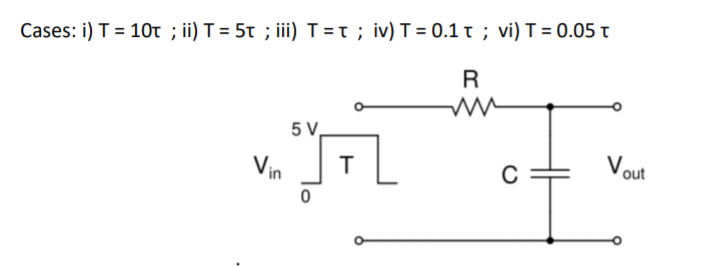
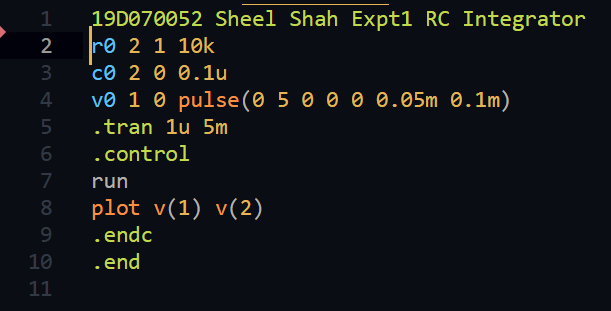
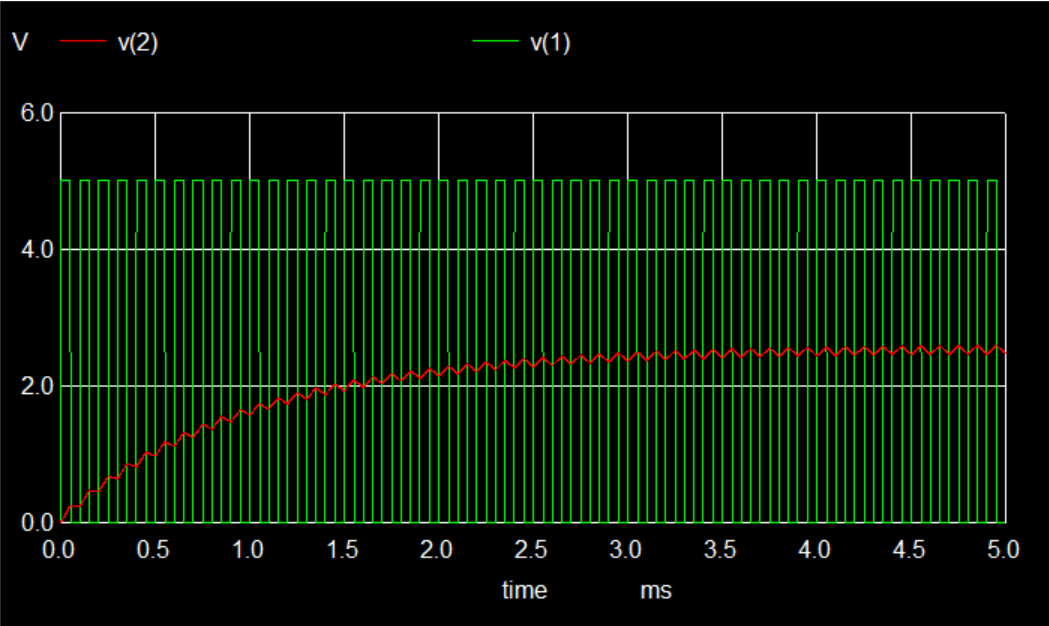
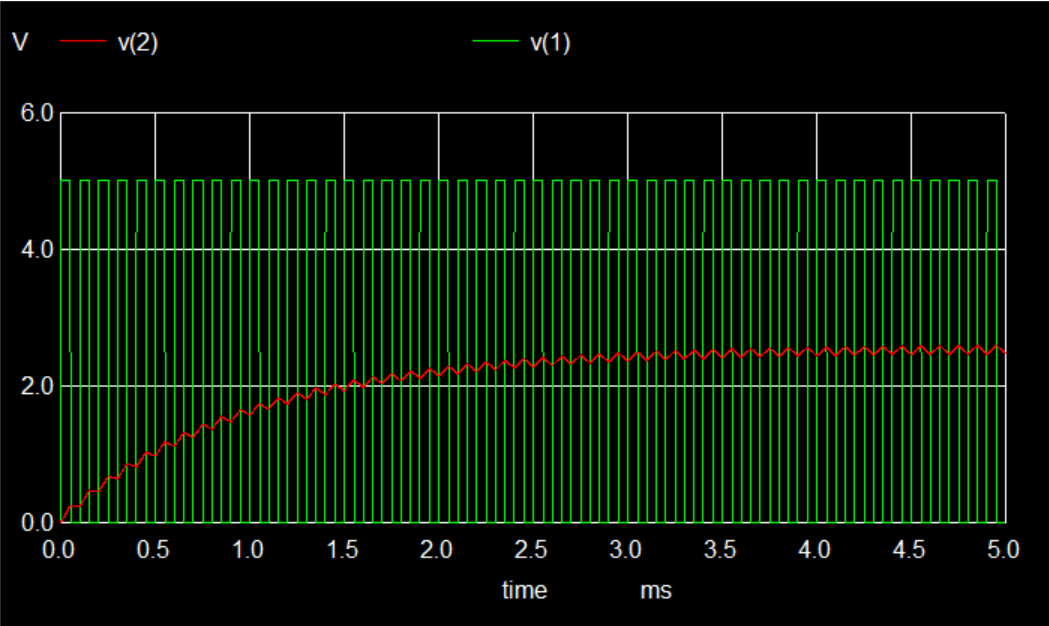
1. RC Integrator:

Tau = R\*C = 10k \* 0.1u = 1m

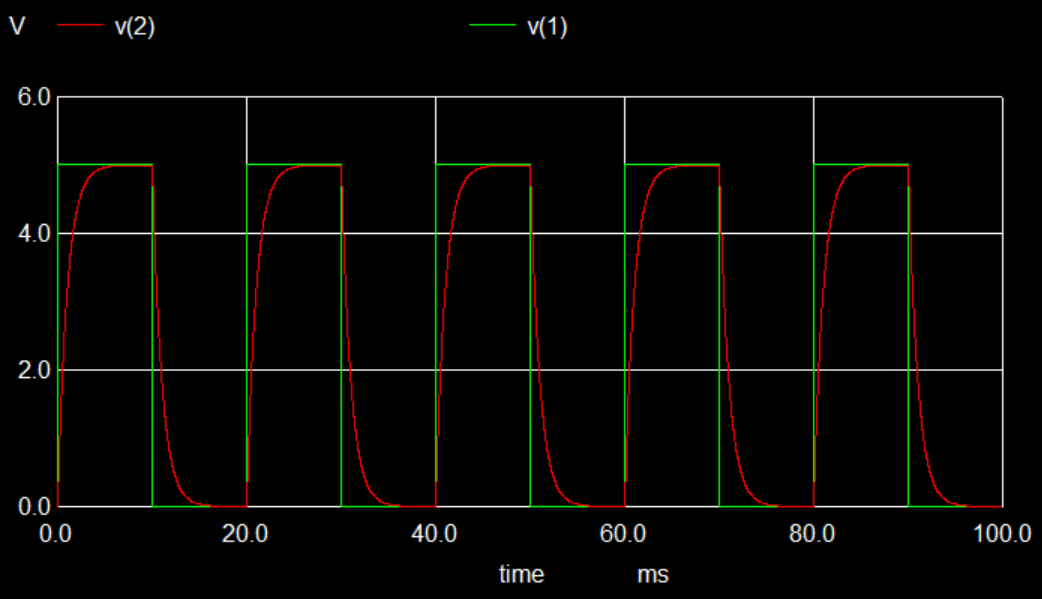




T = 0.05\*tau: (good integrator)

