# Physics 3B for Material Engineering course number 203-1-2421 Semester B 2015

TA - Omer Tzuk

Ben-Gurion University of the Negev

physweb.bgu.ac.il/~omertz/

Updated -

March 15, 2015

# Overview

Lecturer: Prof. Ron Folman
Assistant: Omer Tzuk

## Course Policy:

- The final grade is 100 % exam grade
- 80 % of homework submission (by deadline) is obligatory
- If you dont submit your obligatory amount of homework, your final grade will be decreased by 3 points for every exercise

## Text Books

Oscillations and waves

- D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics Extended, 9th ed., chapters 15-17
- Berkeley Physics course series, Waves – no. 3, chapters 1-6

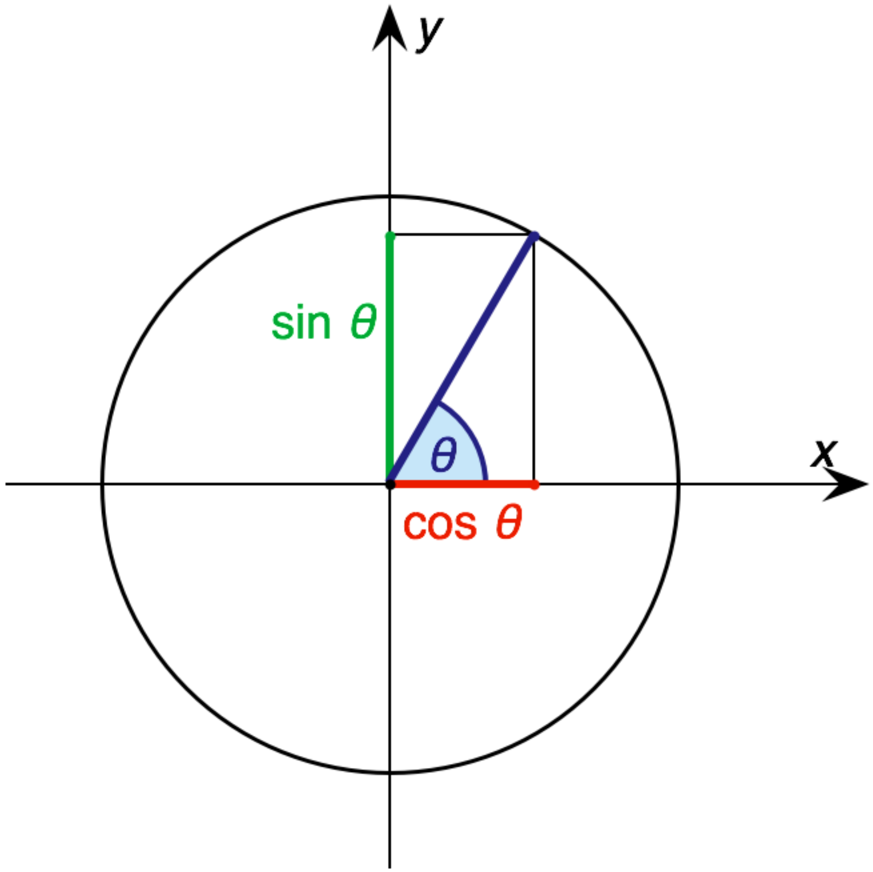
Quantum Mechanics

- D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics Extended, 9th ed., chapters 37-40
- K. Krane, Modern Physics (1983), Chapters 3,4,6, QC21.2.K7 SYSNO 1019699, 1996 2nd edition QC21.2.K7 SYSNO 1380176
- A. Beiser / Concepts of Modern Physics (1967), Chapters 1-8, QC173.B413 SYSNO 0080918

# Trigonometry

## From Wikipedia:

Trigonometry (from Greek trignon, "triangle" and metron, "measure"[1]) is a branch of mathematics that studies relationships involving lengths and angles of triangles. The field emerged during the 3rd century BC from applications of geometry to astronomical studies.



# Trigonometry

## Important identities

$$\sin^2\theta + \cos^2\theta = 1$$

$$\tan\theta = \frac{\sin\theta}{\cos\theta} \qquad \cot\theta = \frac{1}{\tan\theta} = \frac{\cos\theta}{\sin\theta}$$

$$\sec\theta = \frac{1}{\cos\theta} \qquad \csc\theta = \frac{1}{\sin\theta}$$

$$\cos\theta = \sin\left(\tfrac{\pi}{2} - \theta\right) \qquad \sin\theta = \cos\left(\tfrac{\pi}{2} - \theta\right)$$

$$\cot\theta = \tan\left(\tfrac{\pi}{2} - \theta\right) \qquad \tan\theta = \cot\left(\tfrac{\pi}{2} - \theta\right)$$

$$\csc\theta = \sec\left(\tfrac{\pi}{2} - \theta\right) \qquad \sec\theta = \csc\left(\tfrac{\pi}{2} - \theta\right)$$

$$\begin{aligned} \sin(\theta + 2\pi) &= \sin\theta \\ \cos(\theta + 2\pi) &= \cos\theta \\ \tan(\theta + \pi) &= \tan\theta \end{aligned}$$

## Derived identities

$$\begin{aligned} \sin(\alpha + \beta) &= \sin\alpha\ \cos\beta + \cos\alpha\ \sin\beta \\ \cos(\alpha + \beta) &= \cos\alpha\ \cos\beta - \sin\alpha\ \sin\beta \\ \sin(\alpha - \beta) &= \sin\alpha\ \cos\beta - \cos\alpha\ \sin\beta \\ \cos(\alpha - \beta) &= \cos\alpha\ \cos\beta + \sin\alpha\ \sin\beta \end{aligned}$$

$$\sin\alpha + \sin\beta = 2\sin\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2}$$

