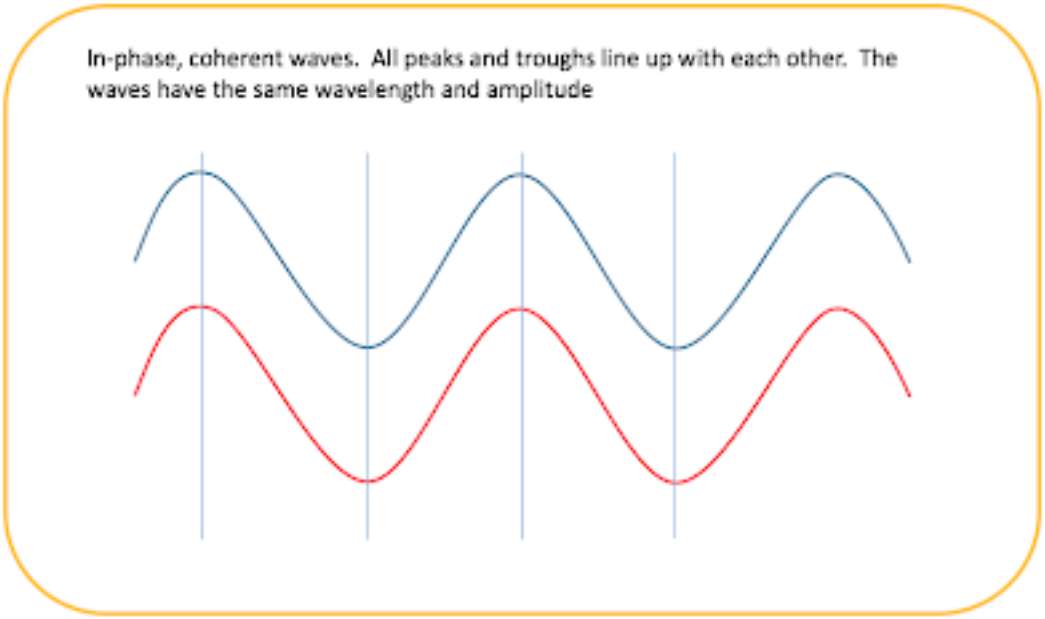
EECS 334 Final Review

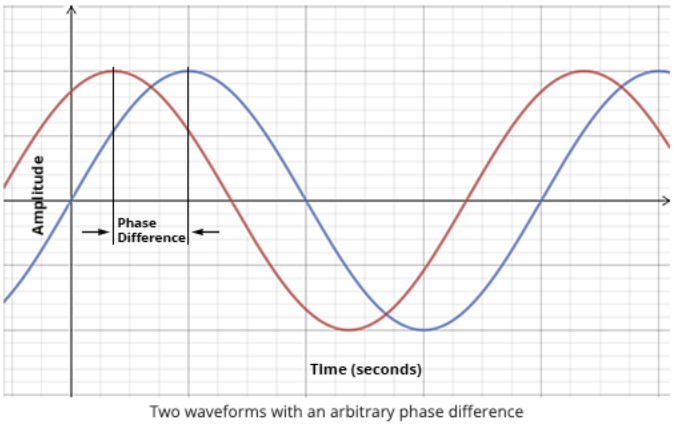
1. Compute the resultant irradiance of coherent and incoherent superposition of waves of the same frequency.

First lets define irradiance. Irradiance is the flux of radiant energy unit area (normal to the direction of flow of radiant energy through a medium), or more colloquially, the fact of shining brightly. Basically, irradiance is a way to measure the energy from light that hits a certain area for a certain amount of time.

Lets define coherent waves; two waves sources are coherent if their **frequency** and **waveform** are identical.

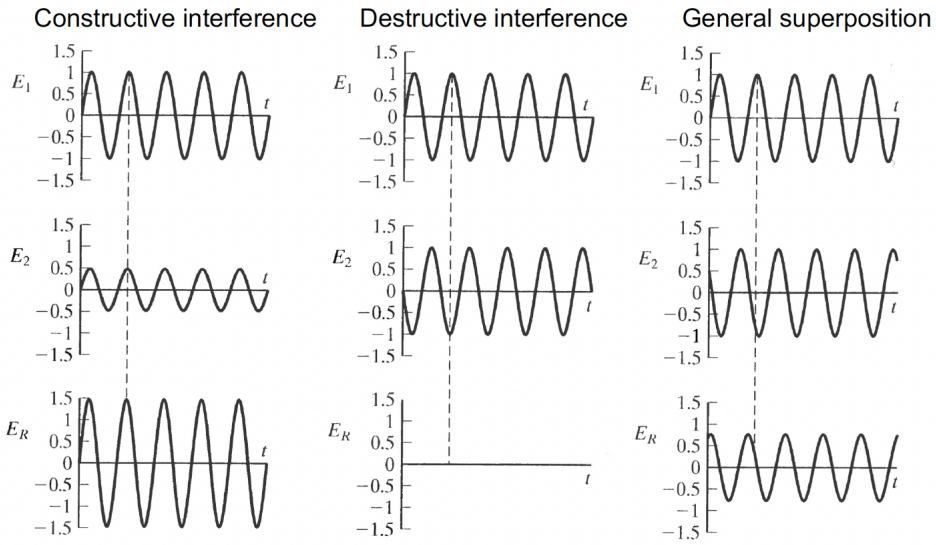


Lastly, the definition of incoherent waves is two or more waves that have don't have the same frequency and phase.



Two waveforms with an arbitrary phase difference

So, what this statement is asking us is to add these two waves, which we can do because of superposition! Superposition is the fact that if we have λ_1 and λ_2 we can add them together. If they interfere **constructively** then they will add into a bigger wave than the original, if interfere **destructive**, then the resulting wave is smaller.



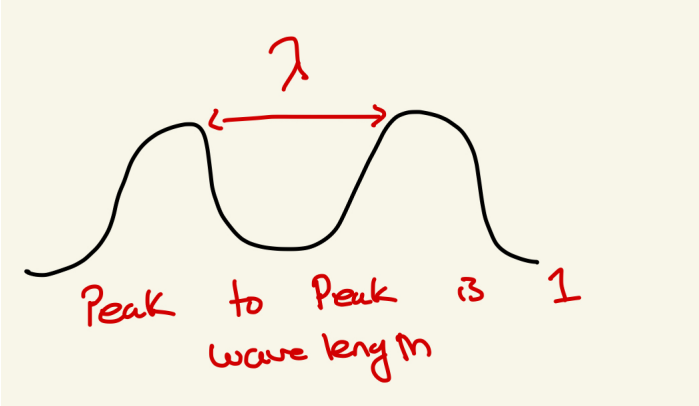
We can say that the resulting wave due to the two path differences is

$$E_R = E_1 + E_2 = E_{01}\cos(\alpha_1 - wt) + E_{02}\cos(\alpha_2 - wt)$$

- If $(\alpha_2 - \alpha_1) = m2\pi$, where m is an integer, then the waves are in-step (the peaks and the troughs arrive at a point P at the same time). This is **constructive interference**.
- $(\alpha_2 - \alpha_1) = (2m + 1)\pi$, then the waves are out of step, resulting in **destructive interference**.

Note: When you hear out of phase, it usually means the wave source is shifted by π.

A real life example of destructive interference. When someone is wearing noise cancelling headphones, the noise coming in has its own wave, but the headphones will send a single back cancelling out the the original wave. This is using the idea of two waves being completely destructive!



If we keep shifting to the right by an interger value, we will keep on getting constructive interference! Look at the diagram below. Wavelength 2 is red and wavelength 1 is black.