9. $$y_{n+2} - \frac{4}{3} y_{n+1} + \frac{1}{3} y_n = \frac{2}{3} h f(t_{n+2}, y_{n+2})$$

so $y' = \lambda y$ implies

$$y_{n+2} - \frac{4}{3} y_{n+1} + \frac{1}{3} y_n = \frac{2}{3} h\lambda\, y_{n+2}$$

or

$$\left(1 - \frac{2}{3} h\lambda\right) y_{n+2} - \frac{4}{3} y_{n+1} + \frac{1}{3} y_n = 0$$

i.e. $(3 - 2z) y_{n+2} - 4 y_{n+1} + y_n = 0$ where $z = h\lambda$.

Now $z \in \partial D \Rightarrow y_n = e^{in\theta}$ for some $\theta \in \mathbb{R}$, i.e.

$$(3 - 2z) e^{i(n+2)\theta} - \frac{4}{3} e^{i(n+1)\theta} + \frac{1}{3} e^{in\theta} = 0$$

or $$(3 - 2z) e^{2i\theta} - 4 e^{i\theta} + 1 = 0$$

Hence $$2z\, e^{2i\theta} = 3 e^{2i\theta} - 4 e^{i\theta} + 1$$

or $$z = \frac{1}{2}\left(3 - 4 e^{-i\theta} + e^{-2i\theta}\right).$$

We want $D \cap \mathbb{R}$ so consider

$$\begin{aligned} \operatorname{Re} z &= \frac{1}{2}(3 - 4\cos\theta + \cos 2\theta) \\ &= \frac{1}{2}(3 - 4\cos\theta + 2\cos^2\theta - 1) \\ &= 1 - 2\cos\theta + \cos^2\theta \\ &= (\cos\theta - 1)^2 \\ &\geq 0 . \end{aligned}$$

Hence $D \cap \mathbb{R} \supseteq (-\infty, 0)$ and it's A-stable.