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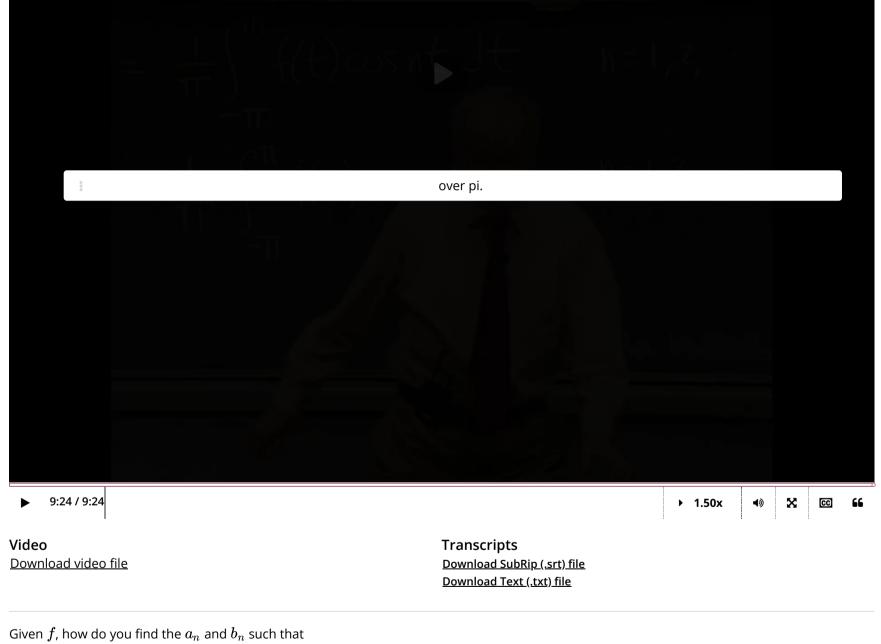
Course > Unit 1: Fourier Series > 1. Introduction to Fourier Series > 8. Fourier coefficient formulas

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8. Fourier coefficient formulas Finding formulas



$$f(t) = rac{a_0}{2} + a_1 \cos t + a_2 \cos 2t + a_3 \cos 3t + \cdots \ + b_1 \sin t + b_2 \sin 2t + b_3 \sin 3t + \cdots ?$$

By the shortcut formulas,

$$a_{n}=rac{\left\langle f,\cos nt
ight
angle }{\left\langle \cos nt,\cos nt
ight
angle }=rac{1}{\pi}\int_{-\pi}^{\pi}f\left(t
ight) \cos nt\,dt,$$

$$b_{n}=rac{\left\langle f,\sin nt
ight
angle }{\left\langle \sin nt,\sin nt
ight
angle }=rac{1}{\pi}\int_{-\pi}^{\pi}f\left(t
ight) \sin nt\,dt,$$

and the coefficient of 1 is

$$rac{a_{0}}{2}=rac{\left\langle f,1
ight
angle }{\left\langle 1,1
ight
angle }=rac{1}{2\pi}\int_{-\pi}^{\pi}f\left(t
ight)\,dt.$$

SO

$$a_0=rac{1}{\pi}\int_{-\pi}^{\pi}f\left(t
ight)\,dt.$$

(Using $a_0/2$ in the series ensures that the formula for a_n for n>0 works also for n=0.) A similar formula holds for b_n .

Conclusion: Given f, its Fourier coefficients can be calculated as follows:

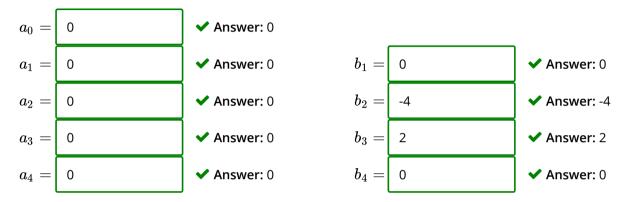
$$a_n = rac{1}{\pi} \int_{-\pi}^{\pi} f(t) \cos nt \, dt \text{ for all } n \geq 0,$$

$$b_{n}=rac{1}{\pi}\int_{-\pi}^{\pi}f\left(t
ight) \sin nt\,dt$$
 for all $n\geq1.$

Identify the coefficients

9/9 points (graded)

Find the Fourier coefficients of $2\sin 3t - 4\sin 2t$.



Solution:

Since $\langle\cos{(nt)}\,,\sin{(mt)}\rangle=0$ for all n and m, all of the $a_i=0$. The only surviving b_i coefficients are b_2 and b_3 .

$$b_2 \; = \; \; rac{1}{\pi} \int_{-\pi}^{\pi} -4 \sin 2t \sin 2t \, dt = -4 rac{\pi}{\pi} = -4$$

Similarly, we find that $b_3=2$.

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