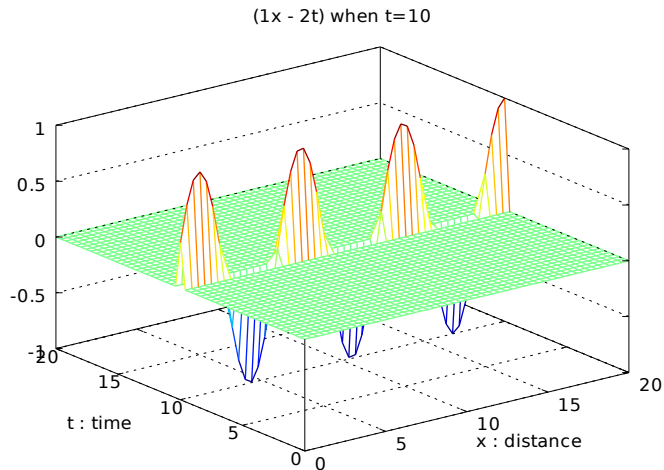
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{1} = 6.28$$

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

COS(x-2t) Example (1)



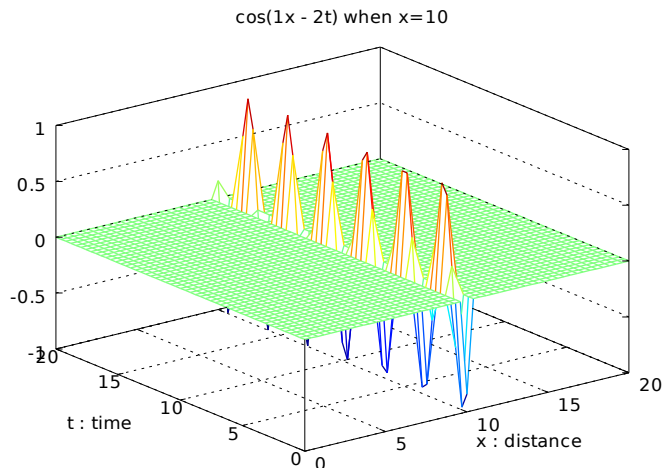
COS(x-2t) Example (2)



$$\cos(x - 20)$$

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

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

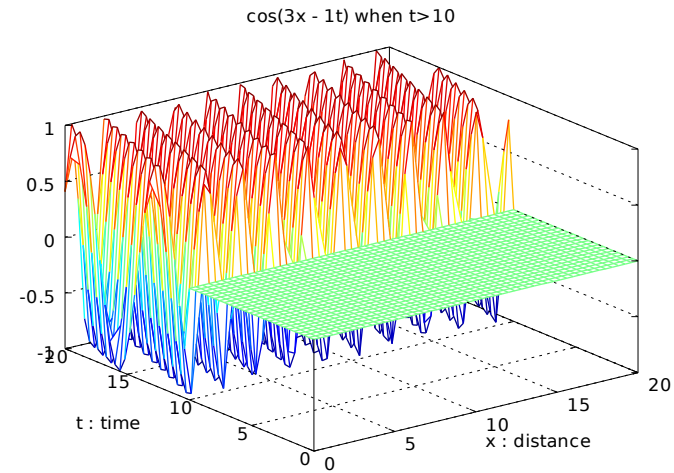
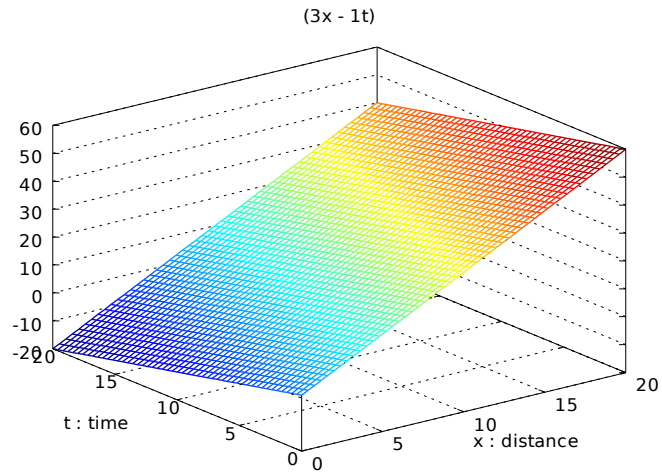


