REPORT FOR ASSIGNMENT 2

EEE2045F
Analog Electronics
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1. MOSFET Characteristics

(a) Identify the type of MOSFET, the threshold voltage, and the DC Voltage applied to the gate of the MOSFET.

It is a N-Channel E-MOSFET
Threshold Voltage is 1.8V
DC Voltage is 2V

(b) Run a simulation to find the cut-off frequency of the circuit (measured from the voltage across the resistor). Using the cut-off frequency, calculate the capacitance of the MOSFET. Hint: You can use the RC equation for critical frequency to calculate the capacitance

Cut-off frequency is 115KHz at -43db

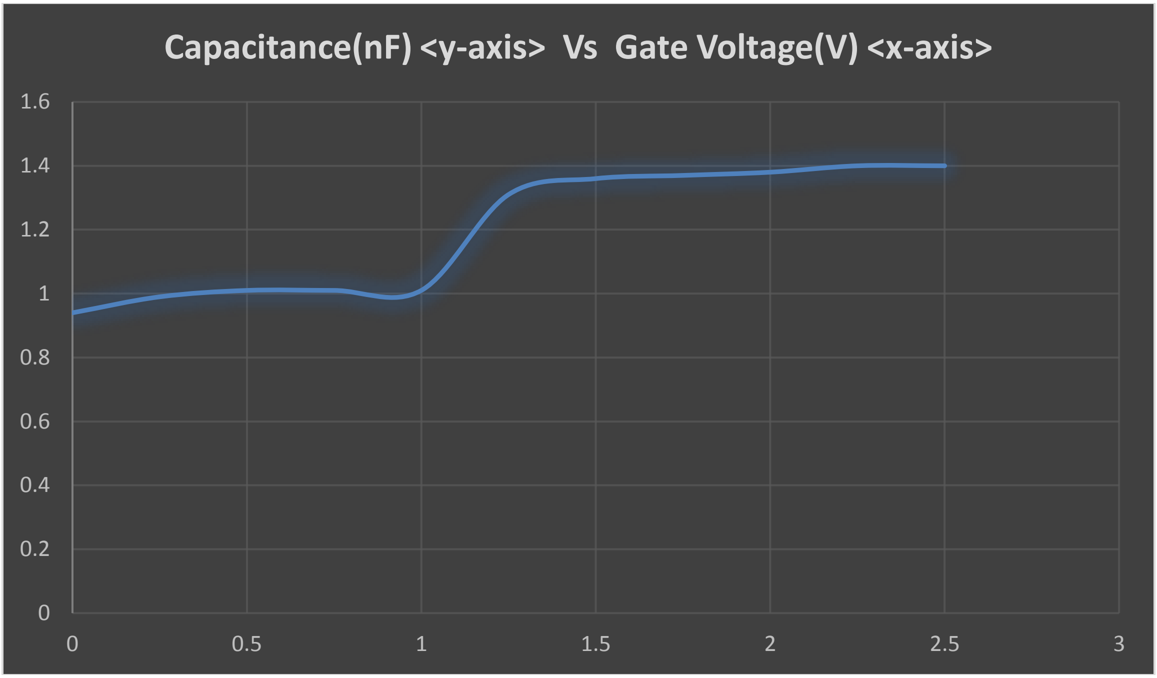
$$f_c = \frac{1}{2\pi RC} \quad ; \quad C = \frac{1}{2\pi Rf}$$

$$C = \frac{1}{2\pi(1000)115KHz}$$

C = 1.38nF

(c) Vary the DC voltage applied to gate from 0 V till 2.5V in steps of 0.25V. For these voltages, calculate the subsequent capacitance values and plot a graph for MOSFET-Capacitance vs. the gate voltage. Elaborate on the shape of the graph.

