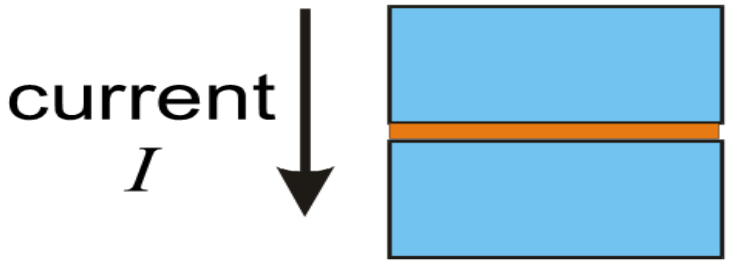
Simulation Of Phase Dynamics of Asymmetric Josephson Junction SQUID

Abdelrazek Sepa

Supervisor: Prof. Shukrinov Yury & Dr. Rahmonov Ilhom

Josephson Effect

Obtained by B. Josephson in 1962



superconductor $\Psi_1 = |\Psi_1| \exp(i\theta_1)$

tunnel barrier

superconductor $\Psi_2 = |\Psi_2| \exp(i\theta_2)$

Phase difference: $\varphi = \theta_2 - \theta_1$

dc Josephson effect: $I_s(\varphi) = I_c \sin\varphi \quad (1)$ $I < I_C,\ V=0$

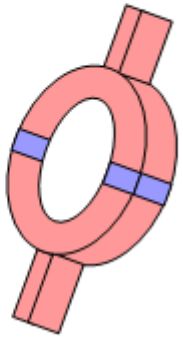
ac Josephson effect: $\frac{d\varphi}{dt} = \frac{2e}{\hbar} V \quad (2)$ $I > I_C,\ V > 0$

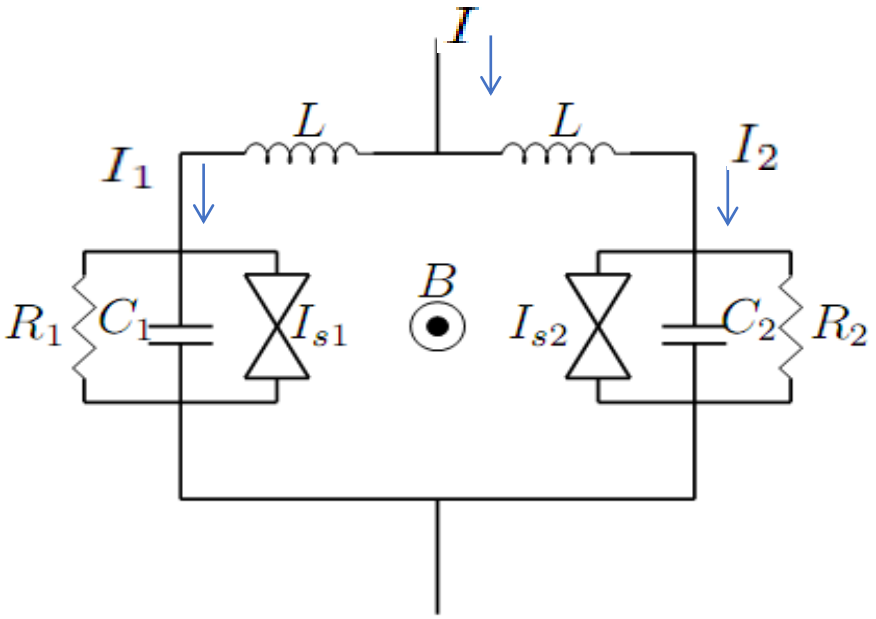
Josephson junction is a *quantum dcvoltage - to - frequency converter*

$1\,\mu\text{V} \leftrightarrow 483.59767\ \text{MHz}$

DC-SQUID

Double junction SQUIDs.





$$\dot{V}_1 = \frac{2}{\beta_c(1+c)}\left\{\frac{I}{2} - \frac{R+1}{2R}V_1 - \sin\varphi_1 + \frac{1}{2\beta_L}[2\pi(n-\varphi_e) - (\varphi_1 - \varphi_2)]\right\}$$