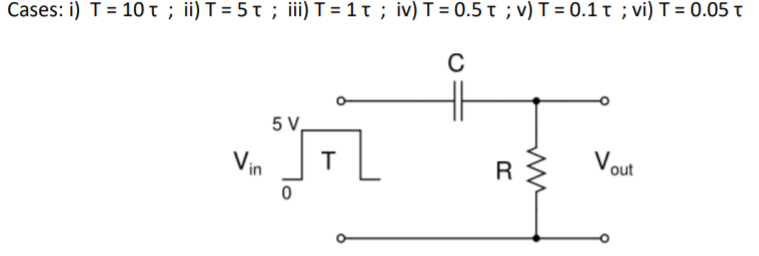


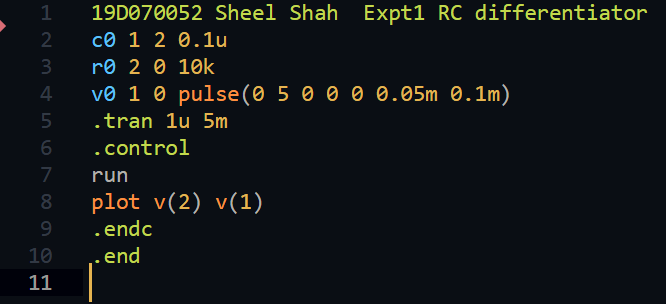
T = 10\*tau: (bad integrator)



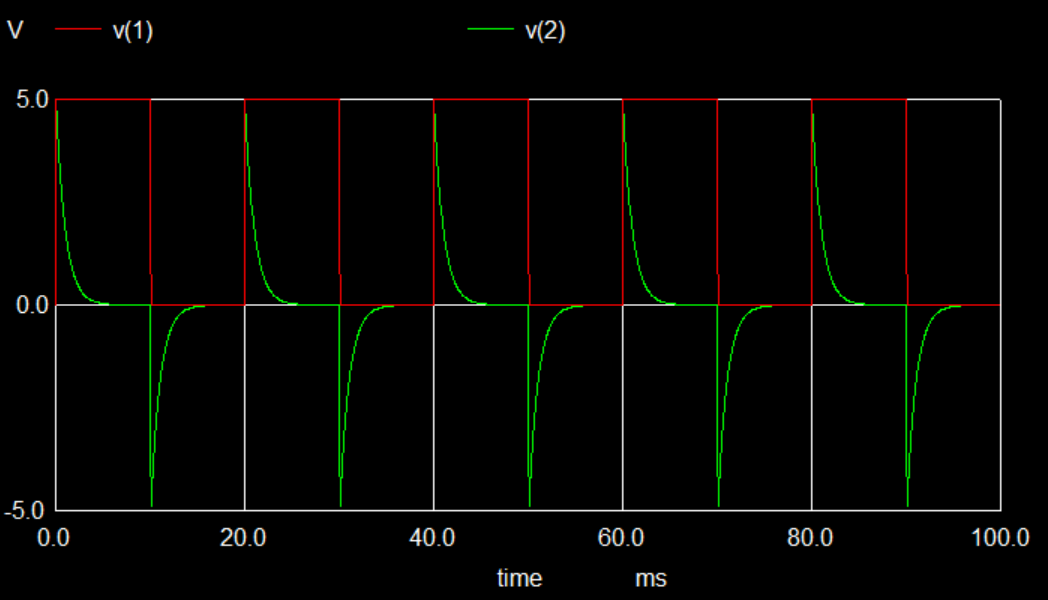
1. RC Differentiator:

Tau is same as calculated above.

