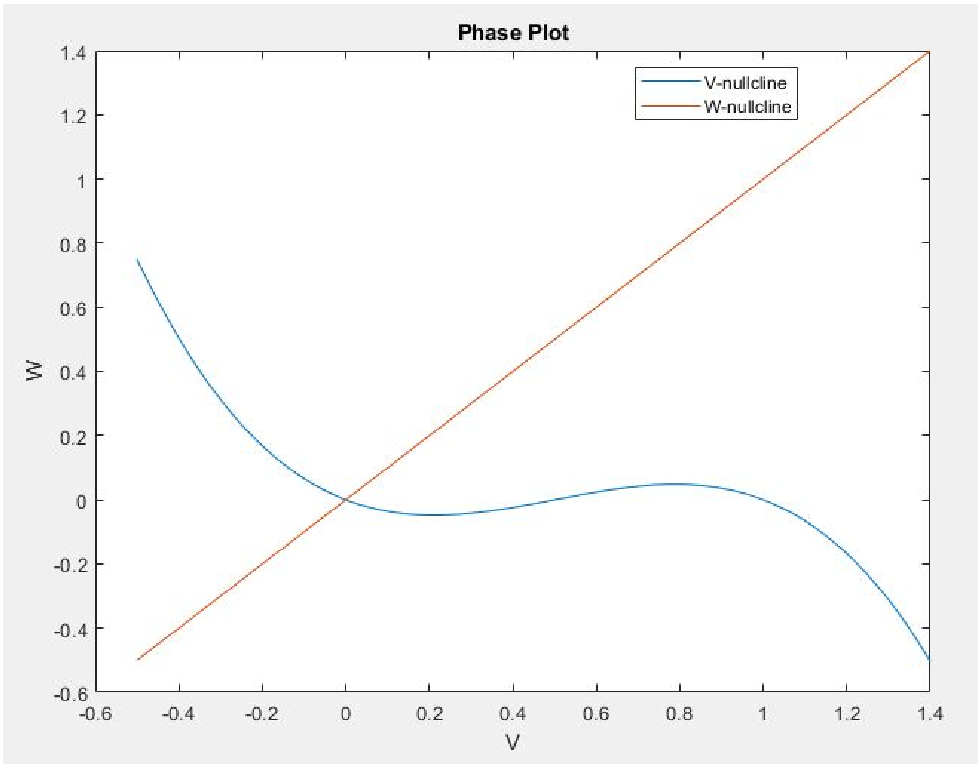
Assignment 2

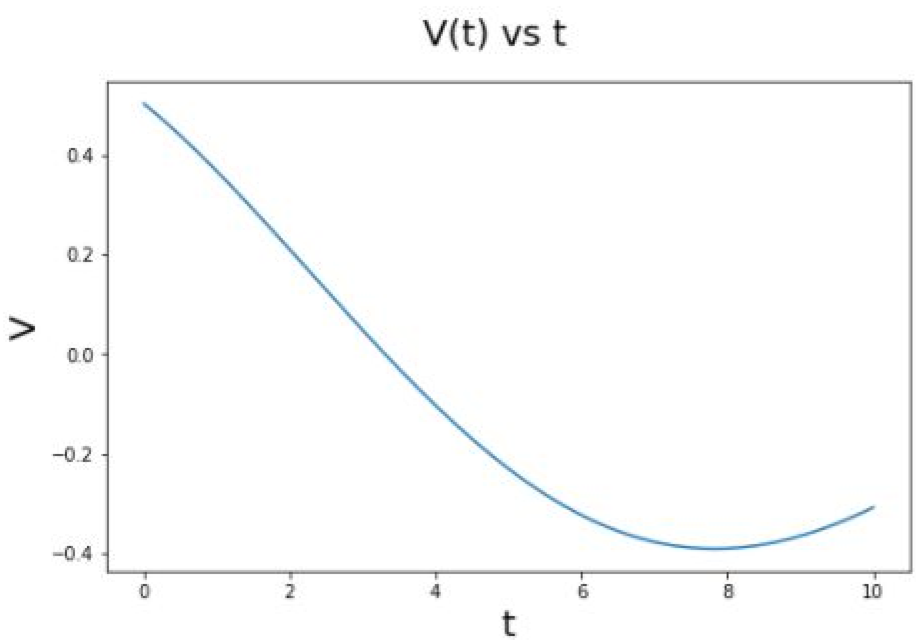
Case 1. Parameters: a = 0.5, b = 0.1, r = 0.1, I_{ext} = 0.