$$\cos(10 - 2t)$$

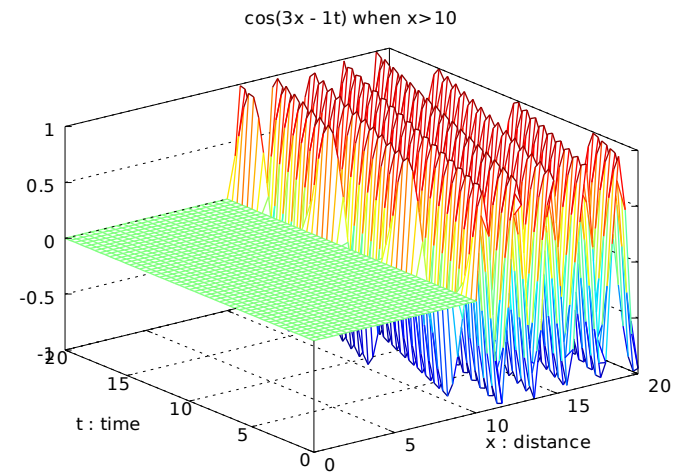
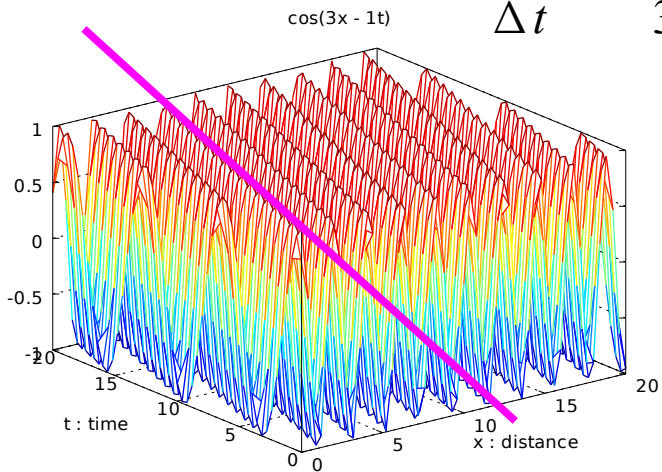
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = 3.14$$

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

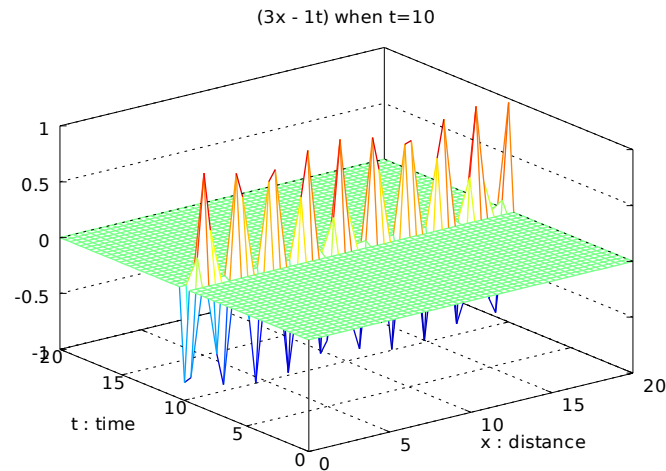
COS(3x-t) Example (1)