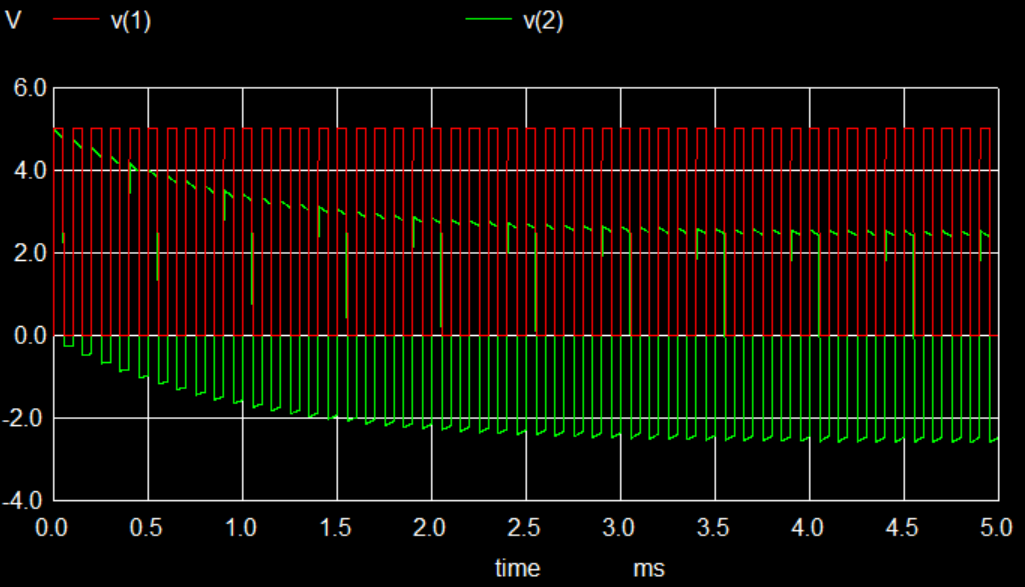




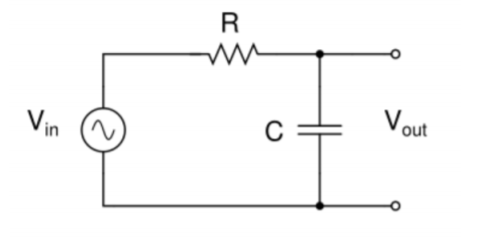
T = 10\*tau: (good differentiator)

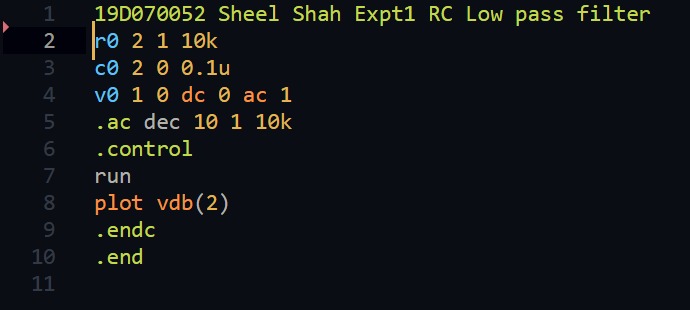


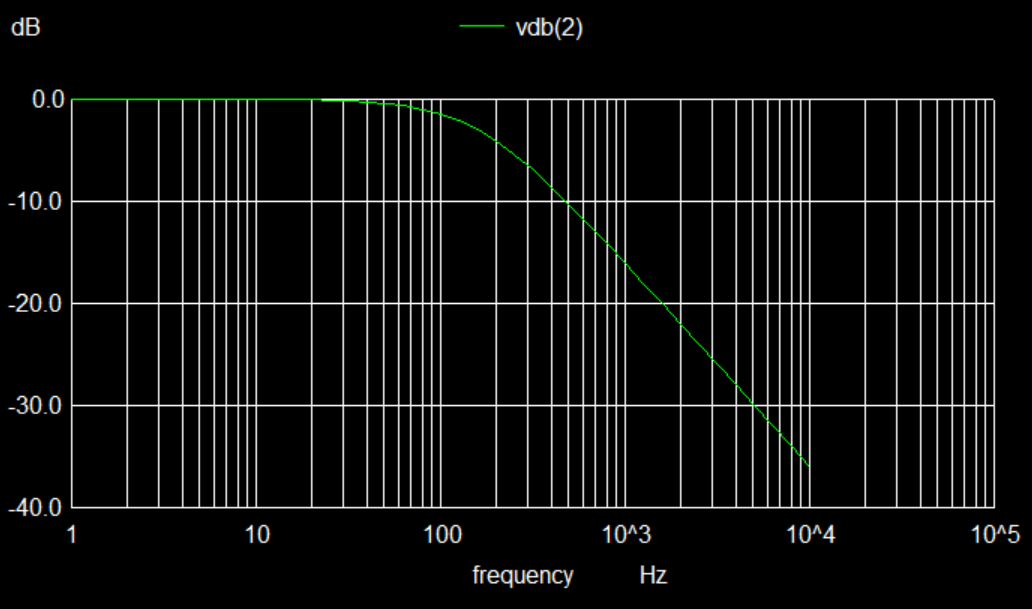
T = 0.05\*tau: (bad differentiator)



