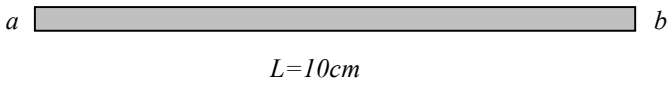
Phys 321 Electronics Quiz #1 **Oct 3, 2016**

Work carefully and independently. Fill the blanks with your final answers and the correct units. For full credit you must show your work on the spaces below or back of page.

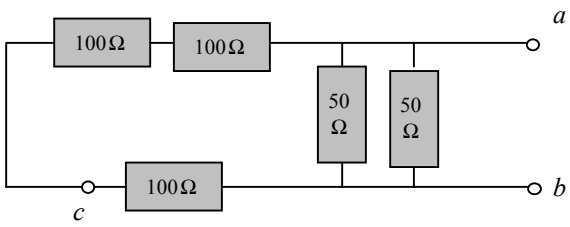
#1- A carbon cylinder of resistivity 40 μΩ-m has a radius of 1mm and length 10cm. What is the resistance of the cylinder when measured from point *a* to *b*?



R = _____

R=ρL/A=0.00005*0.1/(3.14159*0.001^2)=1.27Ω

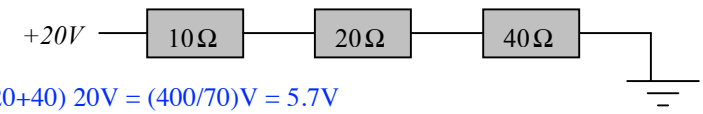
#2- (a) Find the resistance between *a* and *b*. (b) Then determine the resistance between *a* and *c*.



R*ab*=_____ R*ac*=_____

Rab=(1/300+1/50+6/50)^-1 = (1/300+6/300+6/300)^-1 = (300/13)Ω=23Ω
Rac=(1/200+1/125)^-1= 77Ω

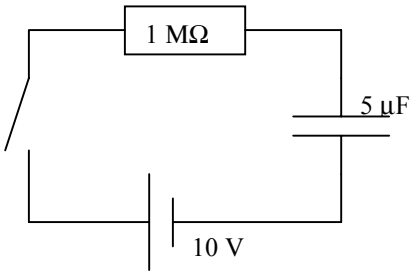
#3- Use the voltage divider theorem to determine the voltage drop across the 20 Ω resistor.



V_{20}= 20/(10+20+40) 20V = (400/70)V = 5.7V

V_{20} = _____

#4- Find the time constant of the RC circuit and the voltage across the resistor at t=2 sec after the switch is thrown.



τ = _____

$V_R(2s)$ =_____

$\tau = RC = 5\mu F \times 10\Omega = 5$ s

$V_R = V_{max} \exp(-t/RC) = 10V \exp(-2/5) = 6.7$ V

#5- A 10V signal is attenuated by -30db. What is the voltage of the resulting signal?

V = _____

-30db = 20db log(V/Vin)

-1.5 =log(V/Vin)

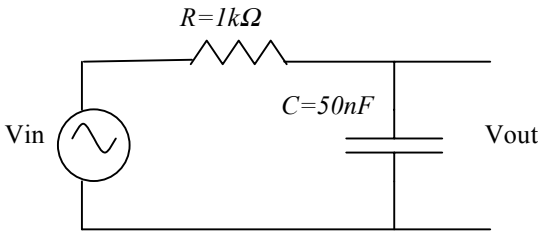
$V = 10V \times 10^{-1.5} = 0.32$ V

#6- The capacitance and inductance of a transmission line are given by 30pF/m and 5µH/m respectively. At what speed *v* will a signal traverse the line in m/s.

v = _____

$$v = \frac{1}{\sqrt{L'C'}} = \frac{1}{\sqrt{(5x10^{-6}H)(30x10^{-12}F)}} = 8.16x10^{7} m/s$$