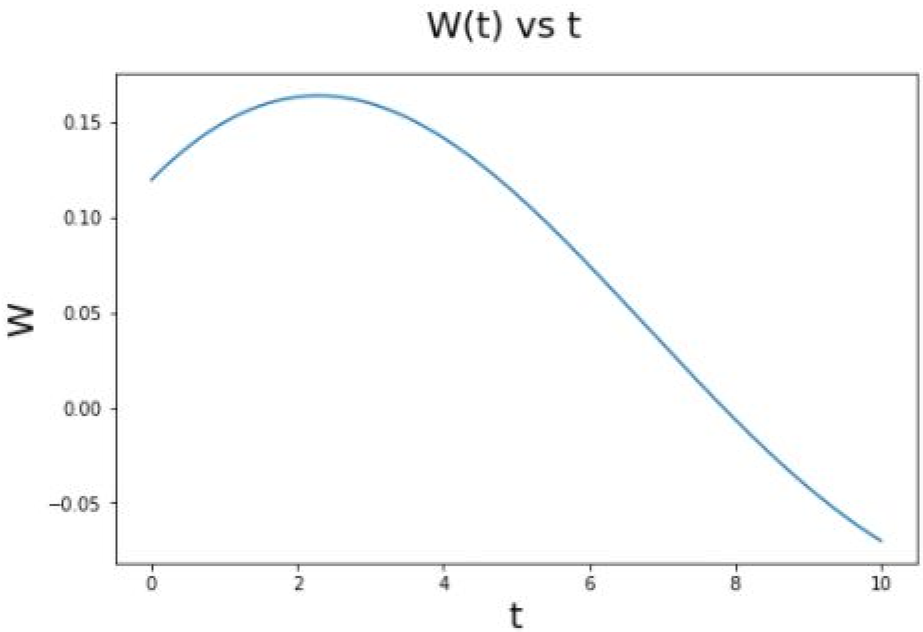
[a] Phase Plot



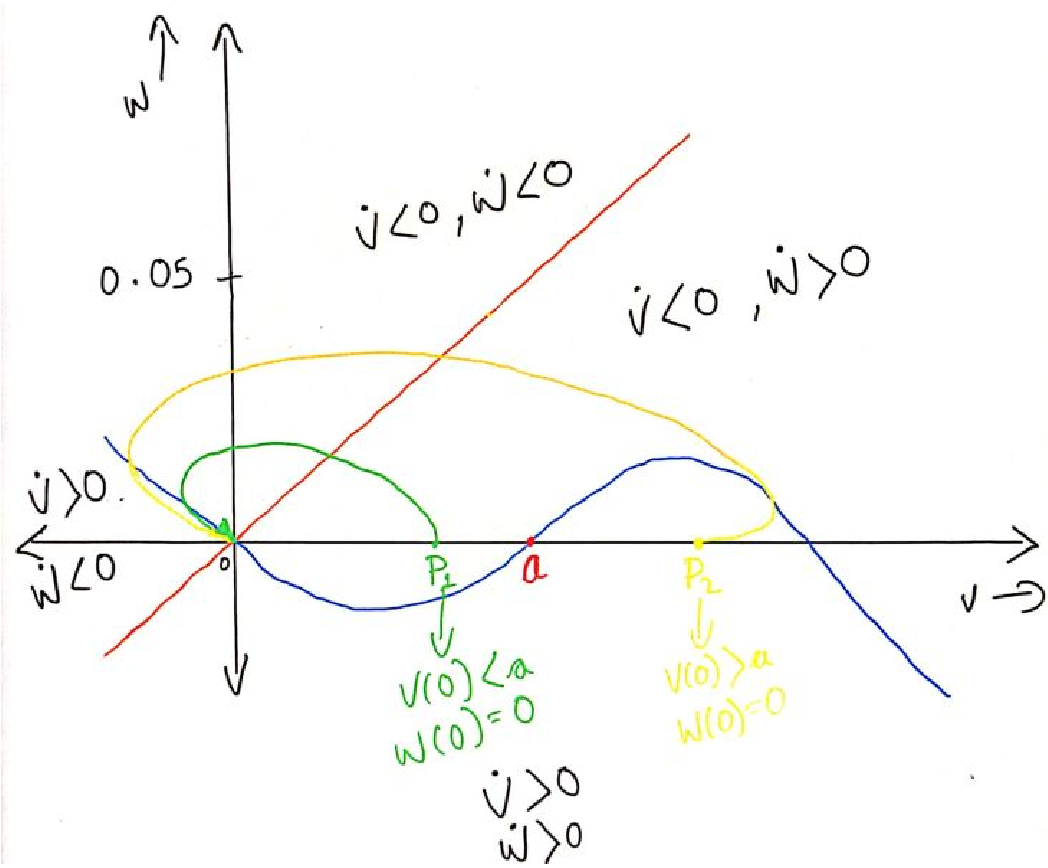
[b]