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



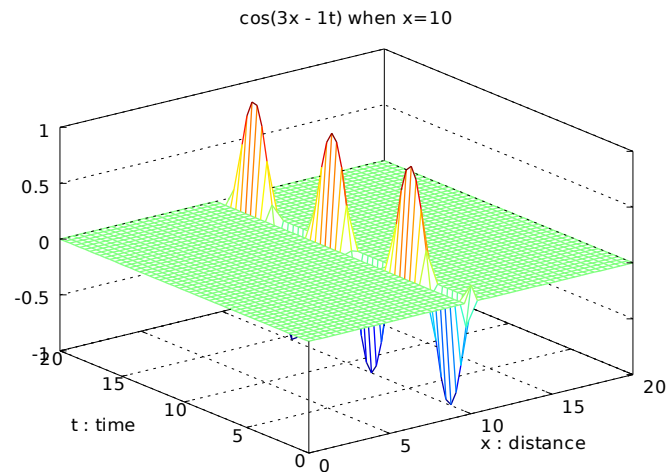
COS(3x-t) Example (2)



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

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

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

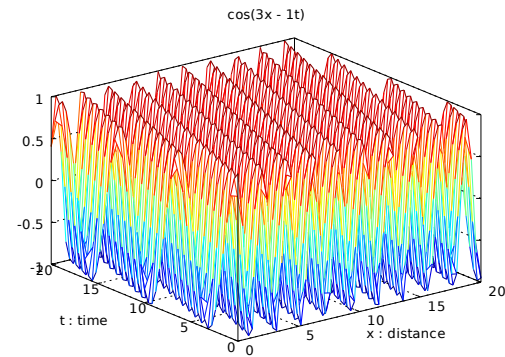
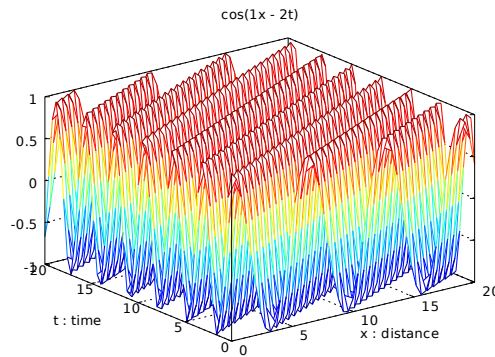
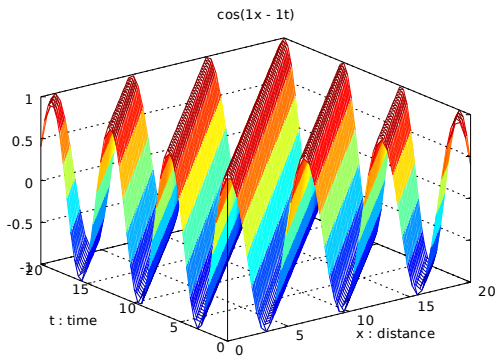
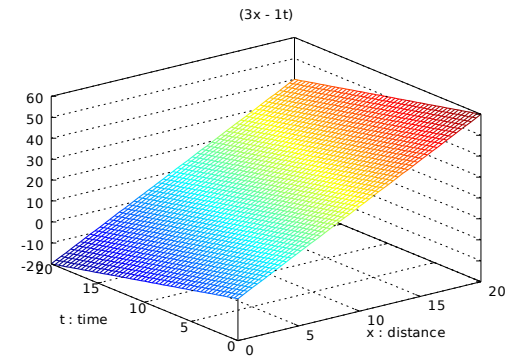
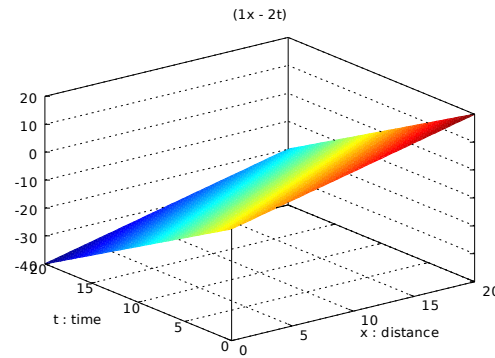
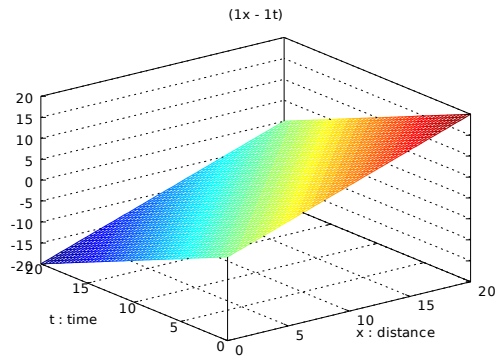