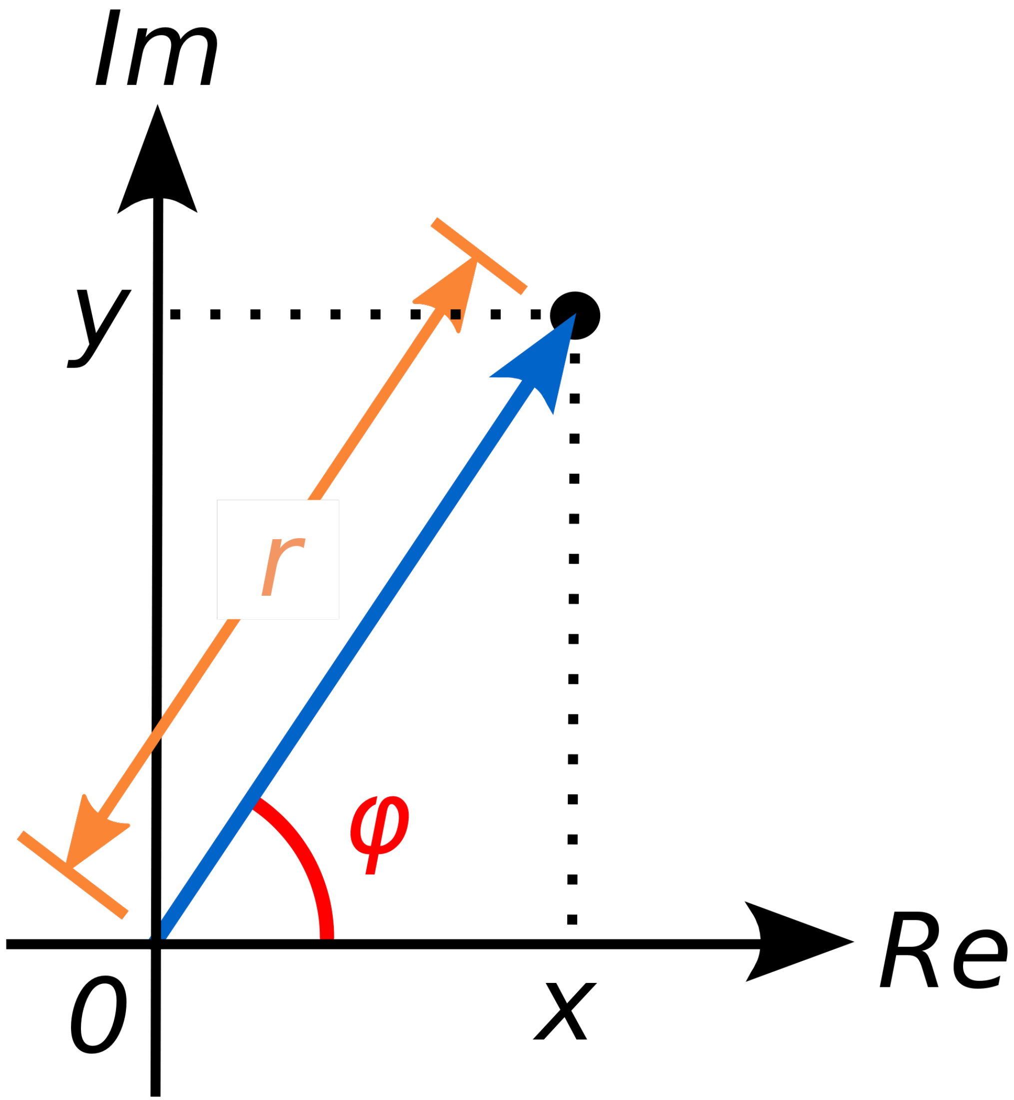
$$\cos\alpha + \cos\beta = 2\cos\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2}$$

$$\sin\alpha - \sin\beta = 2\cos\frac{\alpha+\beta}{2}\sin\frac{\alpha-\beta}{2}$$

$$\cos\alpha - \cos\beta = -2\sin\frac{\alpha+\beta}{2}\sin\frac{\alpha-\beta}{2}$$

# Complex Functions

## Complex numbers




## Euler's Formula

$$e^{ix} = \cos x + i \sin x$$

$$\cos x = Re\{e^{ix}\} = \frac{e^{ix} + e^{-ix}}{2}$$

$$\sin x = Im\{e^{ix}\} = \frac{e^{ix} - e^{-ix}}{2i}$$

# Derivation

## Definition

$$\textit{derivative of f(x)} = f'(x) = \frac{\textit{change in f}}{\textit{change in x}}$$
$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

## Some Differentiation rules

$$(f(x) \cdot g(x))' = f'(x)g(x) + f(x)g'(x)$$

If $f(x) = h(g(x))$ we have

$$f'(x) = h'(g(x)) \cdot g'(x)$$
$$\textit{example - } f(z(x)) = \sin(z(x)),\ z(x) = 3x$$
$$f'(x) = \cos(3x) \cdot (3) = 3\cos(3x)$$

Link - Differentiation rules

# Determinants

A scalar value that is attributed to a square matrix.

## How to calculate the determinant of a matrix

Determinant of $2 \times 2$ matrix

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc.$$

Determinant of $3 \times 3$ matrix

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = a\begin{vmatrix} e & f \\ h & i \end{vmatrix} - b\begin{vmatrix} d & f \\ g & i \end{vmatrix} + c\begin{vmatrix} d & e \\ g & h \end{vmatrix}$$

$$= a(ei - fh) - b(di - fg) + c(dh - eg)$$

$$= aei + bfg + cdh - ceg - bdi - afh.$$

# Tylor Expansion

## Definition

Taylor series is a representation of a function as an infinite sum of terms that are calculated from the values of the function's derivatives at a single point.

$$f(x) = f(x_0)+f'(x_0)\cdot(x-x_0)+\frac{1}{2}f''(x_0)\cdot(x-x_0)^2+\frac{1}{6}f^{(3)}(x_0)\cdot(x-x_0)^3+...+\frac{1}{n!}f^{(n)}(x_0)(x-x_0)^n+...$$

