Answer (g).

We are asked to find the Fourier transform Y of

$$y(t) = \left[te^{-j5t}x(t)\right]^*.$$

In what follows, we use the prime symbol to denote the derivative (i.e., f' denotes the derivative of f). To begin, we have

$$\begin{aligned} y(t) &= \left[te^{-j5t}x(t)\right]^* \\ &= \left[e^{-j5t}\underbrace{tx(t)}_{v_1(t) = tx(t) \quad ①}\right]^*. \end{aligned}$$

Letting $v_1(t) = tx(t)$, we have

$$y(t) = \left[\underbrace{e^{-j5t}v_1(t)}_{v_2(t) = e^{-j5t}v_1(t) \quad ②}\right]^*.$$

Letting $v_2(t) = e^{-j5t}v_1(t)$, we have

$$y(t) = v_2^*(t). \quad ③$$

Thus, we have written $y(t)$ as

$$③ \longrightarrow \quad y(t) = v_2^*(t)$$

where

$$\begin{aligned} ① &\longrightarrow \quad v_1(t) = tx(t) \quad \text{and} \\ ② &\longrightarrow \quad v_2(t) = e^{-j5t}v_1(t). \end{aligned}$$

Taking the Fourier transforms of the preceding equations, we obtain

$$\begin{aligned} ④ \quad V_1(\omega) &= jX'(\omega), && \longleftarrow \text{FT of ① using frequency-domain differentiation property} \\ ⑤ \quad V_2(\omega) &= V_1(\omega+5), \quad \text{and} && \longleftarrow \text{FT of ② using frequency-domain shifting property} \\ ⑥ \quad Y(\omega) &= V_2^*(-\omega). && \longleftarrow \text{FT of ③ using conjugation property} \end{aligned}$$

Combining the above equations, we have

$$\begin{aligned} Y(\omega) &= V_2^*(-\omega) && ⑥ \\ &= [V_1(-\omega+5)]^* && \text{substitute ⑤} \\ &= \left[jX'(-\omega+5)\right]^* && \text{substitute ④} \\ &= -jX'^*(-\omega+5). && (ab)^* = a^*b^* \end{aligned}$$