n	f	f(0)
0	$\cos\pi x$	1
1	$-\sin\pi x$	0
2	$-\cos\pi x$	-1
3	$\sin\pi x$	0

... Problem 1.

e) $x(t)$ is periodic with $T=1$ and: $x(t)=\begin{cases}-1 & \text{if } -\frac{1}{2}\le t\le 0\\ 1 & \text{if } 0<t\le \frac{1}{2}\end{cases}$

$$a_k=\frac{1}{T_0}\int_{-T_0/2}^{T_0}x(t)\,e^{-j\frac{2\pi}{T_0}kt}\,dt=\frac{1}{1}\left(\int_{-1/2}^{0}-e^{-j\frac{2\pi}{1}kt}\,dt+\int_{0}^{1/2}e^{-j\frac{2\pi}{1}kt}\,dt\right)=-\left(\frac{e^{-j2\pi kt}}{-j2\pi k}\right)\Bigg|_{t=-1/2}^{0}+\left(\frac{e^{-j\frac{2\pi}{1}kt}}{-j2\pi k}\right)\Bigg|_{t=0}^{1/2}=$$

$$=j\frac{-(e^{-0}-e^{+j\pi k})+(e^{-j\pi k}-e^{-0})}{2\pi k}=j\frac{-1+e^{j\pi k}+e^{-j\pi k}-1}{2\pi k}=$$

$$=j\frac{-2+\cos\pi k+j\sin\pi k+\cos\pi k-j\sin\pi k}{2\pi k}=j\frac{\cos\pi k-1}{\pi k}$$

at $k=0$: $a_0=\lim_{k\to 0}j\frac{\cos\pi k-1}{\pi k}=\frac{j}{\pi}\lim_{k\to0}\frac{1-\frac{k^2}{2}-1}{k}=\frac{j}{\pi}\lim_{k\to0}\frac{\frac{k^2}{2}}{k}=\lim_{k\to0}\frac{j}{2\pi}k=0$

$$\boxed{a_k=\begin{cases}j\frac{\cos(\pi k)-1}{\pi k} & \text{if } k\neq 0\\ 0 & \text{if } k=0\end{cases}}$$