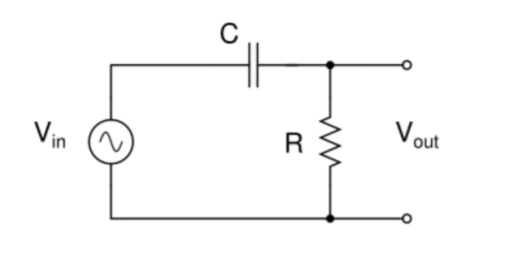
1. RC Lowpass filter

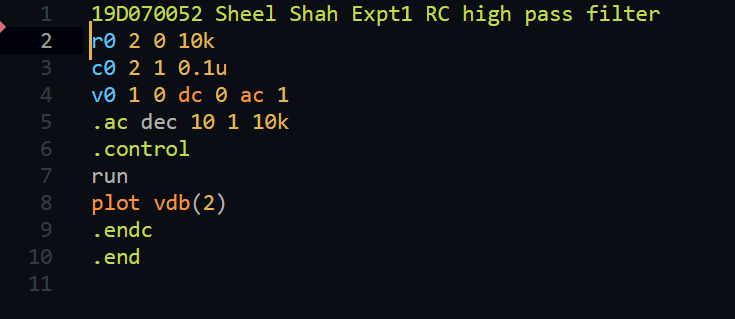


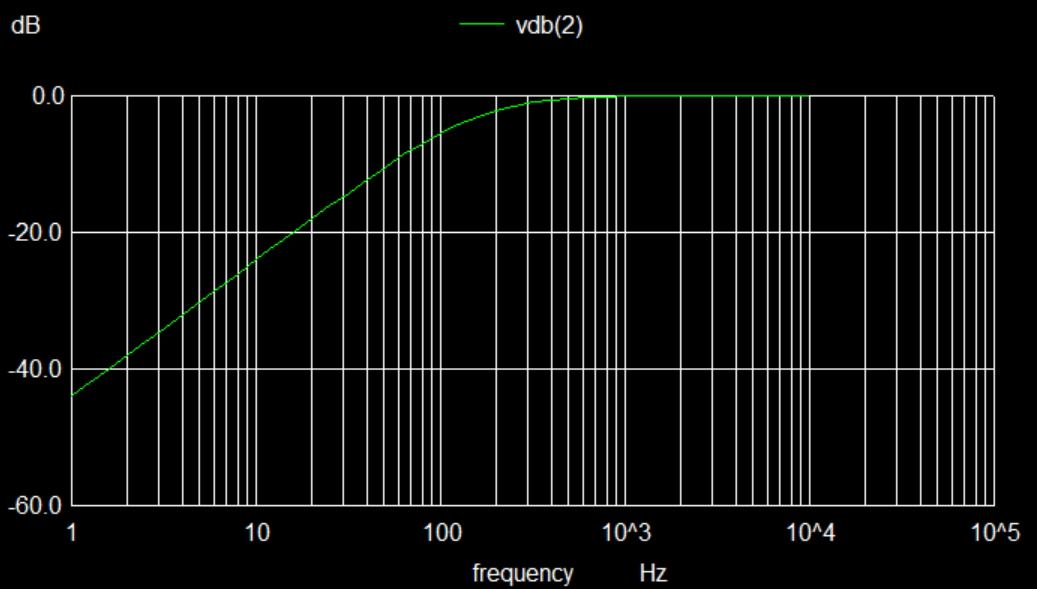




1. RC Highpass filter







1. RC bandpass filter

Trivial analysis gives us the transfer function T(s) as sRC / (1 + (s\*s\*R\*C)^2 + 3sRC)

For peak, we set the real part of the denominator to 0 => w\_peak = 1 / (RC)

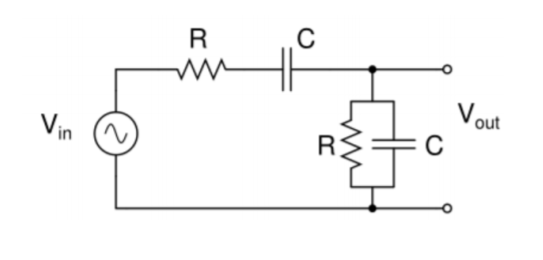
F\_peak = w\_peak / 2pi = 159 Hz

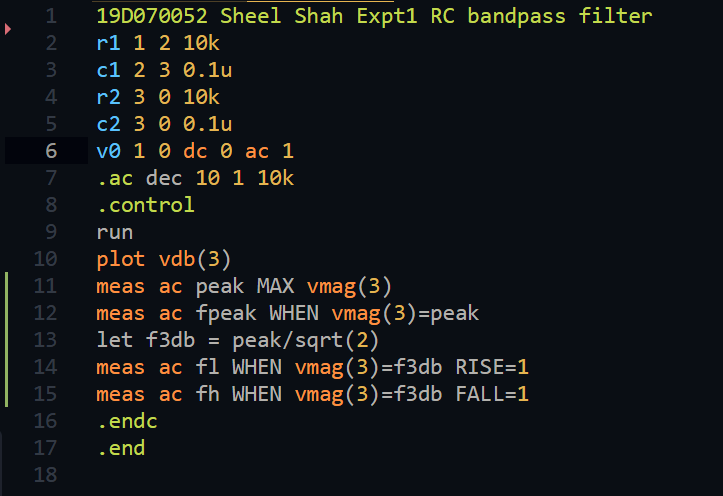
For -3dB points, magnitude is 1/root(2)

