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Phys 330
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Quiz #3 Electromagnetic Theory

1). a) Let $\bar{V} = a\hat{x} + b\hat{y} + c\hat{z}$

Fouriers trick =

$\hat{x}_i \cdot \hat{x}_j = 0 \quad \hat{x}_i \cdot \hat{x}_i = 1$

$\bar{V} \cdot \hat{z} = z\left(a\hat{x} + b\hat{y} + c\hat{z}\right.$ $a_0 \quad b_0 \quad c_1$ $\boxed{\bar{V} \cdot \hat{z} = C}$

b). $\bar{X} = \sum_{i=1}^{n} c_i \hat{x}_z = C_z$ $\boxed{B = \bar{V} \cdot \hat{z}}$

Fouriers $= V \cdot \hat{x}_m = \sum_{i=1}^{n} c_n \tilde{x}_i \cdot \hat{x}_m = C_m$

$\bar{V} \cdot \hat{x}_z = \sum_{i=1} c_i \cdot \hat{x}_i \cdot \hat{x}_z = C_z$

$\boxed{\hat{x}_y \cdot \hat{x} = D}$

c). $f(x) = \frac{a_0}{2} + \sum_{n=1} a_n \sin$

3). $f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \sin(nx) + b_n (\cos(nx))$ $\quad f(x) = \sin(3x) \quad n=0 \; n=\infty$

$a_0 = 0 = \frac{a_0}{2}$

Dot product of both sides

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

$b_n = \frac{1}{\pi}\int f(x)\cos(nx)dx$

$a_n = \frac{1}{\pi}\int_0^{\pi} \sin(nx)dx \quad a_n = \frac{1}{\pi n}\cos(nx)\Big|_{\pi}^{0} = \frac{1}{n\pi}\{1 - \cos(n\pi)$

even n for A=0
odd n for $A = \frac{2}{n\pi}$

$b_n = \frac{1}{\pi}\int_0^{\pi} 1 \cdot \cos(nx)dx$

$= \frac{1}{\pi}\int_0^{\pi} \cos(nx)dx = \frac{1}{n\pi}\sin(nx)\Big|_0^{\pi}$

$\frac{1}{n\pi}\sin(n\pi) - \sin(0)$

$b_n = 0$

$b_0 = \frac{1}{\pi}\int_0^{\pi} \cos(0 \cdot x)dx$

$\frac{1}{\pi}\pi \quad b_0 = 1$

$f(x) = \frac{2}{\pi} \sum_{n=1,3,5}^{\infty}$

$f(x) = \frac{2}{\pi} \sum_{n=1,3,5}^{\infty} \frac{\cos(nx)}{n}$ $\quad \frac{1}{n},\ 1, \frac{1}{3}, \frac{1}{5}, \frac{1}{7}, \frac{1}{9}$

because n is odd for A_0 the leading coefficients must be odd going to infinity.

2a). $V(x,y,z) \to 0$ $\quad g(y) = \sinh(x)$
$\underline{\underline{y \to \infty}}$

$\sinh(\infty) = \infty \quad a \le 0$

$\boxed{B = g(y) = \sinh(x)}$

b). Eq 3.5 $\to$ $V_0(y,z) = V_0$
3.51

$C_{n,m} = \frac{4V_0}{ab} \int_0^a \int_0^a \sin(n\pi y/a)$
$\sin(n\pi z/a)\,dy\,dz$

$C_{n,m} = \frac{4V_0}{ab} \int_0^a \int_0^a \sin(n\pi y/a)\sin(n\pi z/a)\,dy\,dz$

$n,m = (3,5)$ $\quad$ $n,m =$ even function $\to 0$

$\frac{4}{ab} \cdot \int_0^a \sin\left(\frac{2\pi y}{a}\right)dy \cdot \int_0^b \sin\left(\frac{2\pi z}{b}\right)dz$

$\int_0^a \sin\left(\frac{2\pi y}{4}\right)dy = 0$

$= \frac{4}{ab} \cdot 0 \cdot \int_0^b \sin\left(\frac{2\pi z}{b}\right)dz$

$\int_0^b \sin\left(\frac{2\pi z}{b}\right)dz = 0$

$\frac{4}{ab} \cdot 0 \cdot 0 = 0$ for even functions

for n,m = $n=3$ $\quad m=5$ other page $\to$

$$\frac{4}{ab}\cdot\int_0^a \sin\left(\frac{3\pi y}{a}\right)dy = \frac{3}{3\pi}a$$

$$= \frac{4}{ab}\cdot\frac{2}{3\pi}a\cdot\int_0^b \sin\left(\frac{5\pi z}{b}\right)dz$$

$$\int_0^b \sin\left(\frac{5\pi z}{b}\right)dz = \frac{2}{5\pi}b$$

$$= \frac{4}{ab}\cdot\frac{2}{3\pi}a\frac{2}{5\pi}b$$

$$= \frac{4}{ab}\cdot\frac{2}{3\pi}a\frac{2}{5\pi}b = \frac{16}{15\pi^2}$$

$$\boxed{= \frac{16}{15\pi^2}}$$