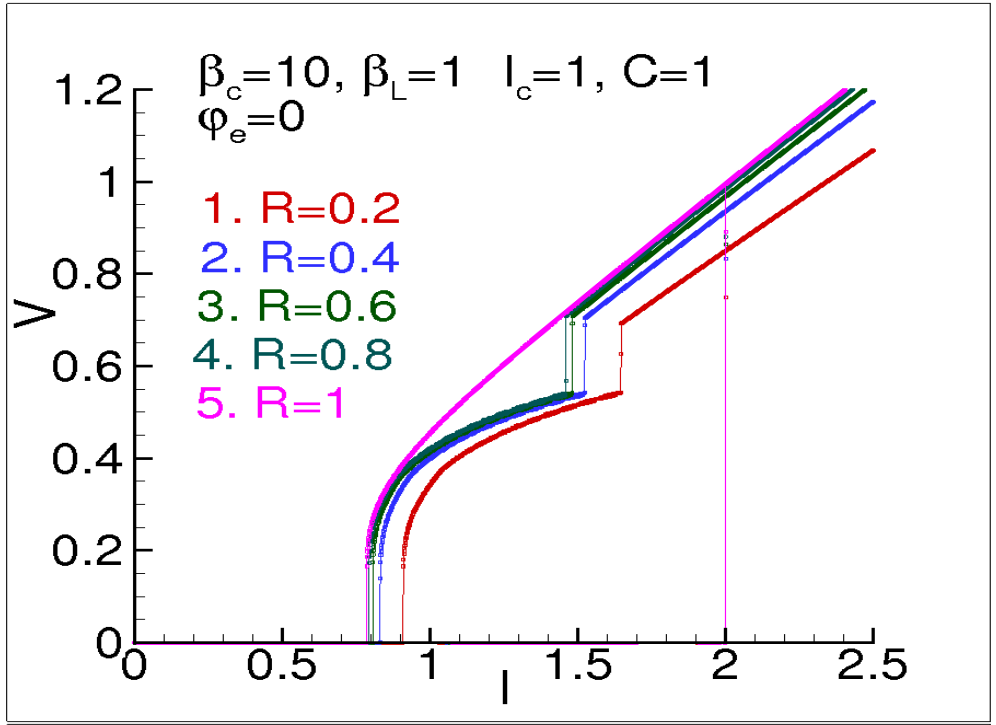
$$\dot{V}_2 = \frac{2}{\beta_c(1+c)}\left\{\frac{I}{2} - \frac{R+1}{2R}V_2 - Ic\sin\varphi_2 + \frac{1}{2\beta_L}[2\pi(n-\varphi_e) - (\varphi_1 - \varphi_2)]\right\}$$

