Principle of Superpostion
for second order linear <u>homogeneous</u> equations.

Consider $A(x)\,y'' + B(x)\,y' + C(x)\,y = 0$
Suppose two functions $y_1(x)$ and $y_2(x)$ satisfy this equation

THEN so does $c_1 y_1 + c_2 y_2$, where c_1 and c_2 are any constants.

<u>Proof</u>: We know $Ay_1'' + By_1' + Cy_1 = 0$
and $Ay_2'' + By_2' + Cy_2 = 0$

So look at

$$A(c_1y_1+c_2y_2)'' + B(c_1y_1+c_2y_2)' + C(c_1y_1+c_2y_2)$$

$$= Ac_1y_1'' + Ac_2y_2'' + Bc_1y_1' + Bc_2y_2' + Cc_1y_1 + Cc_2y_2$$

$$= c_1(Ay_1'' + By_1' + Cy_1) + c_2(Ay_2'' + By_2' + Cy_2)$$

$$= c_1 \cdot 0 + c_2 \cdot 0 = 0$$ QED

<u>Example</u>: since e^{2x} and e^{-2x} solve $y'' - 4y = 0$
so do:
- $e^{2x} + e^{-2x}$
- $e^{2x} - e^{-2x}$
- $15e^{2x}$
- $\pi e^{2x} + 17e^{-2x}$ etc.