DC Voltage (V)	Cut-off Frequency (kHz)	Capacitance (nF)
0	170	0.94
0.25	161	0.99
0.50	158	1.01
0.75	157	1.01
1.00	157	1.01
1.25	122	1.31
1.50	117	1.36
1.75	116	1.37
2.00	115	1.38
2.25	114	1.40
2.50	114	1.40



As the gate voltage increases, the mosfet capacitance increases gradually. This is because as the more the voltage, the more can the capacitor store electric energy. There is also a sharp rise in mosfet capacitance after the 1.25V gate voltage.

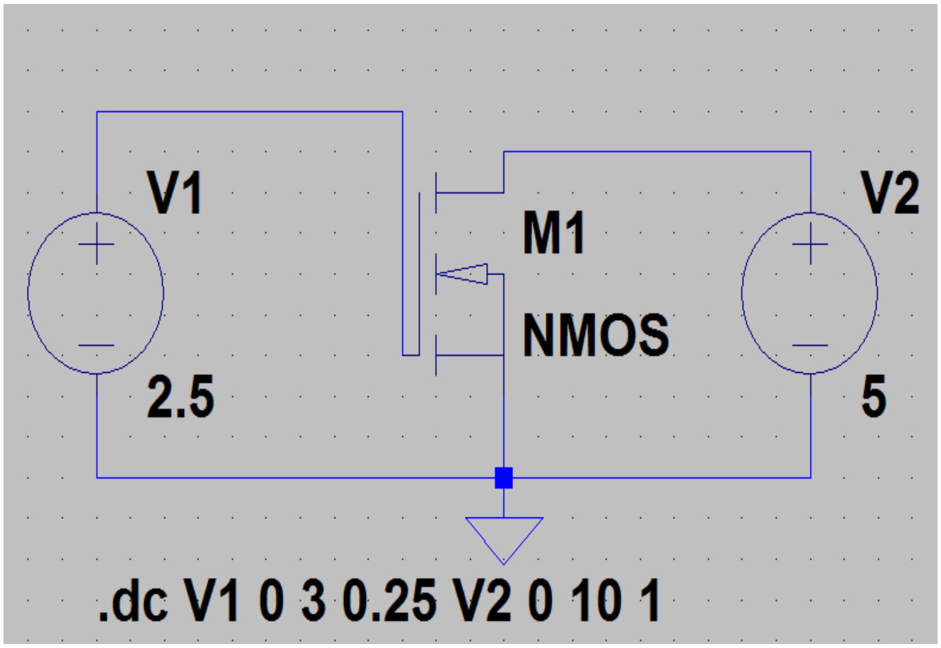
2. NMOS and PMOS

Explain the difference between a NMOS and PMOS and plot their characteristics curves LTspice (you may use any standard MOSFET circuit). Distinguish between NMOS/PMOS and NMOS4/PMOS4.

