

Solution to VTU Question Bank**MODULE-I**
Fourier Series

1. Obtain the Fourier expansion of

$$f(x) = \begin{cases} x, & 0 \leq x \leq \pi \\ 2\pi - x, & \pi \leq x \leq 2\pi \end{cases}$$

Deduce that $\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \dots$

(June 2014)

Sol: Here, $a_0 = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) dx = \frac{2}{\pi} \int_0^{\pi} f(x) dx$

$$= \frac{2}{\pi} \int_0^{\pi} x dx = \pi$$

$$a_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \cos nx dx = \frac{2}{\pi} \int_0^{\pi} f(x) \cos nx dx$$

since $f(x) \cos nx$ is even.

$$= \frac{2}{\pi} \int_0^{\pi} x \cos nx dx$$

$$= \frac{2}{\pi} \left[x \left(\frac{\sin nx}{n} \right) - \int \left(\frac{-\cos nx}{n^2} \right) \right]_0^{\pi}$$

$$= \frac{2}{n^2 \pi} [(-1)^n - 1]$$

Also, $b_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \sin nx dx = 0$, since $f(x) \sin nx$ is odd

Thus the Fourier series of $f(x)$ is

$$f(x) = \frac{\pi}{2} + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{1}{n^2} [(-1)^n - 1] \cos nx$$

For $x=\pi$, we get

Vtu Engineering Mathematics Question Papers

M Mark



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