- The plot of V(t) vs t and W(t) vs t is shown below.





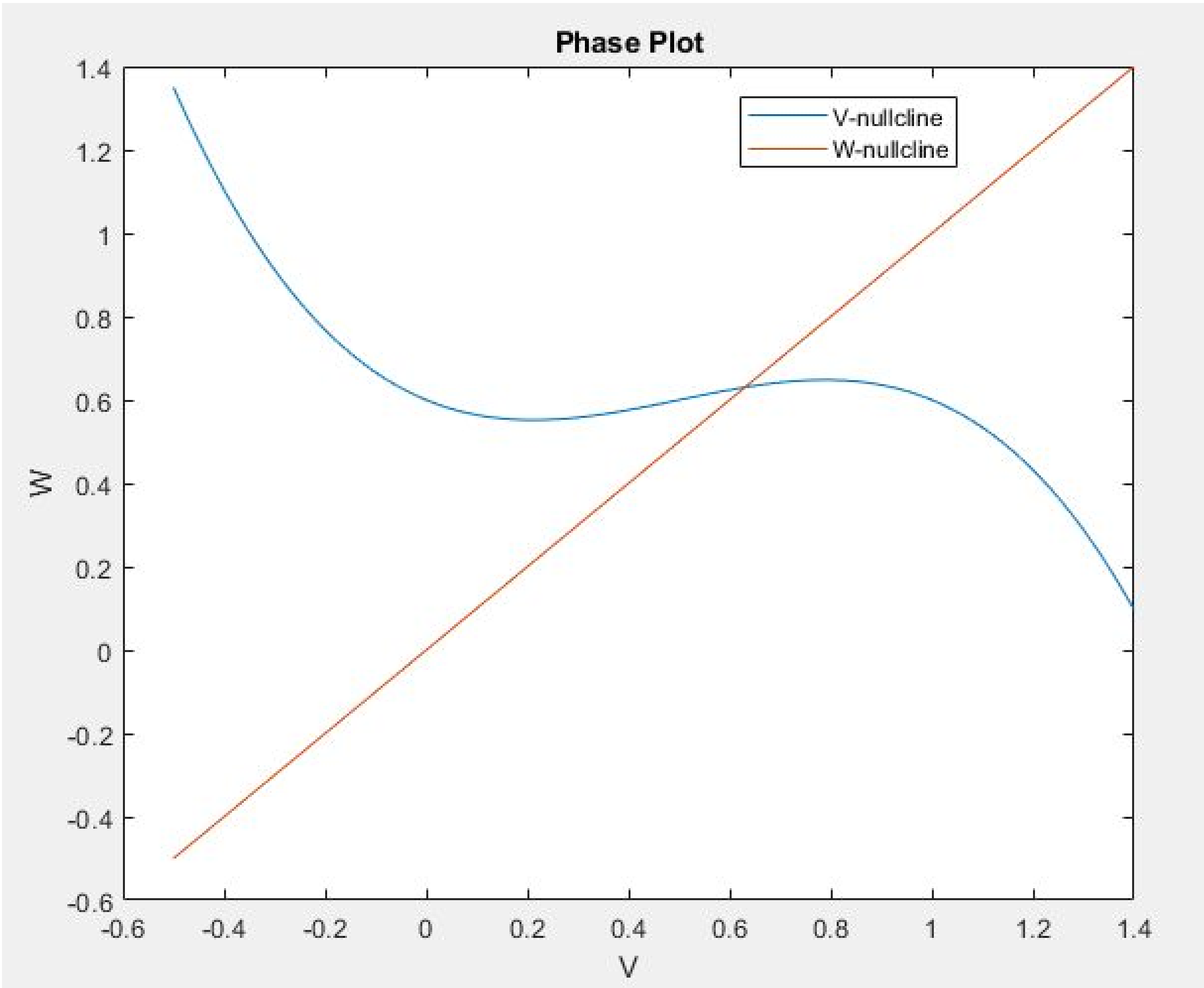
- The trajectory on the phase plane for the points P_1 and P_2 is shown below. The Green curve shows the trajectory of P_1 and the Yellow curve shows the trajectory of P_2.



