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

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

This signal, $t^2 u(t)$, is in our Laplace transform tables, $\frac{1}{s^3}$, with a ROC $\text{Re}(s) > 0$. False

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

$L\{e^{t^2} u(t)\} = \int_0^\infty e^{t^2} e^{-st} dt$, since the $e^{t^2}$ term grows faster than the $e^{-st}$ term, for any finite value of $s$, this integral does not converge. True

(c) The Laplace transform of $e^{jwt}$ does not converge anywhere on the $s$-plane.

$X(s) = \int_{-\infty}^{\infty} e^{i\omega t} e^{-st} dt = \frac{e^{i\omega (s-\omega)} - e^{-\infty}}{s - \omega}$ does not converge for any value of $s$. True

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

$X(s) = \int_0^{\infty} e^{j\omega t} e^{-st} dt = \frac{e^{j\omega s} - 0}{s - j\omega}$ does not converge for any $s$ where $\text{Re}(s) > 0$. False

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

$X(s) = \int_{-\infty}^{0} (-t) e^{-st} dt + \int_{0}^{\infty} t e^{-st} dt$ (1)

$= \left[ \frac{-1}{s} e^{-st} \right]_{-\infty}^{0} + \left[ \frac{-1}{s^2} e^{-st} \right]_{0}^{\infty}$ (2)

Roc: $\text{Re}(s) < 0$ Roc: $\text{Re}(s) > 0$ There is no overlap with the two ROCs, True