## Example

$$f(x) = 3x^3 + 4x^2 - 2x + 1$$

$$f(x) = f(0) + f'(0)\cdot(x-0) + \frac{1}{2}f''(0)\cdot(x-0)^2 + \dots$$

$$f(x) = 1 + (9x^2 + 8x - 2)\Big|_{x=0}\cdot x + \frac{1}{2}(18x+8)|_{x=0}\cdot x^2 + \dots$$

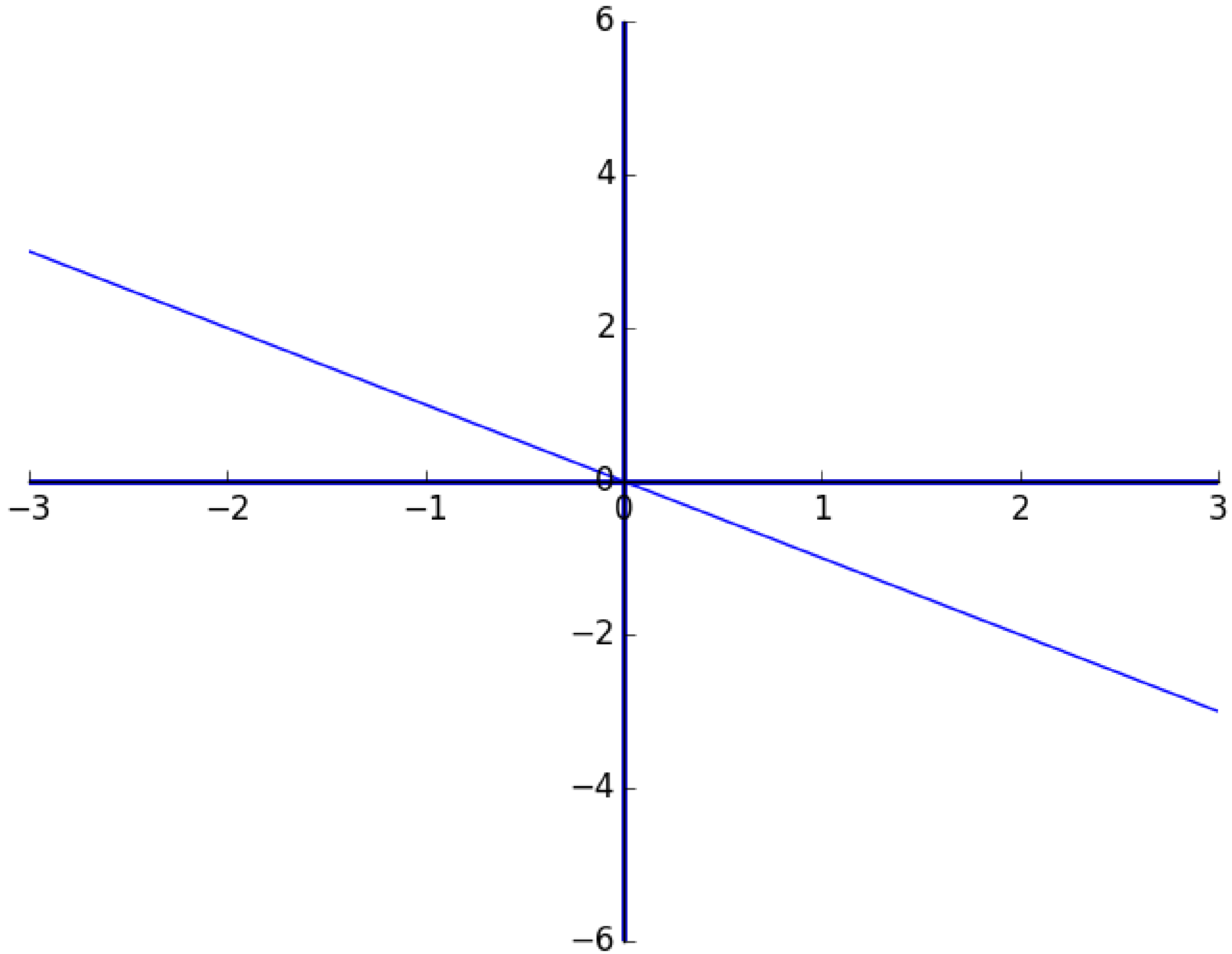
$$f(x) = 1 + (-2)\cdot x + \frac{1}{2}(8)\cdot x^2 + \dots$$

$$f(x) = 1 - 2x + 4x^2 + \dots = 4x^2 - 2x + 1\dots$$

Link to a video of this example - link

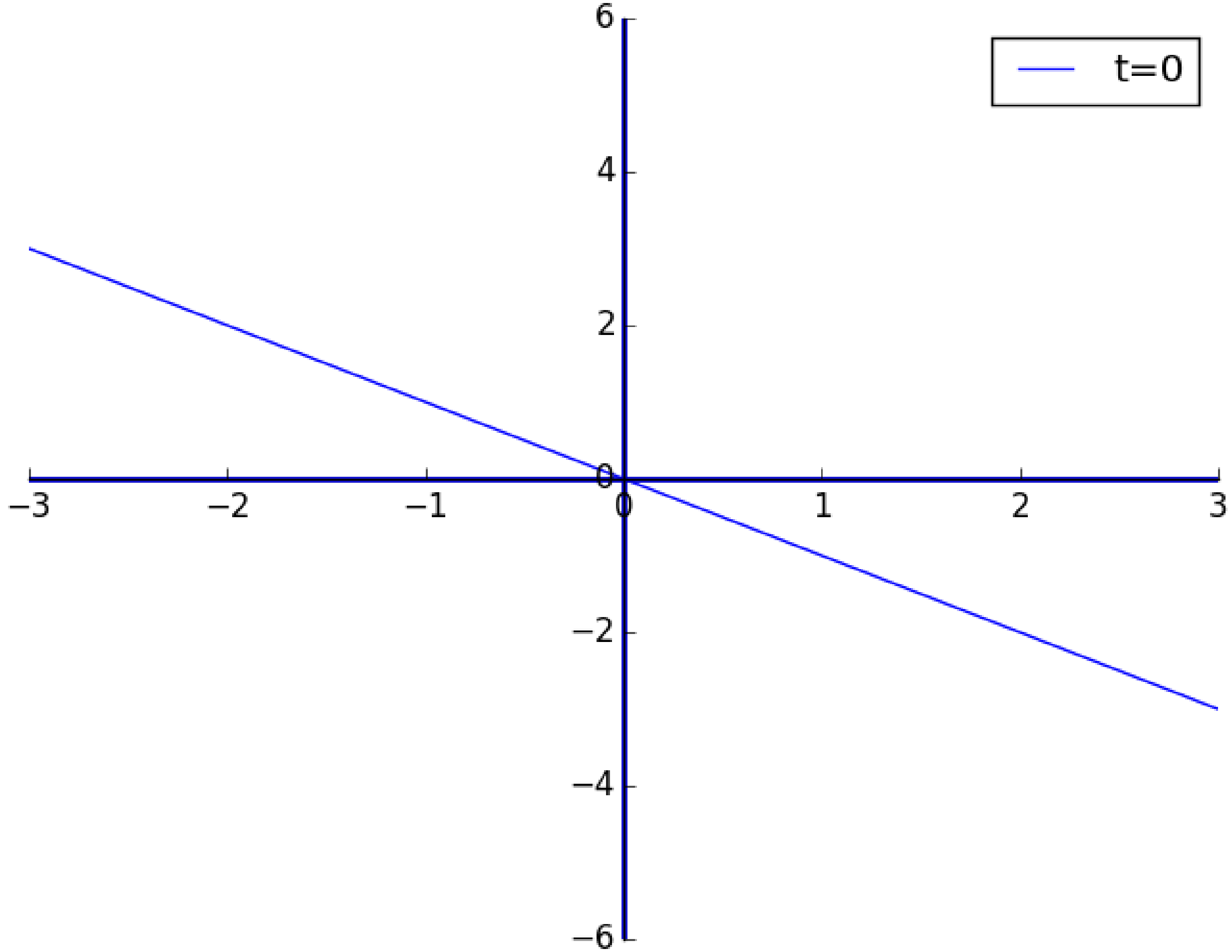
# Travelling wave

$$f(x) = -x$$



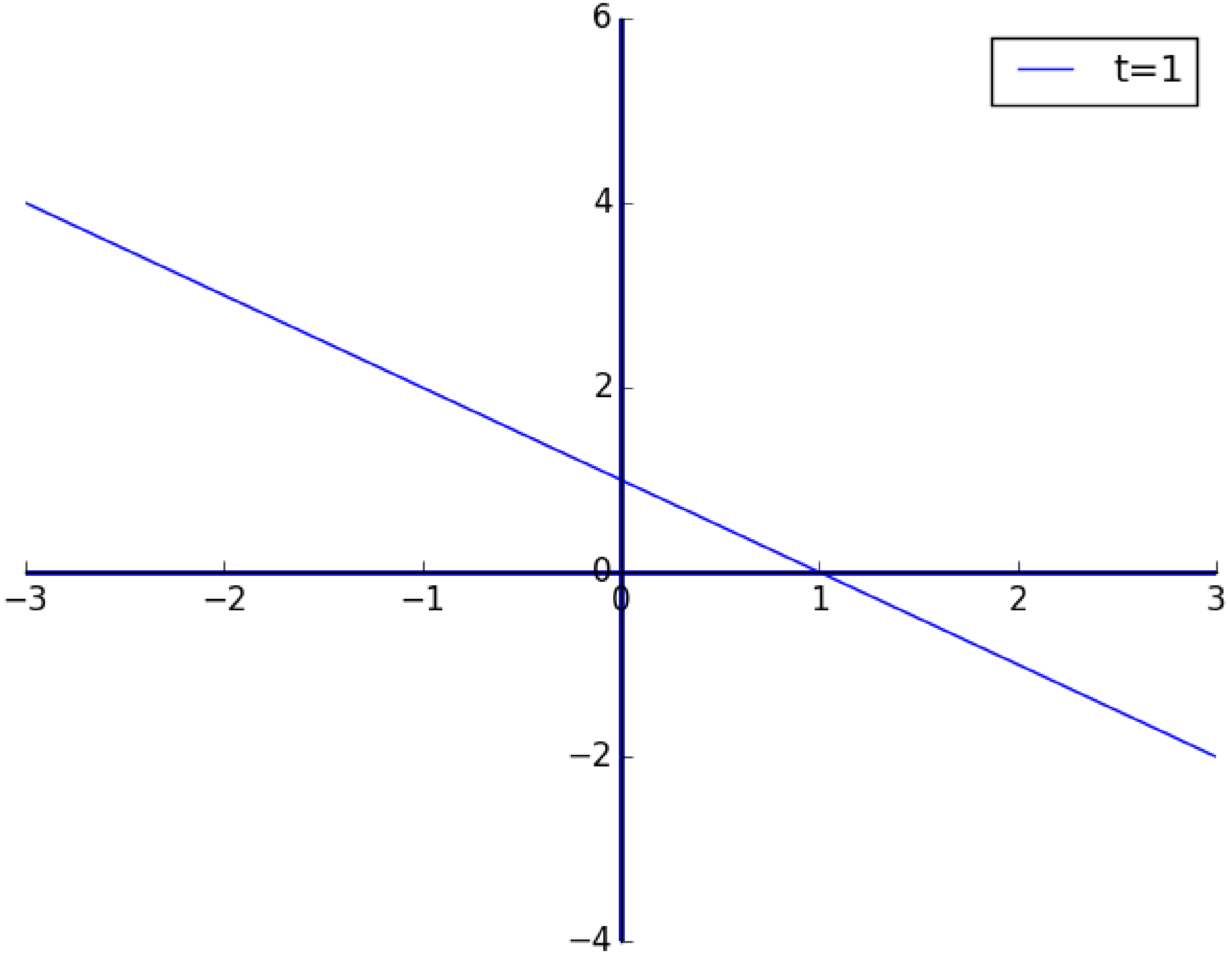
# Travelling wave

$$f(z(x,t)) = -z(x,t), \quad z(x,t) = x - t$$



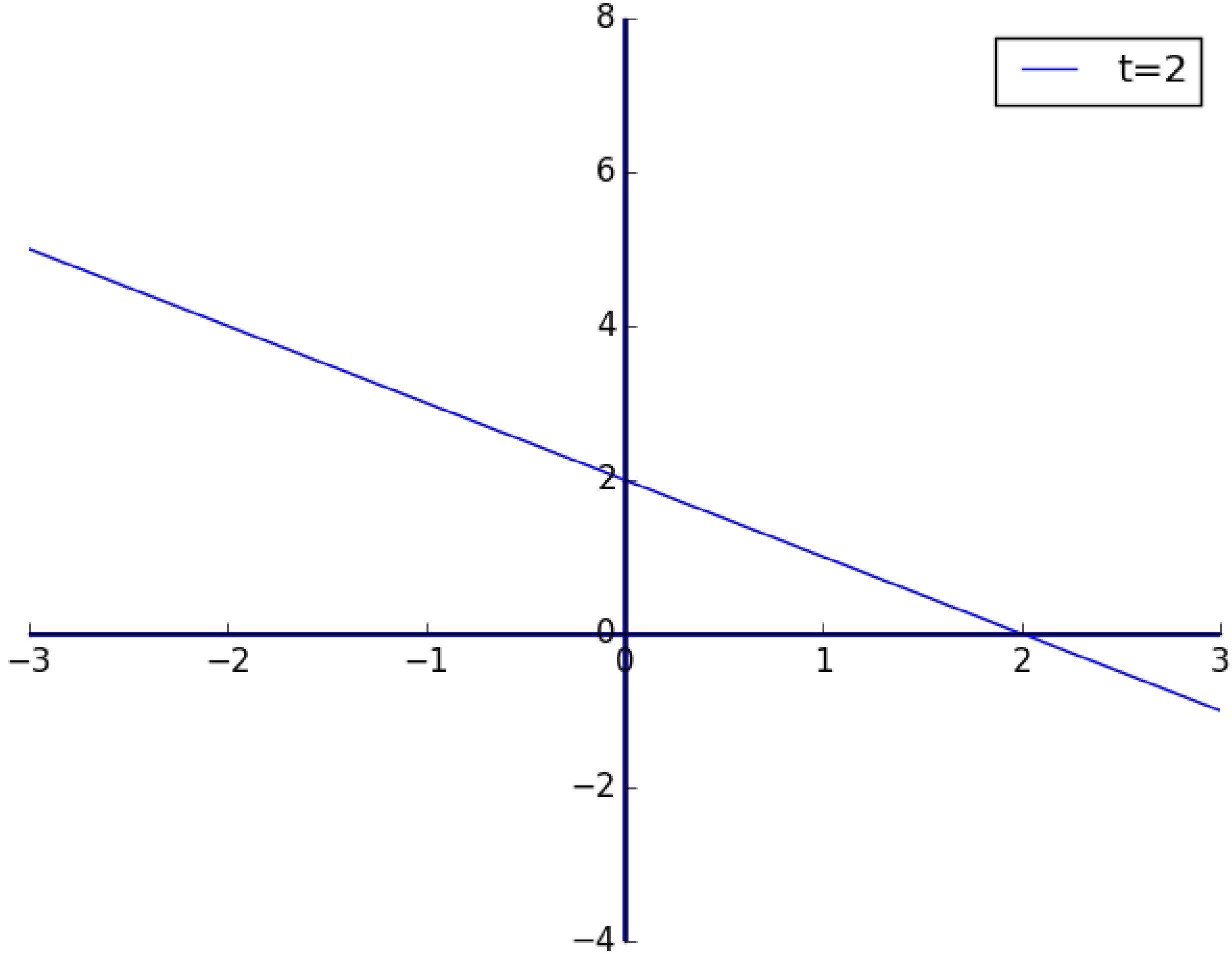
# Travelling wave

$$f(z(x,t)) = -z(x,t), \quad z(x,t) = x - t$$



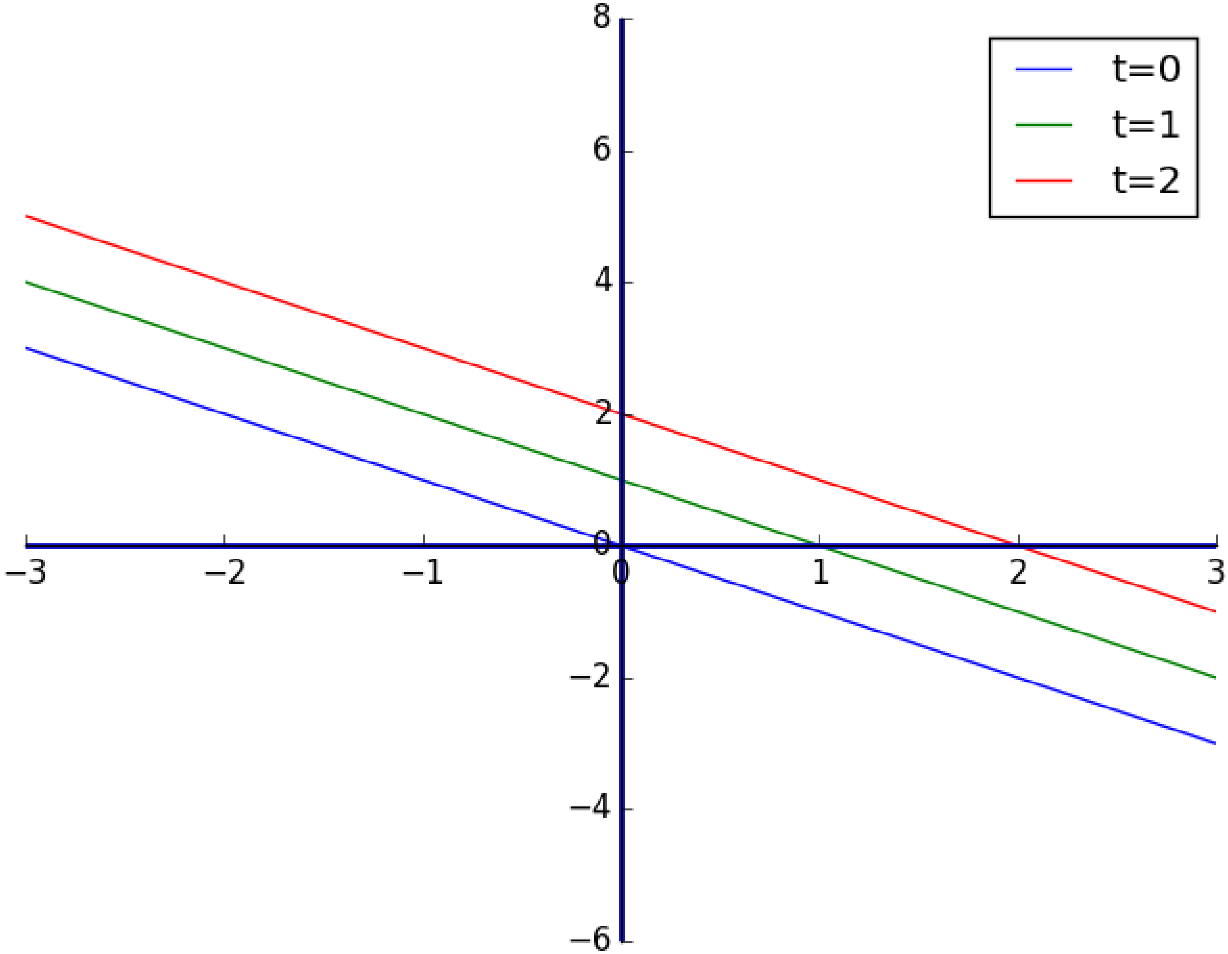
# Travelling wave

$$f(z(x,t)) = -z(x,t), \quad z(x,t) = x - t$$



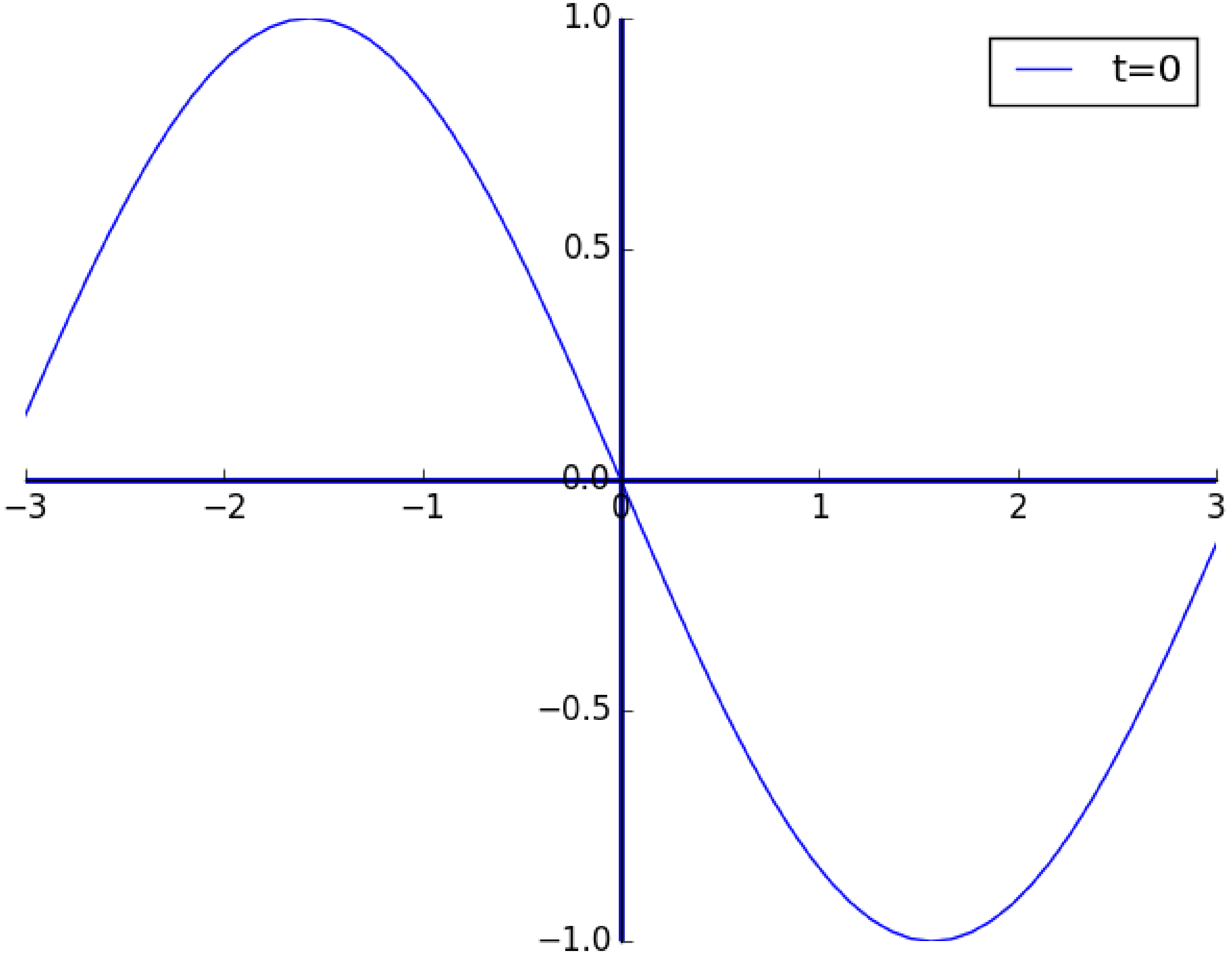
# Travelling wave

$$f(z(x,t)) = -z(x,t), \quad z(x,t) = x - t$$



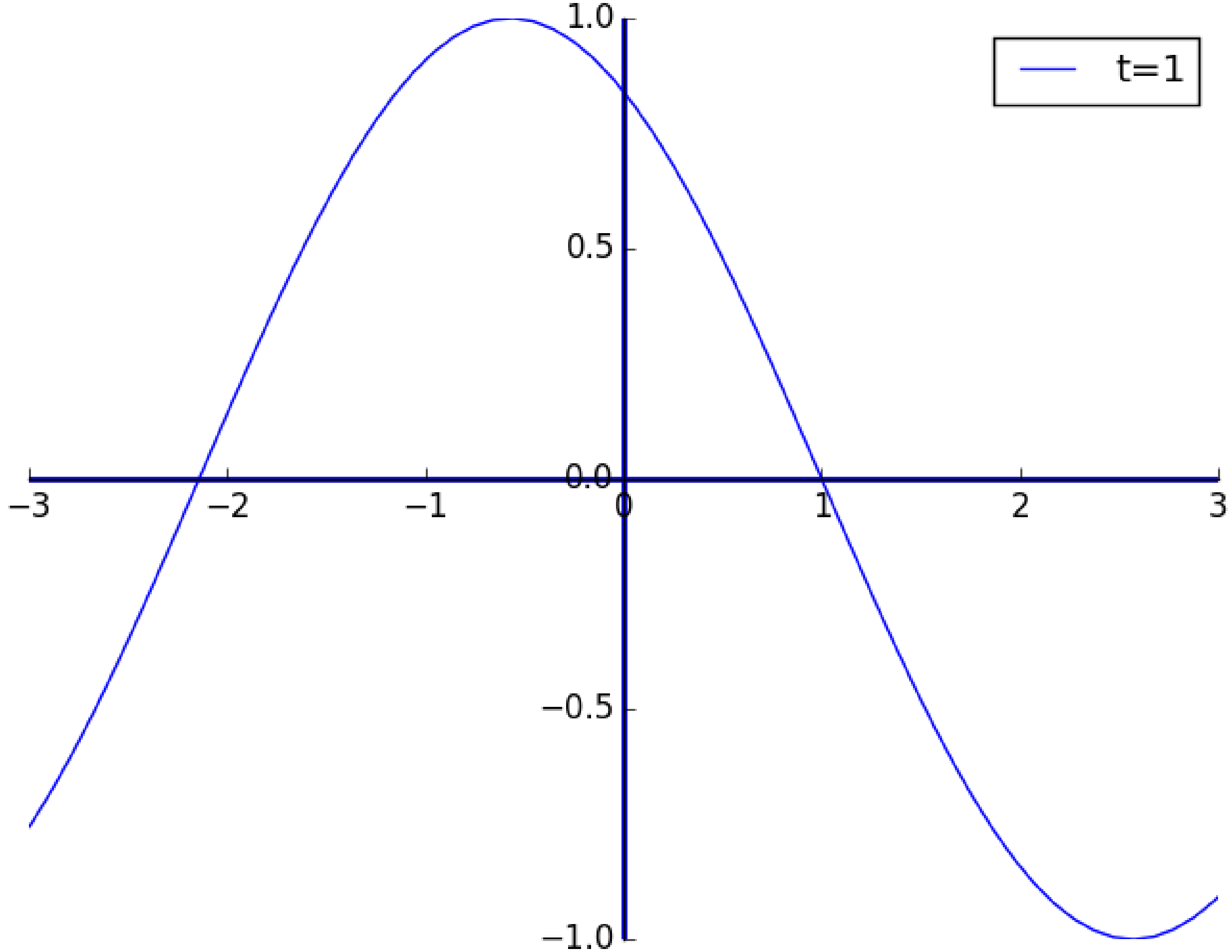
# Travelling wave - sin function

$$f(z(x,t)) = -\sin(z(x,t)), \quad z(x,t) = x - t$$



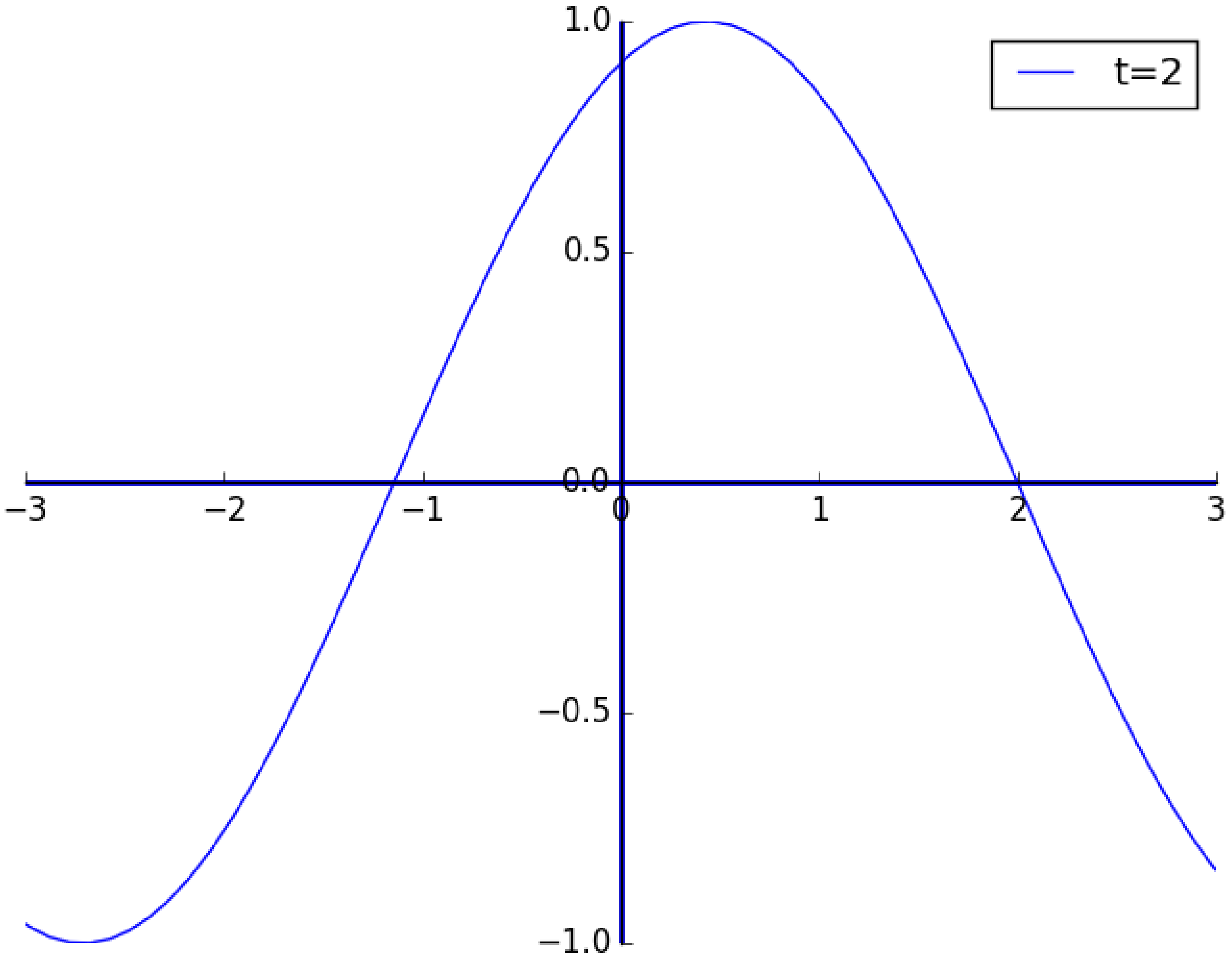
# Travelling wave - sin function

$$f(z(x,t)) = -\sin(z(x,t)), \quad z(x,t) = x - t$$



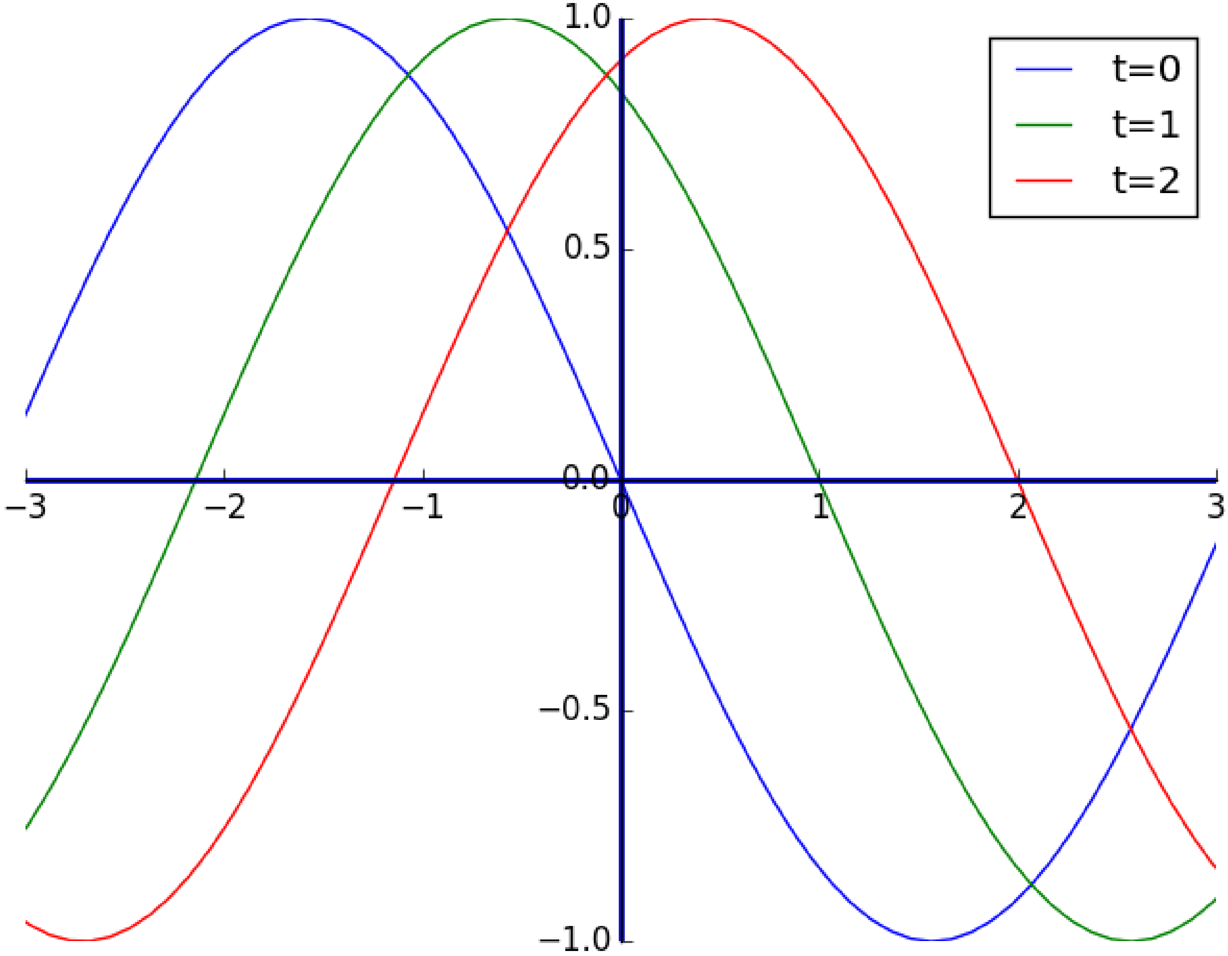
# Travelling wave - sin function

$$f(z(x,t)) = -\sin((x,t)z), \quad z(x,t) = x - t$$



# Travelling wave - sin function

$$f(z(x,t)) = -\sin(z(x,t)), \quad z(x,t) = x - t$$




Link to a video of this example - link