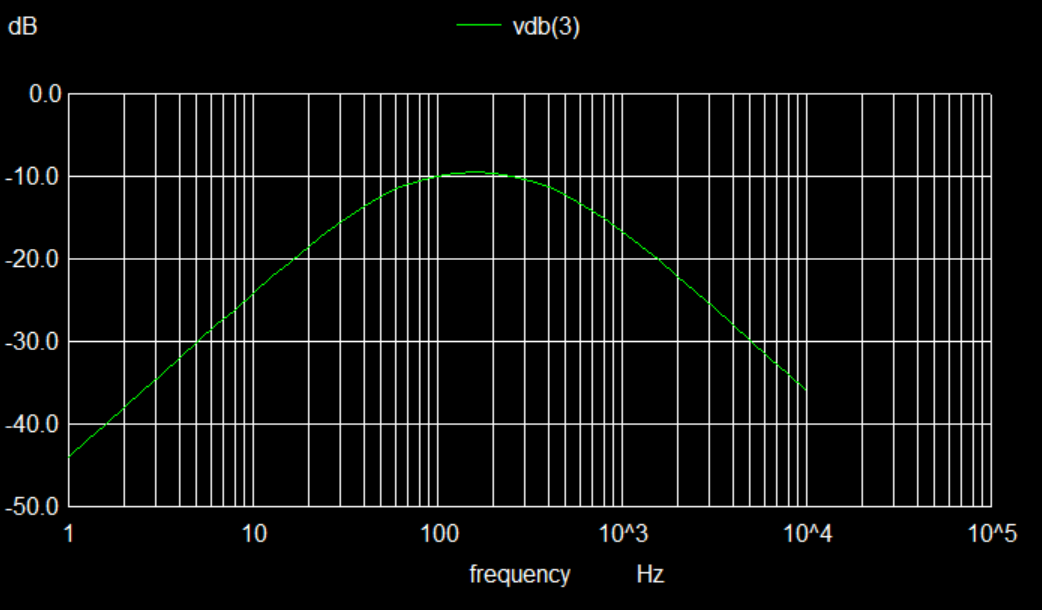
Hence 1 –(wRC)^2 = +/- 3wRC

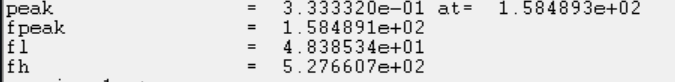
Hence w\_l = (root(13) – 3) / (2RC) and w\_h = (root(13) + 3) / (2RC)

This gives fl = 48Hz, fh = 526Hz









1. RLC bandpass filter

Transfer function is: Vout = R\* Vin / (R + s\*L + (1 / (s\*C)))

So: T(s) = (s / (s^2 + (R/L)\*s + 1/(L\*C))) \* (R/L)

Now with s = j\*w we have T(jw) = (Rjw/L)(1 / ((Rjw/L) + (1/LC – w^2)))

Maxima is attained when the denominator is minimum and hence (1/LC -w^2) is 0

Hence w\_peak = 1/root(LC) = 31.6 krad/s => f\_peak is 5.035 kHz

At f\_l and f\_h, magnitude should be -3db or 1/root(2).

