Language : MATLAB

Source Code: problem_16.m

Here, the used equation to describe the Hopf model is—

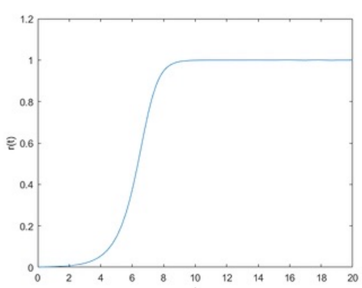
$$\dot{r} = ar - r^3$$

In the same code, I have used $a=1$, $a=0$ and $a=-1$ and captured the respective responses.

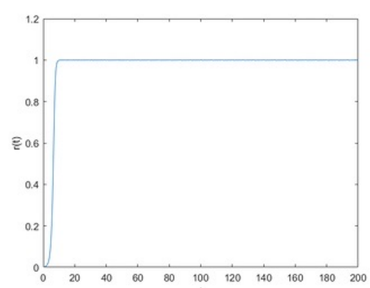
On the other hand, I have used the time intervals $[0, 20]$, $[0, 200]$, and $[0, 20000]$ and captured the respective responses.

All the following responses are captured with initial value $r(0) = r_0 = 0.001$

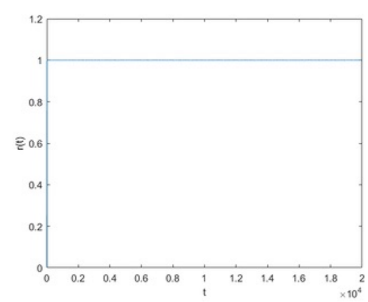
$\boxed{a=1}$



time interval $[0, 20]$

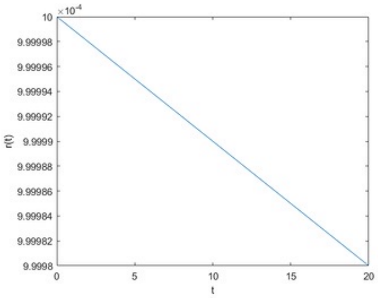


time interval $[0, 200]$

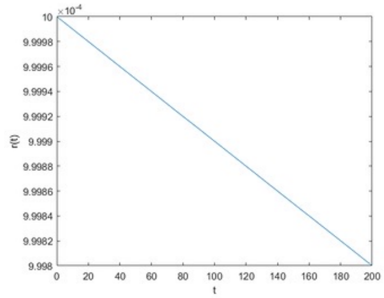


time interval $[0, 20000]$

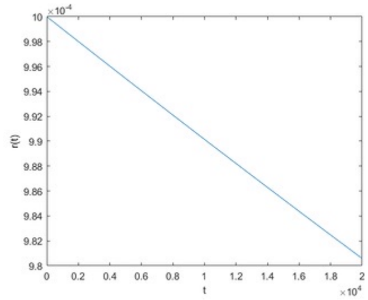
$\boxed{a=0}$



time interval $[0,20]$

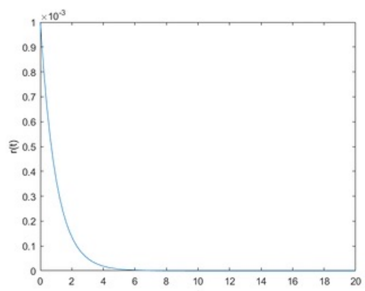


time interval $[0,200]$

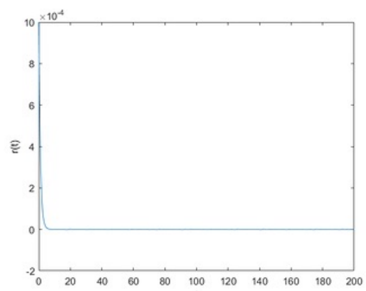


time interval $[0,20000]$

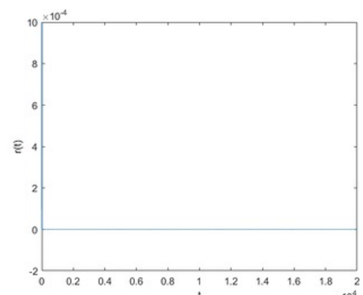
$\boxed{a=-1}$



time interval $[0,20]$

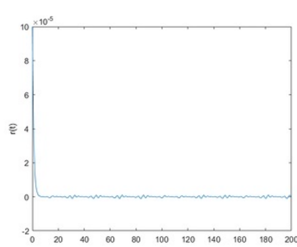


time interval $[0,200]$



time interval $[0,20000]$

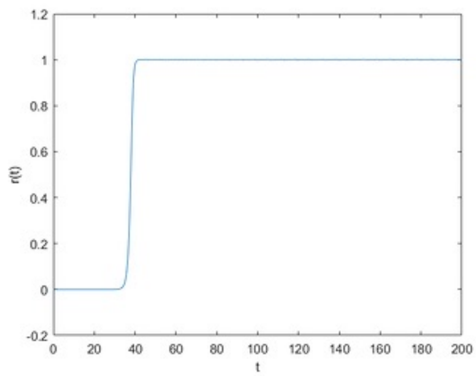
For $a=-1$, if we take the initial value $r(0) = r_0 = 0.0001$, we see a granular curve. for the time interval $[0,200]$



If we want to observe a response that captures the step-up of the Hopf model, we can choose

$a = 1$, time interval $= [0, 200]$ and $r_0 = 0.000\,000\,000\,1$

and then we find the following response -



$ar - r^3 = 0$, when $r = 0$, $\sqrt{a}$; if we take $a = 1$, the curve saturates at $\sqrt{a} = 1$. and also, with r_0 very small r^3 can be neglected in comparison to ar.