Here the fixed point is at (0, 0), which is a stable fixed point. The fixed point is stable because at (0, 0), **$\Delta > 0$ and $\tau < 0$**.

Case 2. By using the pplane8.m file we found the approximate values for I_1 and I_2 where it exhibit oscillation. $\mathbf{I_1 = 0.33, I_2 = 0.73, I_{ext} = 0.6}$

[a] Phase plot for the given value of I_{ext}.



[b] As shown above, the fixed point is at (0.63, 0.63).

In order to show that the fixed point is an unstable point, we first need to find **"Δ" and "τ".**

Δ = f'(v)*(-r) + b where f(v) = v*(a-v)*(v-1) and τ = f'(v) - r

For, a = 0.5, b = 0.1, r = 0.1, v = 0.63. Substituting all the values in the above eqs. we get:-

Δ = 0.08007 and **τ** = 0.0993.

Since, both **Δ > 0 and τ > 0, we can say that the given fixed point is an unstable fixed point [1].**

Figure 2[b] below shows the trajectory (limit cycle behavior/oscillation) of the above system on the phase plane.

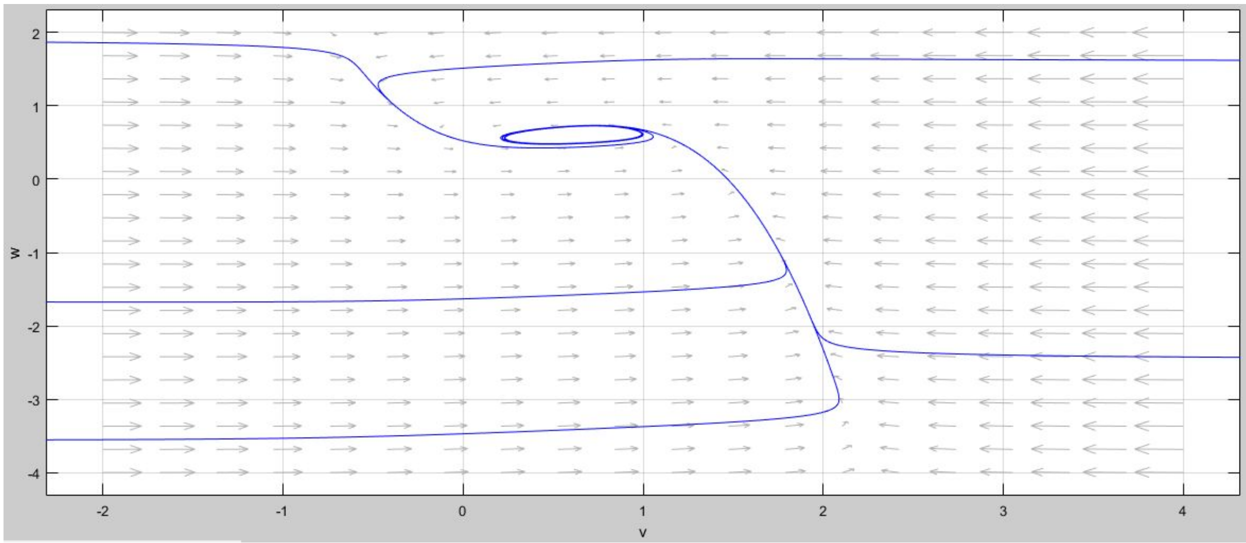
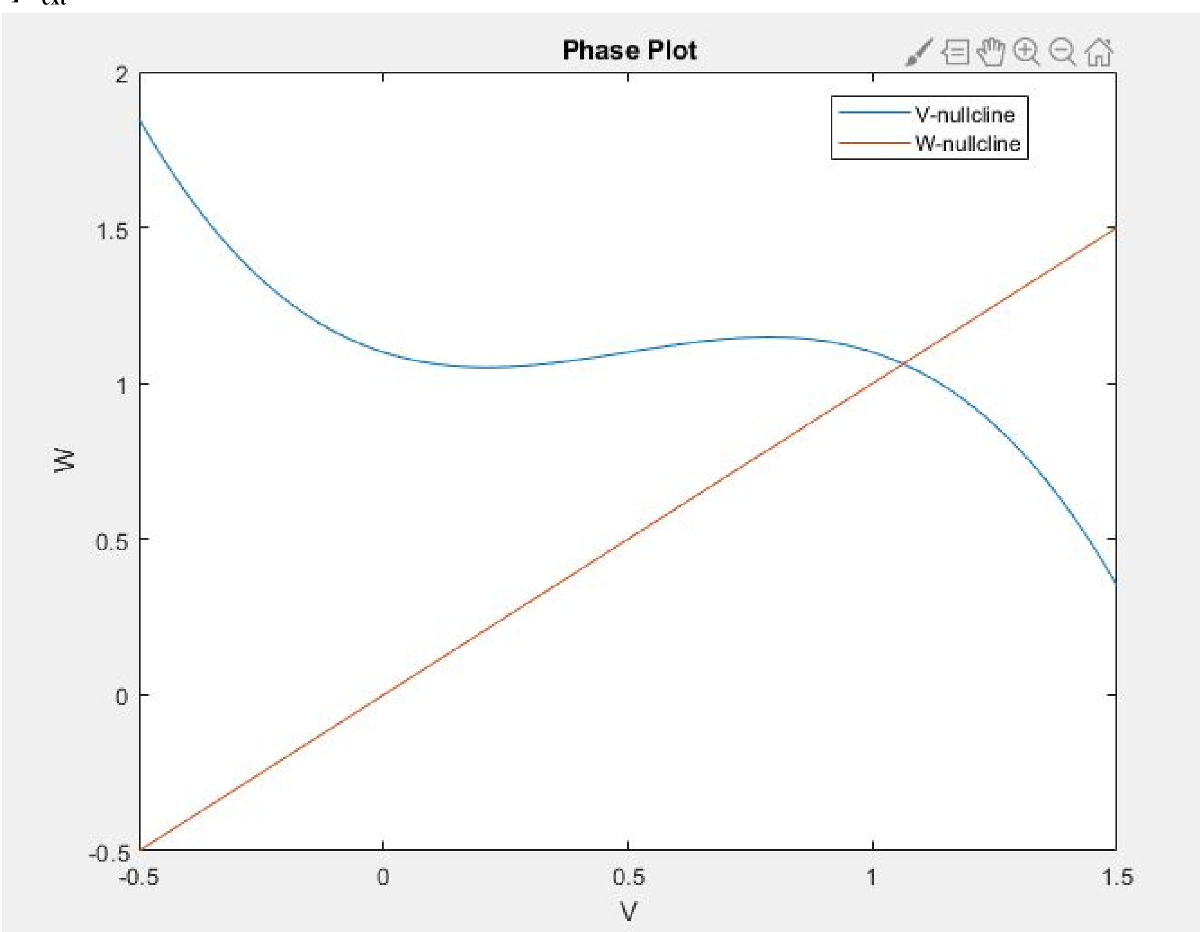


Figure 2[b]

Case 3.

[a] I_{ext} = 1.1



[b] As shown above, the fixed point is at (1.06, 1.06).
In order to show that the fixed point is a stable point, we first need to find **“Δ” and “τ”.**
$\Delta = f'(v)*(-r) + b$ where $f(v) = v*(a-v)*(v-1)$ and $\tau = f'(v) - r$
For, $a = 0.5$, $b = 0.1$, $r = 0.1$, $v = 1.06$. Substituting all the values in the above eqs. we get:-
Δ = 0.17 and **τ** = -0.79.
Since, **$\Delta > 0$ and $\tau < 0$, we can say that the given fixed point is a stable fixed point [1].**
Figure 3[b] shows the trajectory of the points on the phase plane.

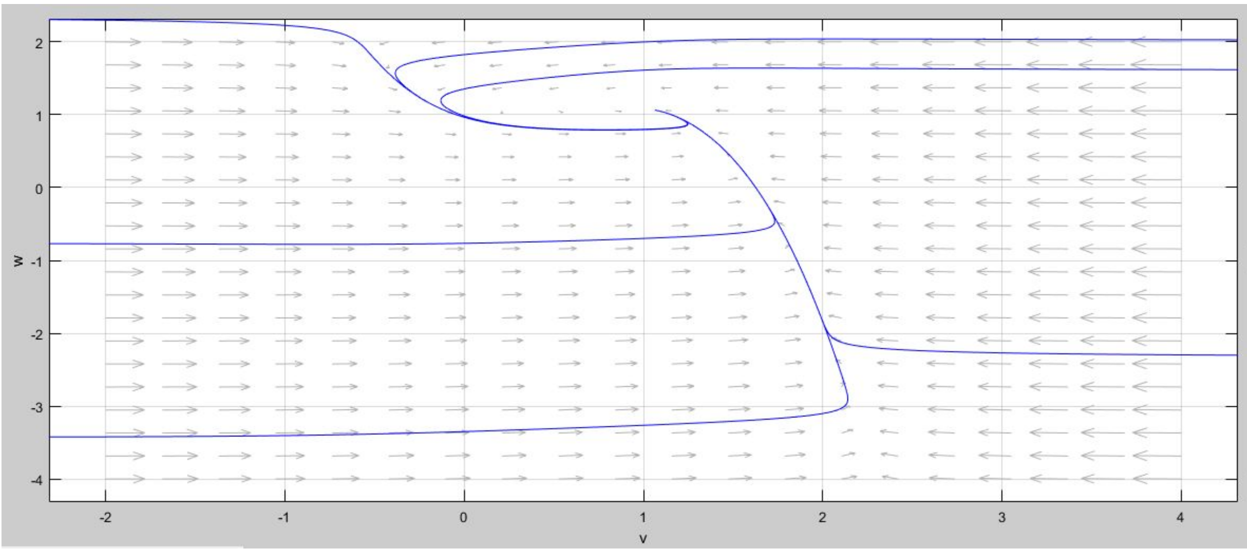
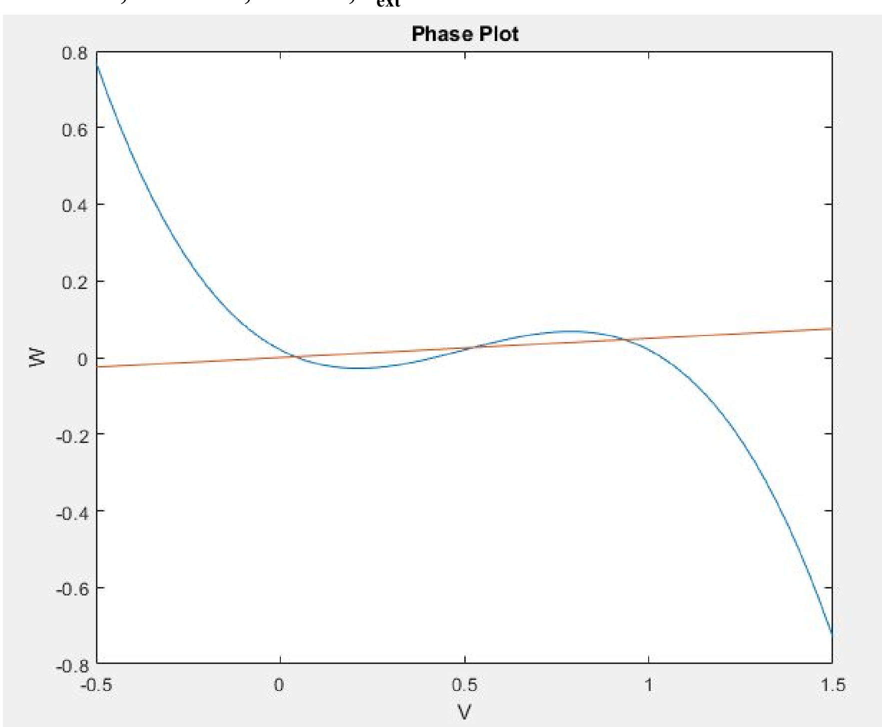


Figure 3[b]

Case 4.
[a] Parameters: **$a = 0.5$, $b = 0.01$, $r = 0.2$, $I_{ext} = 0.02$.**



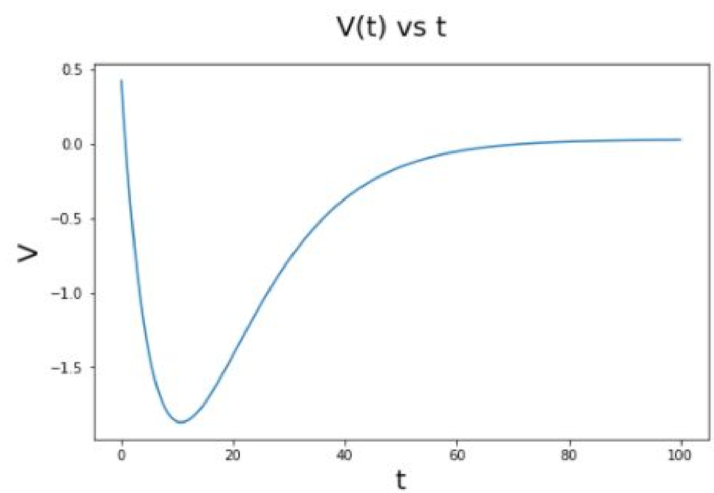
[b] $P_1 = (0.04, 0.0005)$, $P_2 = (0.43, 0.0055)$, $P_3 = (1.01, 0.0127)$. P_1, P_2, P_3 are the fixed points. We know that, **$\Delta = f'(v)*(-r) + b$ where $f(v) = v*(a-v)*(v-1)$ and $\tau = f'(v) - r$**

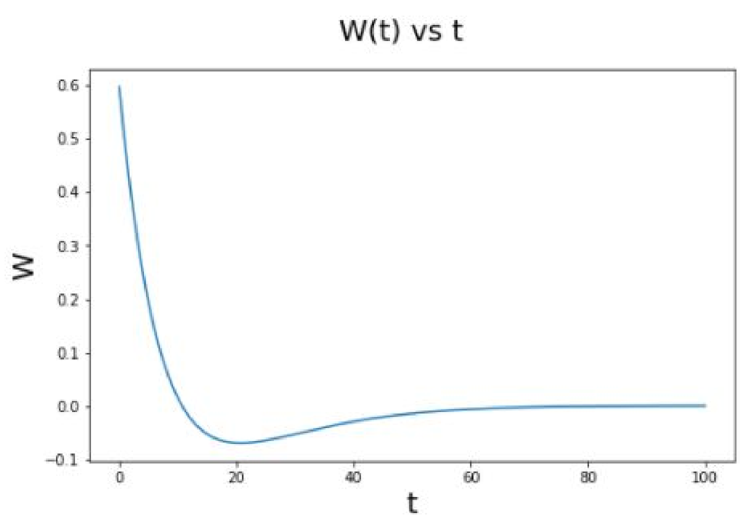
- At P_1, $\Delta = 0.138$ and $\tau = -0.4848$.
  Since, $\Delta > 0$ and $\tau < 0$, we can say that the given fixed point is a stable fixed point [1].

- At P_2, $\Delta = 0.076$ and $\tau = 0.135$.
  Since, $\Delta > 0$ and $\tau > 0$, we can say that the given fixed point is an unstable fixed point [1].

- At P_3, $\Delta = 0.153$ and $\tau = -0.63$.
  Since, $\Delta > 0$ and $\tau < 0$, we can say that the given fixed point is a stable fixed point [1].

[c]



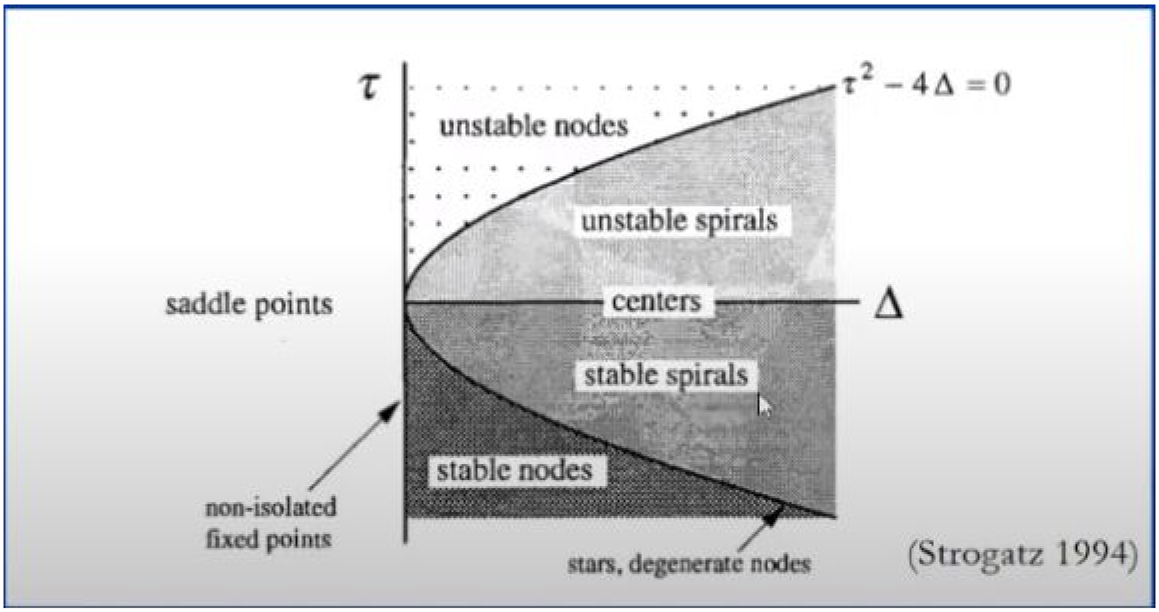


Note:

- main.py was used to display the “Phase plot”, “V(t) vs t” and “W(t) vs t”.
- pplane8.m was used to plot the trajectory of the points on the phase plane.

References:

[1]



[2] pplane.m