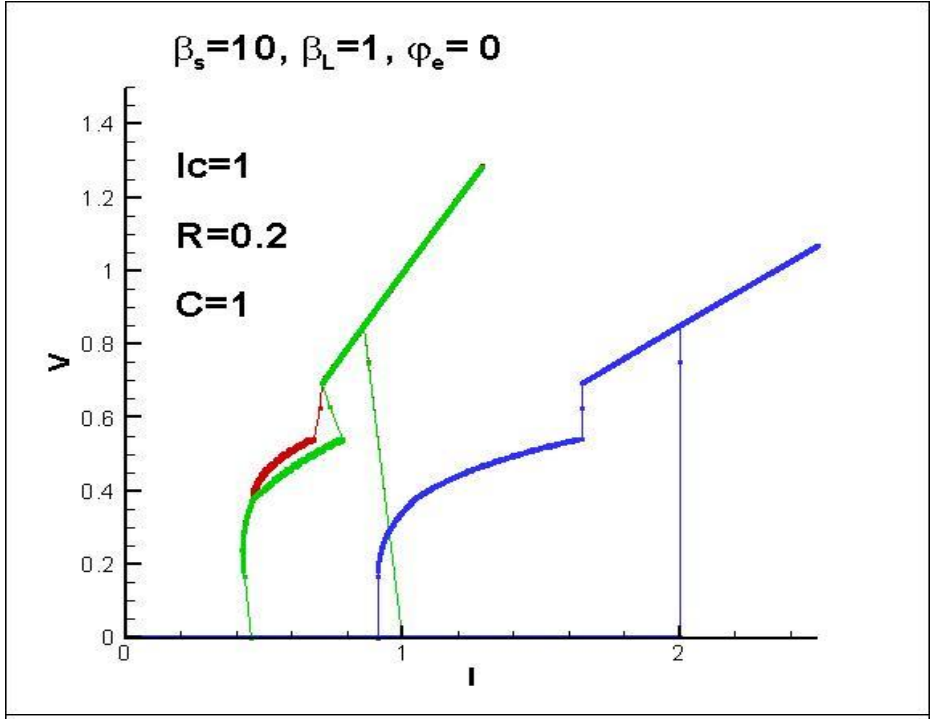
$$\dot{\varphi}_1 = V_1$$

$$\dot{\varphi}_2 = V_2$$

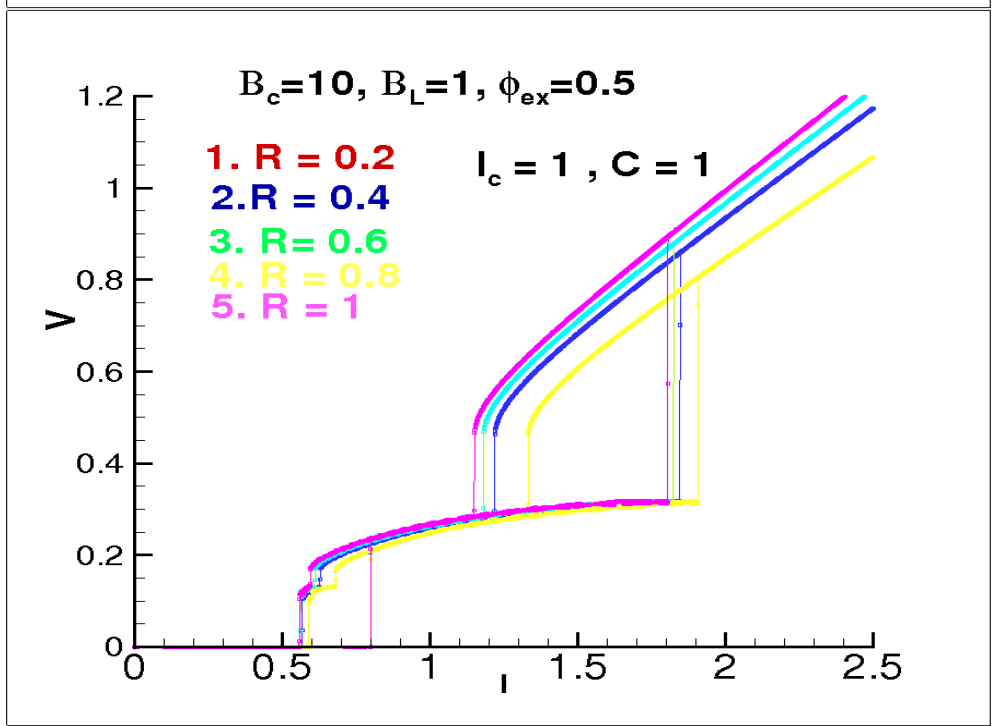
- V: The voltage of the Josephson Junction.
- $\beta_c = \frac{CR^2 I_c 2\pi}{\varphi_0}$: The McCumber parameter.
- C: The relation of capacitance of two Josephson Junction.
- φ: The phase through Josephson Junction.
- I_c: The critical current of two Josephson Junction.
- R: The relation of resistance two Josephson Junction.
- n: integer number “quantization rat”.