$$\cos(30 - t)$$

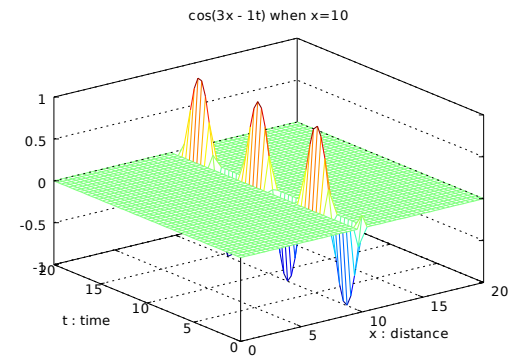
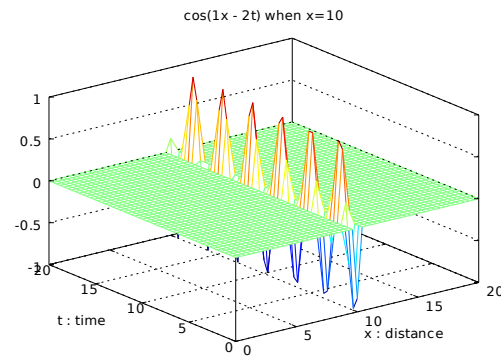
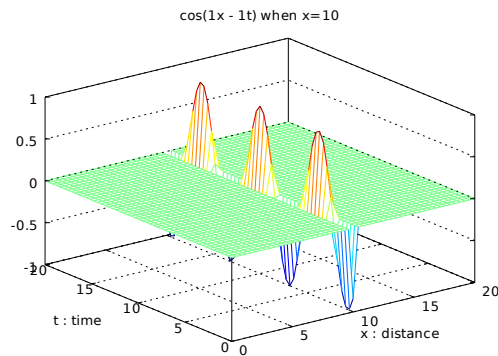
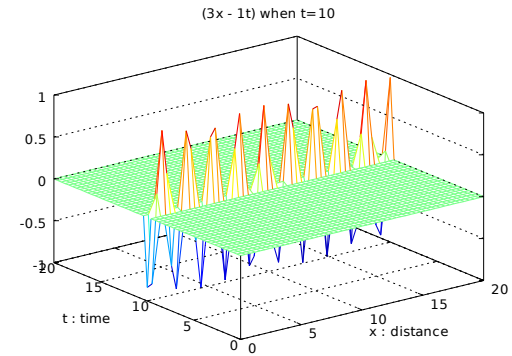
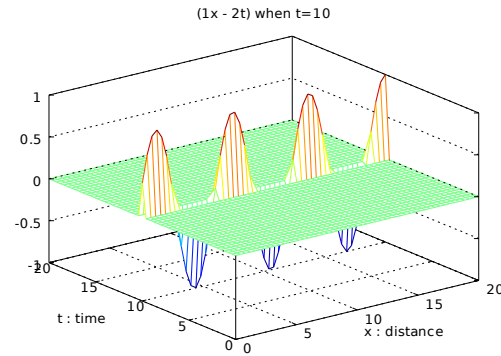
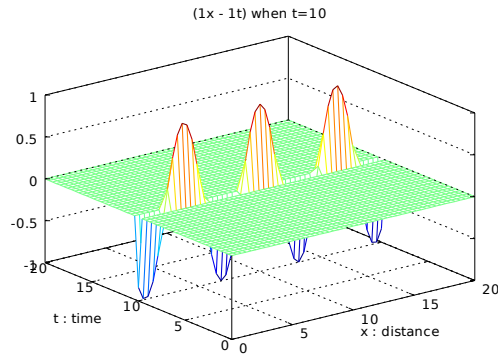
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{1} = 6.28$$

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

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
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