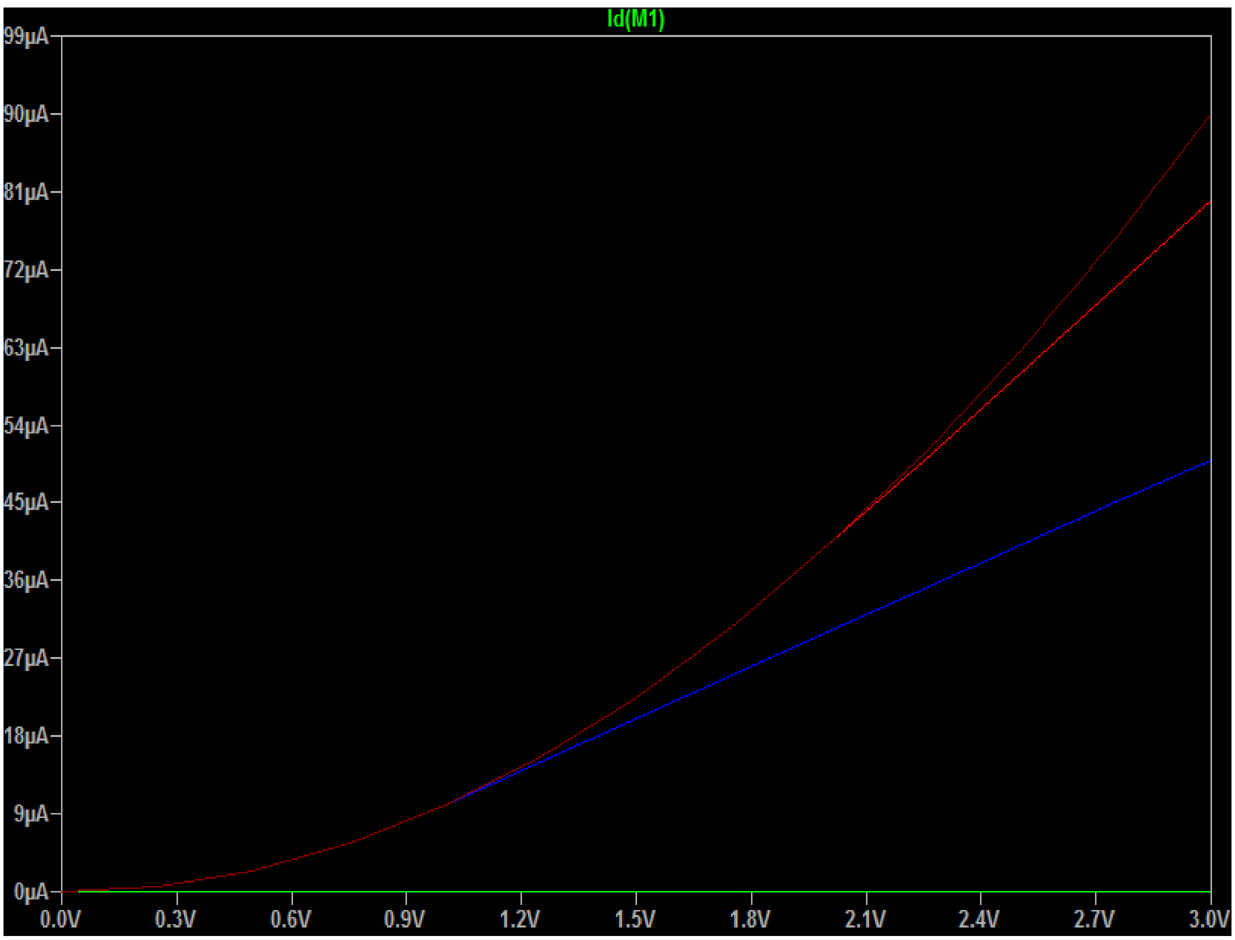
- NMOS has n-type drain and source and p-type substrate WHILE PMOS has p-type drain and source and n-type substrate
- Charge carriers are electrons in NMOS WHILE holes are carriers in PMOS
- At high voltages; NMOS will conduct and PMOS wouldn't and vice versa for low voltages

NMOS/PMOS has 3 terminals namely Source, Drain and Gate whereas ***NMOS4/PMOS4*** has 4 terminals namely Source, Drain, Gate and Body. The body is connected to the source to avoid body effect. Body effect is the change in Threshold voltage of a transistor arising from a voltage difference between the transistor and the body.

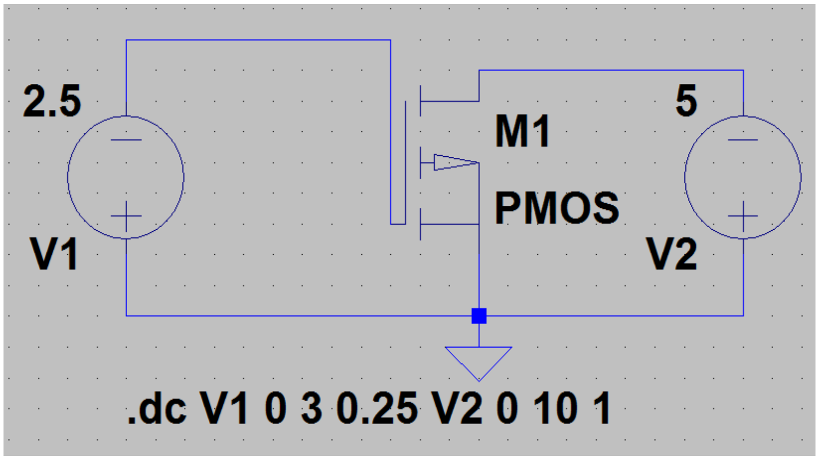
NMOS Circuit:



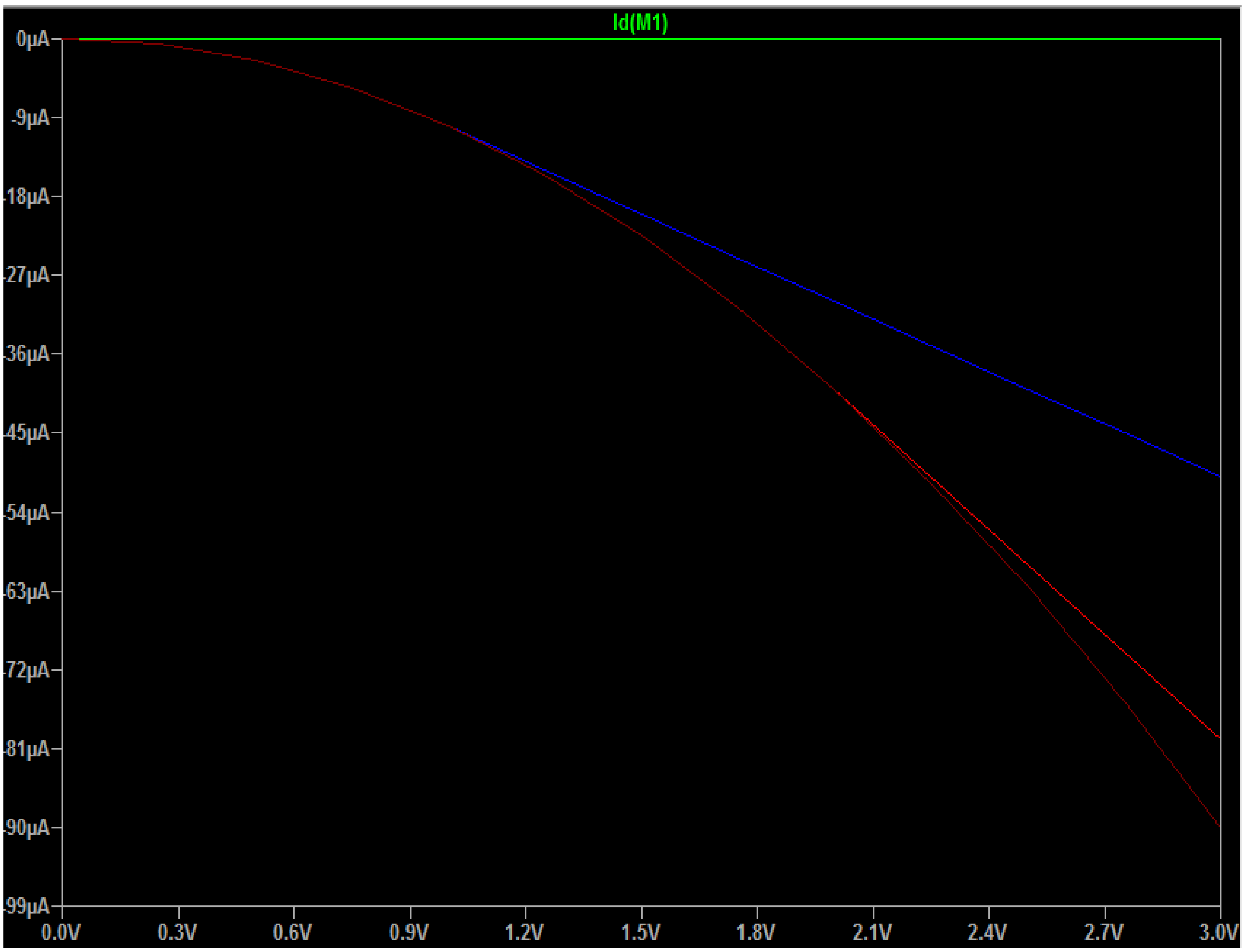
NMOS Characteristic Curve:



PMOS Circuit:



PMOS Characteristic Curve:



3. Filters

(a) Design a 10 MHz low pass filter and plot its characteristics.

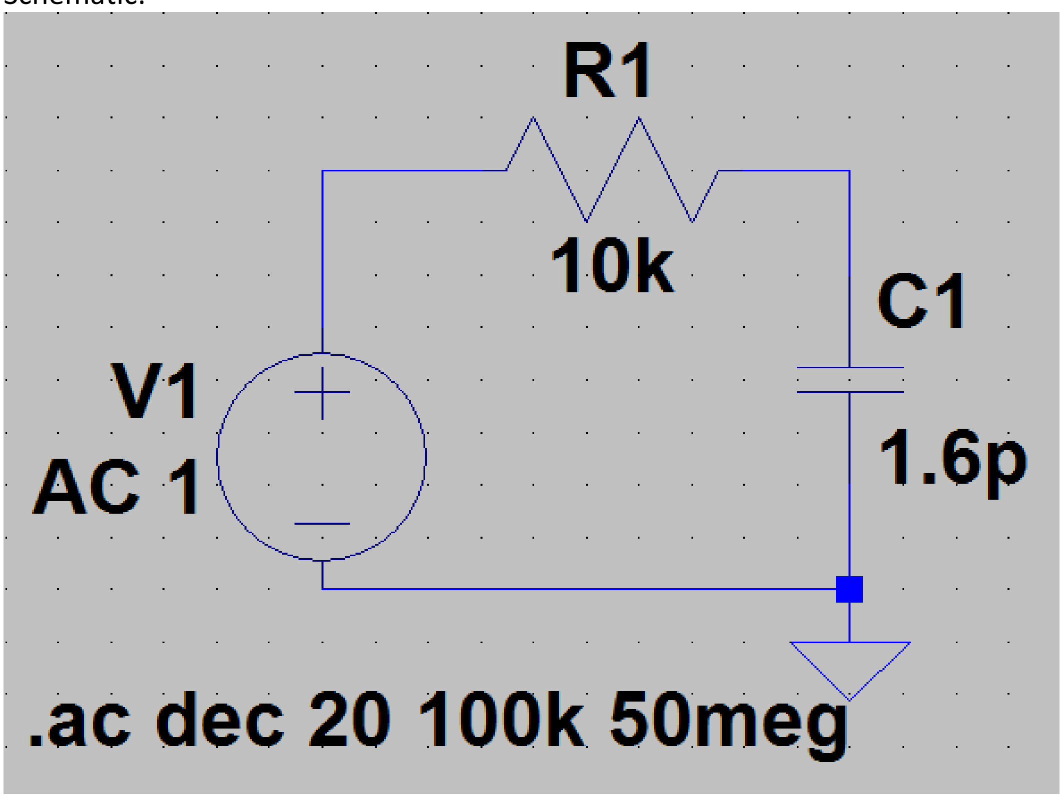
$f_c = \frac{1}{2\pi RC}$; $C = \frac{1}{2\pi Rf}$

If R = 10k:

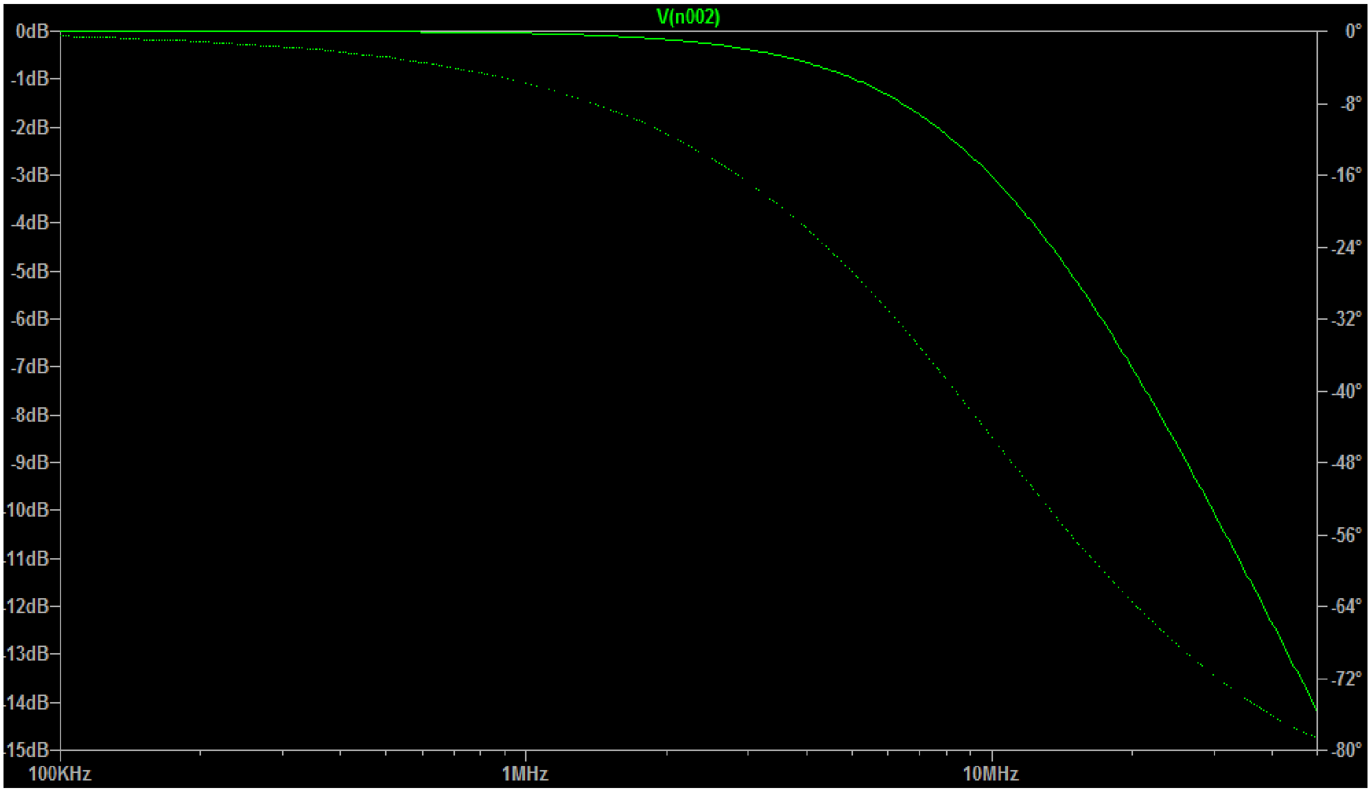
$C = \frac{1}{2\pi(10k)10MHz}$

C = 1.6pF

Schematic:



Plot of its Characteristics:



(b) Design a 1kHz band pass filter and plot its characteristics.