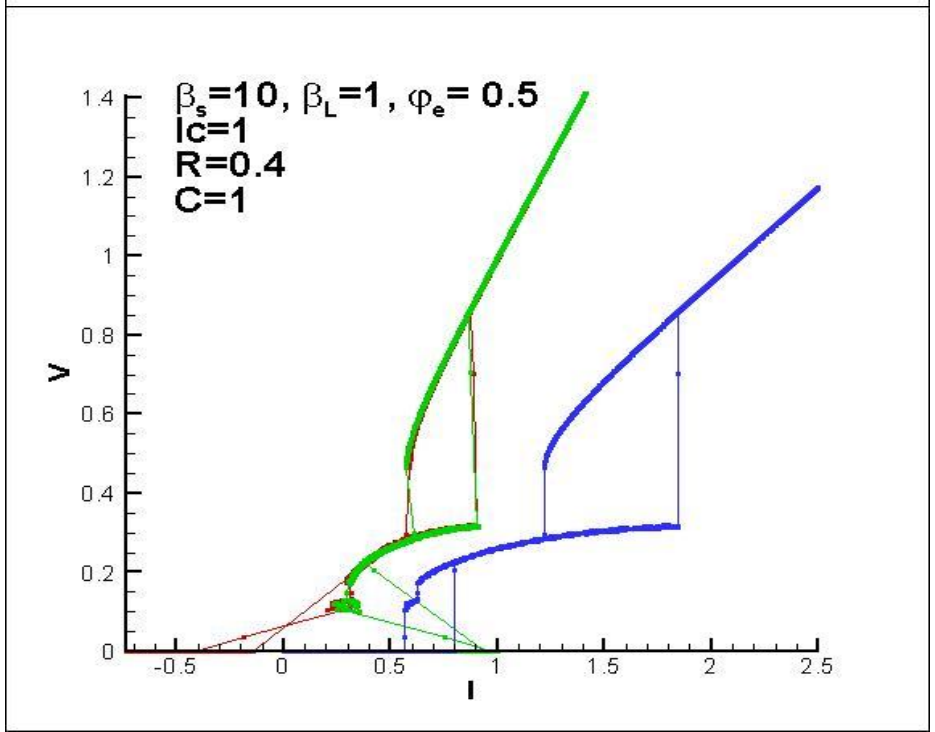
$\varphi_e = 0$



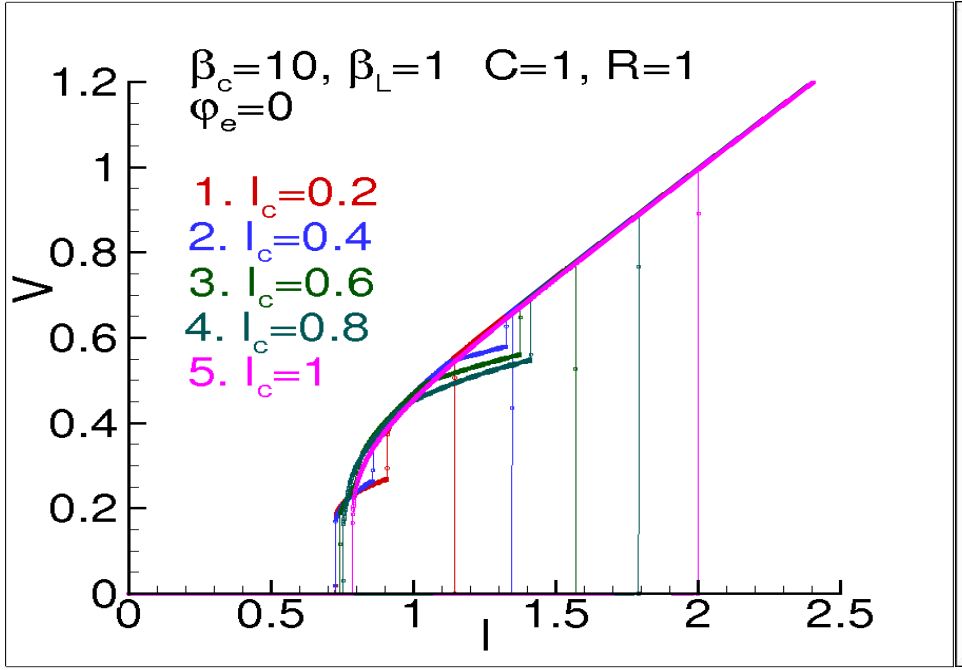


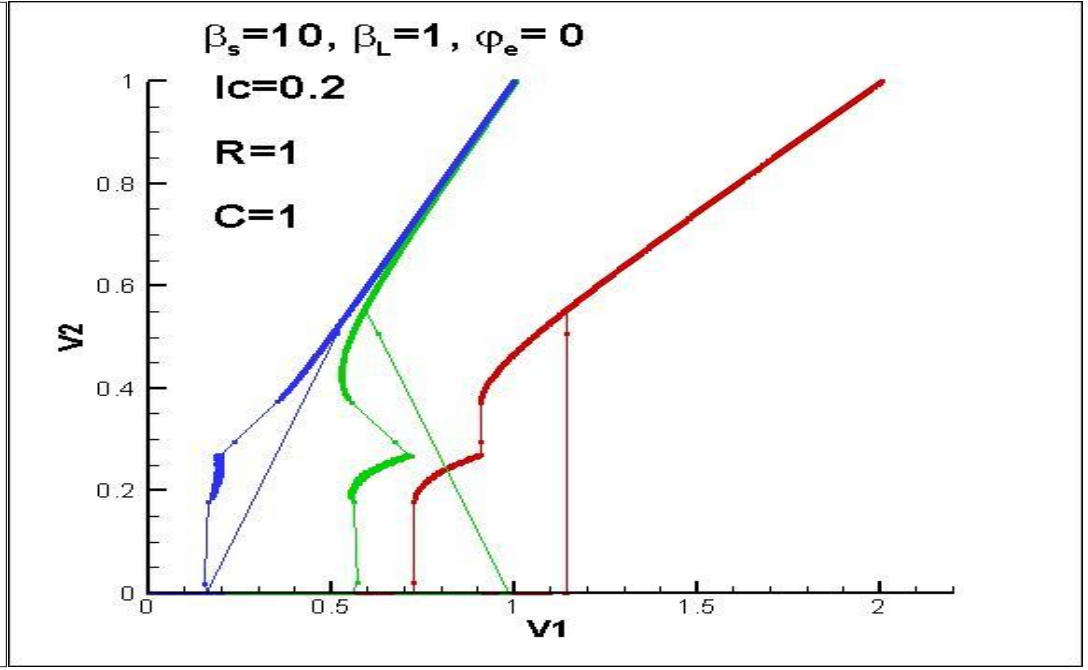
$\varphi_e = 0.5$



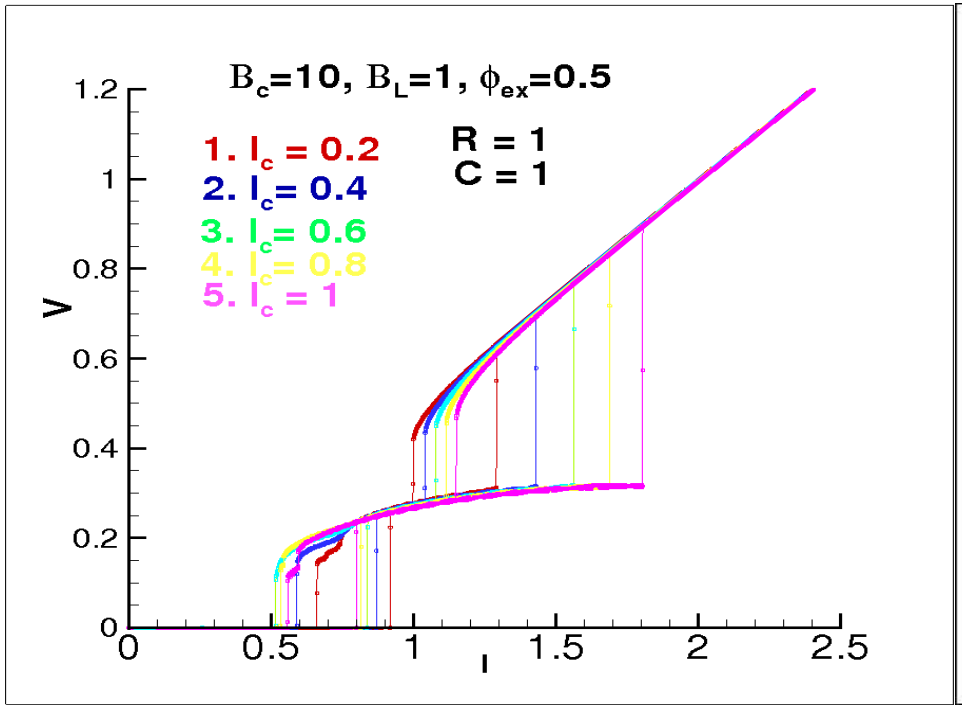


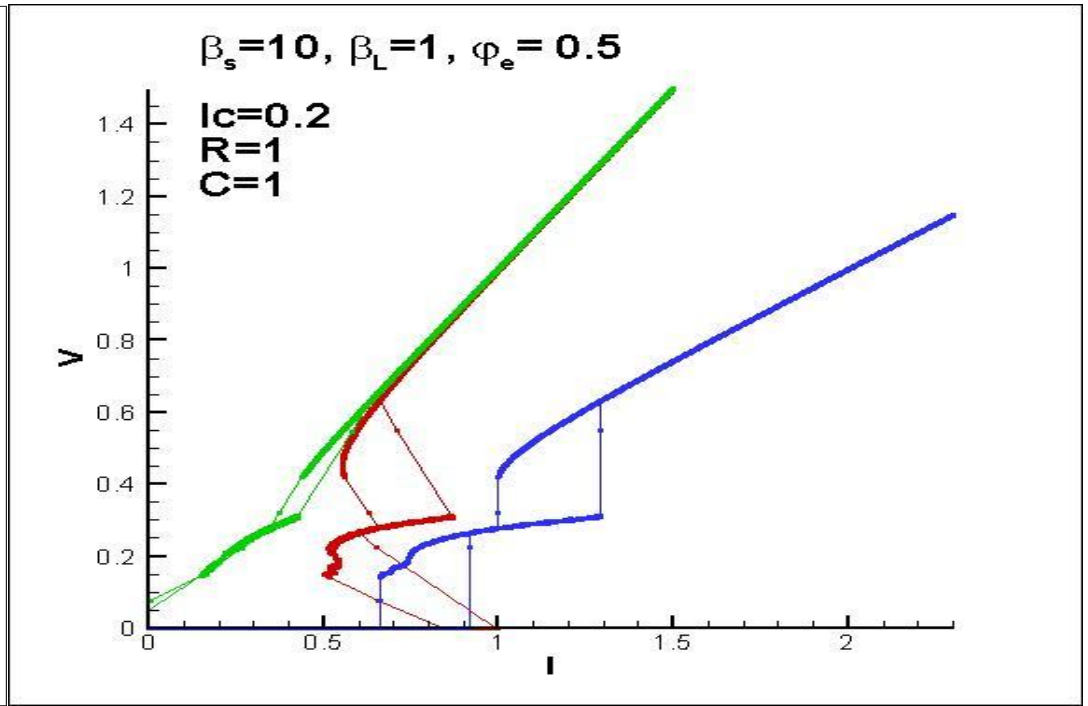
$\varphi_e = 0$



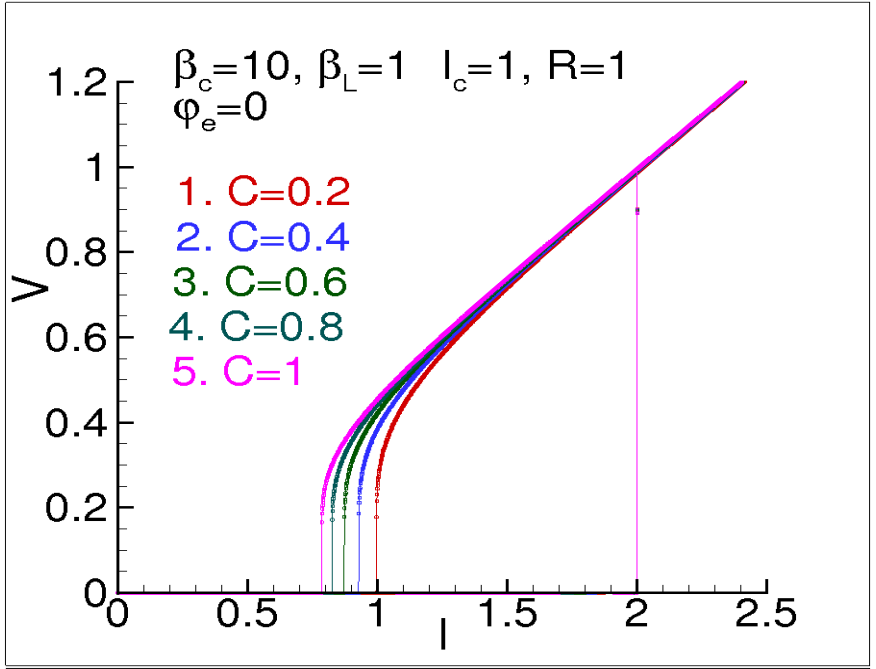


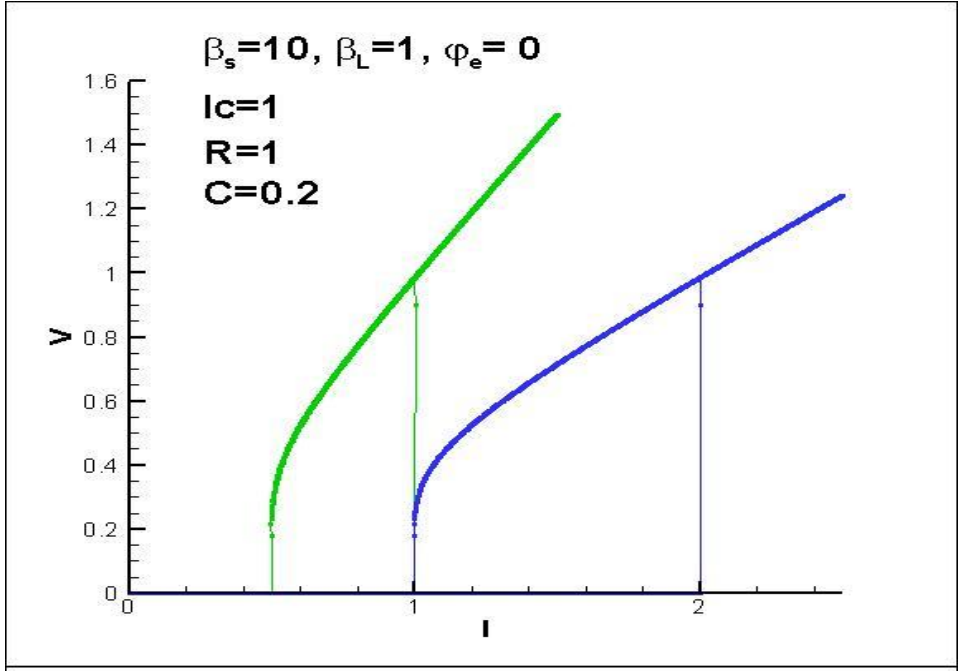
$\varphi_e = 0.5$



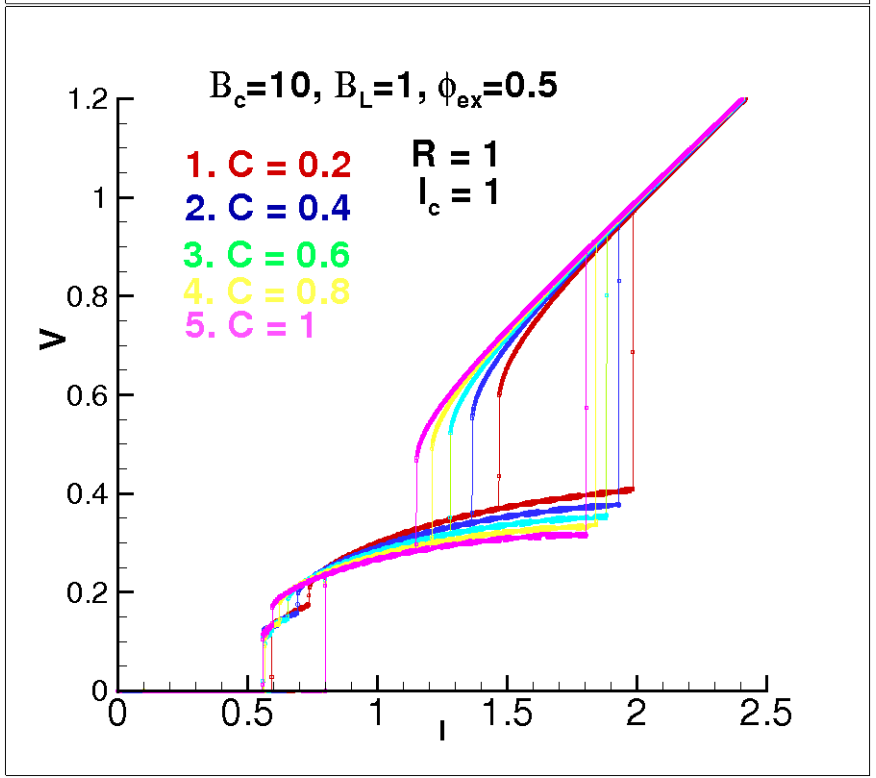


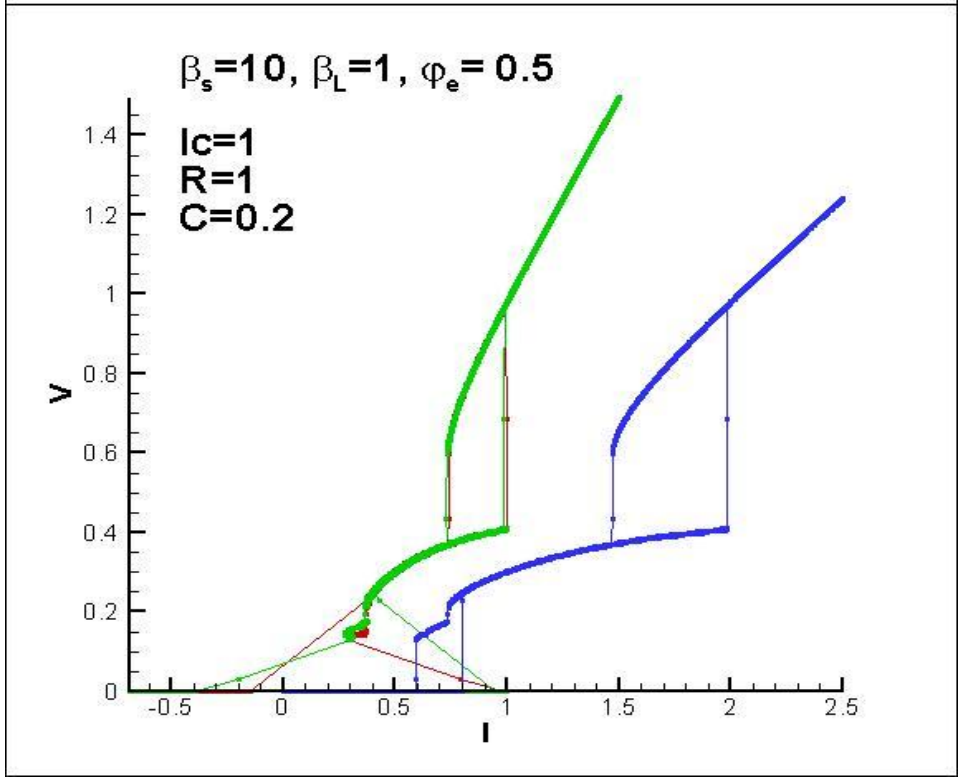
$\varphi_e = 0$





$\varphi_e = 0.5$





Conclusion:

- In the frame work of this practice, we have learnt the method of simulation of IV curve of SQUID. We have demonstrated the effect of different capacitance, resistance and critical current in the Asymmetric SQUID.