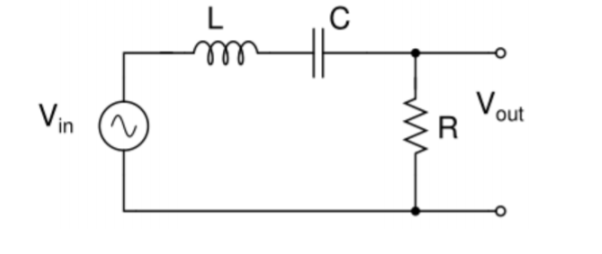
Hence (1/LC -w^2) is +/- Rw/L

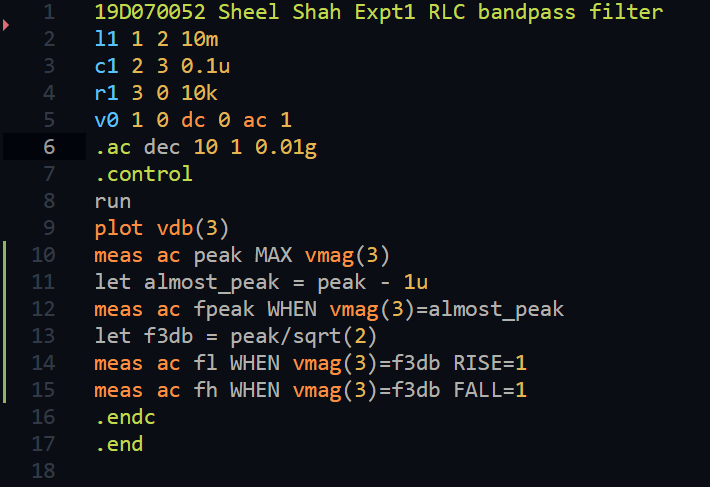
Solving this quadratic gives

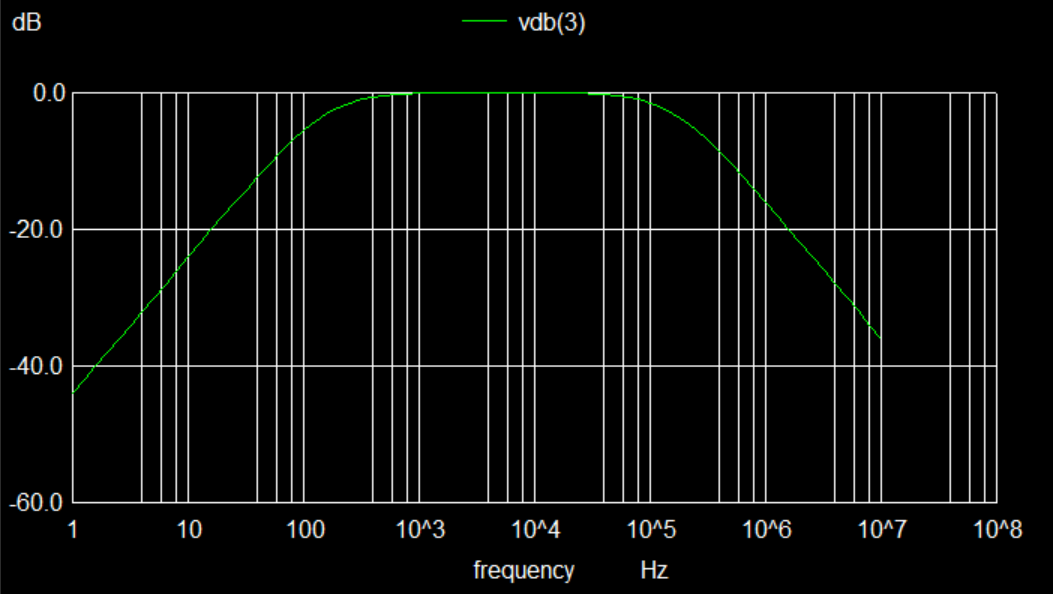
w\_l = root((R/2L)^2 + 1/LC) – R/2L

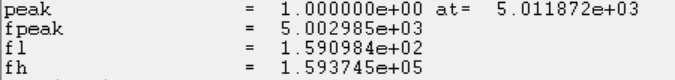
w\_h = root((R/2L)^2 + 1/LC) + R/2L

Hence fl = 1458Hz, 17373 Hz









Major learnings:

I really came to like ngSpice and found the method fairly intuitive. It was good to see that mathematical analysis matched so close to simulations. I also understood (hands on) that mathematical analysis was not perfect, and that in the experiment, it would deviate even more than the simulation.

Challenges faced:

I did not like the plain look of .cir files, and hence wrote Sublime Text syntax highlighting for it. This took quite some time, and a lot of effort but I can’t really complain as this was my personal choice. The report also took quite some time, and it looks really bad too. However I don’t know how Latex works so this was my only choice.

Questions/Clarifications:

If you want to see the code/the plots in.ps, please contact me at [19D070052@iitb.ac.in](mailto:19D070052@iitb.ac.in) and I will share a zip.