F_0 is Critical Frequency
Fc1 is Frequency of High Pass Filter
Fc2 is Frequency of Low Pass Filter

$F_o = \sqrt{(Fc1)(Fc2)}$
$F_o = (1kHz)^2$ = (Fc1)(Fc2)

Easiest Option:
Fc1 = 1kHz
Fc2 = 1kHz

For Low Pass Filter:

$Fc_1 = \frac{1}{2\pi R1C1}$; $C_1 = \frac{1}{2\pi R1Fc1}$

If R_1 = 10k:

$C_1 = \frac{1}{2\pi(10k)1kHz}$

$\underline{\underline{C_1 = 16nF}}$

For High Pass Filter:

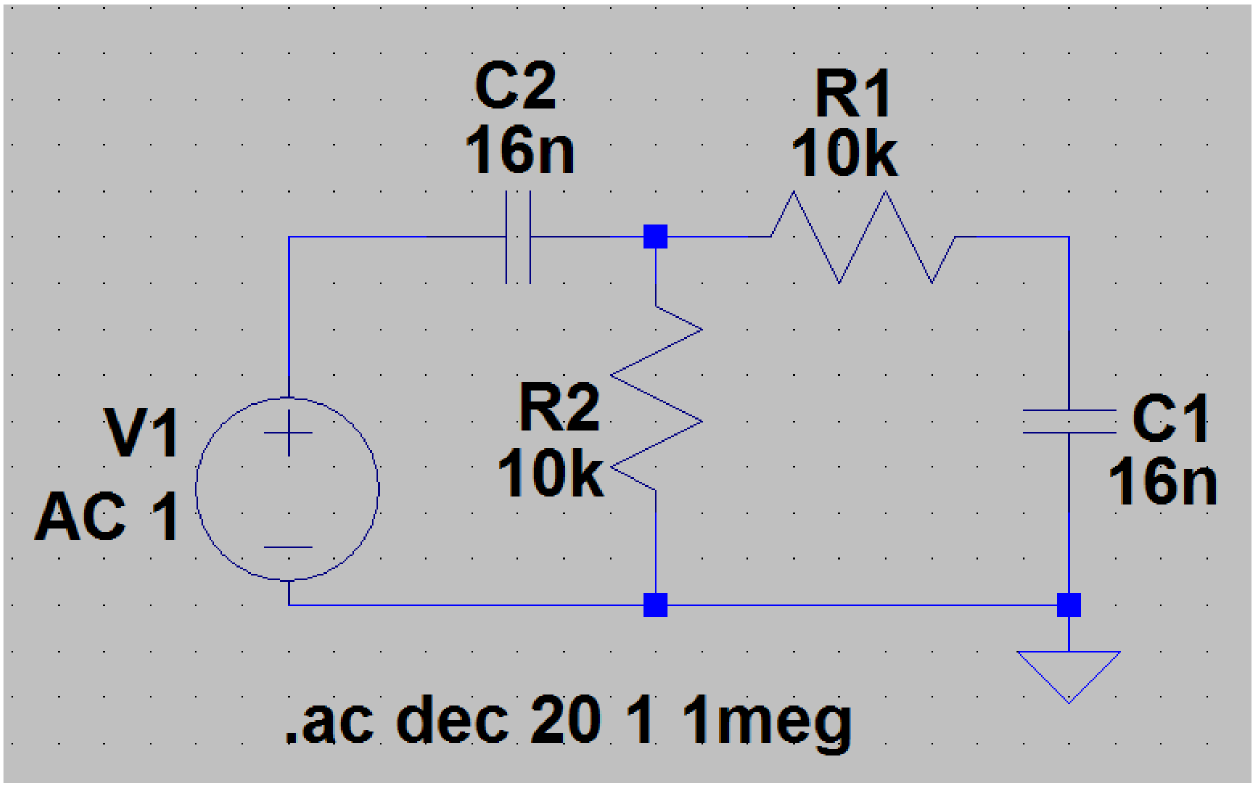
$Fc_2 = \frac{1}{2\pi R2C2}$; $C_2 = \frac{1}{2\pi R2Fc2}$

If R_2 = 10k:

$C_2 = \frac{1}{2\pi(10k)1kHz}$

$\underline{\underline{C_2 = 16nF}}$

Schematic:



Plot of its Characteristics: