1) Complex numbers

These are useful abstract quantities and are very useful in solving problems in physics, engineering etc.
The idea is that we expand numbers from 1D to 2D by introducing an imaginary unit

$$i = \sqrt{-1}$$

So each number can be described as

$a + ib$; $x + iy$ etc

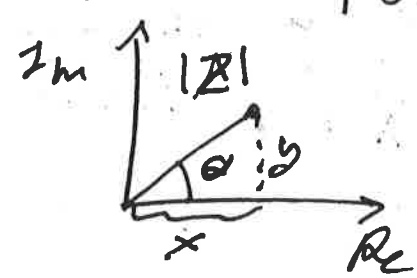
What we consider regular numbers such as 1, 2, 7, 107 etc are the Real part of the complex number.
So if $z = a + ib$ is the complex number

$x = a = Re(z)$ real

$y = b = Im(z)$ imaginary

parts

$$z = x + iy \equiv |z|\left[\cos\theta + i\sin\theta\right] = |z|e^{i\theta}$$ euler formula



Where $\boxed{|z| = \sqrt{x^2 + y^2}}$

$$\theta = \arctan\left(\frac{y}{x}\right)$$

For example if we have

$z = 3 + 4i$ it means that

$Re(z) = 3$

$Im(z) = 4$

$$|z| = \sqrt{3^2+4^2} = 5$$

$$\theta = \arctan\left(\frac{4}{3}\right) = 0.9273 \text{ rad} = 53.13^\circ$$

So $z = 5e^{53.13 i}$

So what's the connection to ocilators?

So: in our case we had:

$$x = A\cos(\omega t + \phi)$$

So

$$x = Re\left[Ae^{i\omega t+\phi}\right] = Re\left[A(\cos(\omega t+\phi) + i\sin(\omega t+\phi)\right] = A\cos(\omega t+\phi) \quad 0 =$$

it's much simpler to solve diferential eqs with the complex exponent.

Its easier to solve it

So

this should be k/m!

$$\ddot{x} = -\frac{k}{\omega}x$$

now we will guess

$x = Ae^{i\omega t}$ (take Re @ end!)

3)

$$\dot{x} = i\omega A e^{i\omega t} = i\omega x$$

$$\boxed{\ddot{x} = -\omega^2 x} \qquad \omega^2 = \frac{k}{m}$$

Well that is easy but when things will become more complicated it will Really help!