#7- (a) Derive an expression for Vout/Vin of the filter as a function of ω, L, and C. (b) Determine the break frequency f_b of the filter and (c) identify it as a low-pass or hi-pass filter. (d) At what frequency will the circuit act as a differentiator or integrator?



f_b = _____

Lo-pass _____ Hi-pass_____
(check one)

Diff. _____ Int_____ f=_____
(check one)

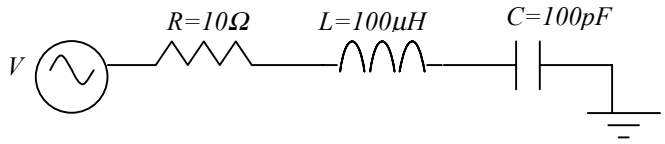
$$\left|\frac{Vout}{Vin}\right| = \left|\frac{-j/\omega C}{R - j/\omega C}\right| = \frac{1/\omega C}{\sqrt{R^2 + 1/\omega^2 C^2}} = \frac{1}{\sqrt{1+\omega^2 R^2 C^2}}$$

$$f_B = \frac{1}{2\pi RC} = 3185 Hz \qquad LOW-PASS: gain \to 0 \ as \ \omega \to \infty$$

A low pass filter would pass low frequencies including DC levels.

A Differentiator would kill DC levels, so the filter must act as an Integrator for f ≤ f_B

#8- Find the Q value of the circuit. What ac current flows through the circuit at the Q resonance if Vac= 100Vrms ?



Q = _____ I(ωo) = _____

$$\omega_o = \frac{1}{\sqrt{LC}} = 10^7 \ rdn/s$$

$$Q = \left.\frac{|X_L|}{R}\right|_{\omega=\omega_0} = \frac{\omega_o L}{R} = 10^7 \ x \ 100x10^{-6}/10 = \mathbf{100}$$

$$I = 10/Z \quad where \quad Z = R = 10\Omega \ at \ \omega_0 \ resonance$$

$$I_{rms}(\omega_o) = 100V/10\Omega = \mathbf{10A}$$

#9- The output impedance of an waveform generator is Zout=200Ω. The input is attached to an amplifier with an input impedance of Zin=1MΩ. What transformer ratio is needed to insure maximum power transfer?

N1/N2= _____

The transformer matching conditon is

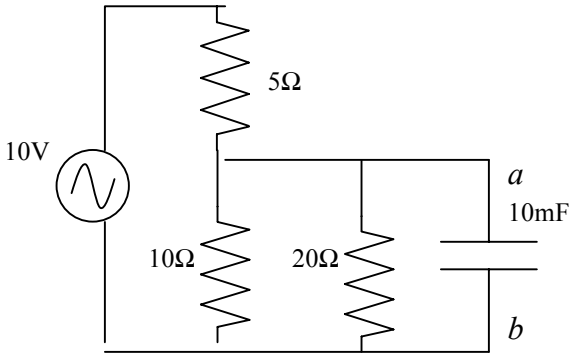
$$\frac{Z_1}{Z_2}=\left(\frac{N_1}{N_2}\right)^2 \rightarrow \left(\frac{N_1}{N_2}\right)=\sqrt{\frac{200\Omega}{10^6\Omega}}=0.014$$

#10- Use Thevenin's Theorem to find the Thevenin voltage V_{TH} and resistance R_{TH} seen across the capacitor between points *a, b*. Using this informations find the RC time constant for capacitor charging. Provide units please.

V_{TH} = _____

R_{TH} = _____

T_{RC} = _____



Re *move capacitor from* $a-b$

$R_{TH}=20\|10\|10=(\frac{1}{20}+\frac{1}{10}+\frac{1}{5})^{-1}=\frac{20}{7}\Omega=2.9\Omega$ *shorting the* 10*V* sup *ply*

$V_{TH}=\frac{20\|10}{5+20\|10}\times 10V=\frac{20/3}{5+20/3}\times 10V=\frac{20}{15+20}\times 10V=\frac{200}{35}V=5.7V$

$\tau=R_{TH}C=(2.9\Omega)(0.01F)=0.03s$