Determine whether each of the following statements is true or false. Justify your answers

(a) The Laplace transform of $t^2u(t)$ does not converge anywhere on the s-plane.

This signal, $t^2u(t)$, is in our Laplace transform tables, $\frac{1}{s^2}$, with a RoC $Re\{s\} > 0$. False

(b) The Laplace transform of $e^{t^2}u(t)$ does not converge anywhere on the s-plane

$\mathcal{L}\{e^{t^2}u(t)\} = \mathcal{F}\{e^{t^2-\sigma t}u(t)\}$, since the t^2 term grows faster than the σt term, for any finite value of σ, this integral does not converge, True

(c) The Laplace transform of $e^{j\omega_0 t}$ does not converge anywhere on the s-plane

$$X(s) = \int_{-\infty}^{\infty} e^{j\omega_0 t} e^{-st}\,dt = \left.\frac{e^{t(j\omega_0 - s)}}{j\omega_0 - s}\right|_{t=-\infty}^{\infty}$$ ← does not converge for any value of s, True

(d) The Laplace transform of $e^{j\omega_0 t}u(t)$ does not converge anywhere on the s-plane.

$$X(s) = \int_{0}^{\infty} e^{j\omega_0 t} e^{-st}\,dt = \left.\frac{e^{t(j\omega_0 - s)}}{j\omega_0 - s}\right|_{t=0}^{\infty}$$ ← this integral converges for any s where $Re\{s\} > 0$

False

(e) The Laplace transform of $|t|$ does not converge anywhere on the s-plane

$$X(s) = \underbrace{\int_{-\infty}^{0} (-t)e^{-st}\,dt}_{\text{O+W Table 9.2 pair \# 5}} + \underbrace{\int_{0}^{\infty} (t)e^{-st}\,dt}_{\text{O+W table 9.2 pair \# 4}}$$

$$= \underbrace{\frac{1}{s^2}}_{\text{Roc: } Re\{s\} < 0} + \underbrace{\frac{1}{s^2}}_{\text{Roc: } Re\{s\} > 0}$$

There is no overlap with the two ROCs, true