We start Algorithm 7.1 with the first value $h_\Phi := 1$. The condition number $cond_{C^2}(\Phi, h_\Phi)$ is of order 10^{-8} and hence the Algorithm 7.1 tells us to decrease h. One can consider also the next $h_\Phi := 0.316$, but following the Algorithm 7.1 we devide h_Φ by 10 and proceed with $h_\Phi := 0.1$. The condition number $cond_{C^2}(\Phi, h_\Phi)$ is now of order 10^{-6} and so we again decrease h_Φ by 10 and proceed with $h_\Phi := 0.01$. The condition number is now approximately

$$cond_{C^2}(\Phi, h_\Phi) \approx 4 * 10^{-3},$$

which is bigger than 0.001 and smaller than 0.1. Hence, Algorithm 7.1 yield the estimate

$$h_F \approx 6.32 * 10^{-4},$$

which is pretty much in the middle between $3.16 * 10^{-4}$ and 10^{-3}, a bit closer to $3.16 * 10^{-4}$.

If you want to make sure, you can run the algorithm again, starting with $h_\Phi := 0.316$, then going on with $h_\Phi := 0.0316$ and finally for $h_\Phi := 3.16 * 10^{-3}$ the condition number becomes approximately

$$cond_{C^2}(\Phi, h_\Phi) \approx 5 * 10^{-2},$$

which is again bigger than 0.001 and smaller than 0.1. In this case Algorithm 7.1 yield the estimate

$$h_F \approx 6.27 * 10^{-4},$$

confirming the choice of $h_F := 3.16 * 10^{-4}$.

Regarding the error, using the error estimate $2\sqrt{M_2 * \epsilon_A}$ from page 53 with $M_2 := 120$ (or $M_2 := 122$), i.e., the value corresponding to h_Φ given by the algorithm, we obtain that the error is bounded by $\approx 7.6 * 10^{-2} = 0.076$.

Bonus: Using the error estimates $2\epsilon_A/h + M_2 h/2$ from page 52 (with $M_2 := 120$), one can check the error for other values of h. It is easy to see that for $h \leq 10^{-4}$, the error bound is ≥ 0.24 since already the first term is at least 0.24.

On the other hand, the second term corresponds to $60h$, so for $h \geq 3.16 * 10^{-3}$ the error bound ≥ 0.18.

It remains to check the only interesting case $h_F := 10^{-3}$. We obtain

$$2.4 * 10^{-2} + 60 * 10^{-3} = 0.024 + 0.06 = 0.084.$$

Note that for $h_F := 10^{-3}$ the first term itself (0.024) as well as second term itself (0.06) are smaller than the best error estimate 0.076, but the sum (0.084) is a bit greater. This confirms our choice $h_F := 3.16 * 10^{-4}$.