ics 302
Winter Quarter 1992
March 17, 1994
George Williams

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FINAL EXAM

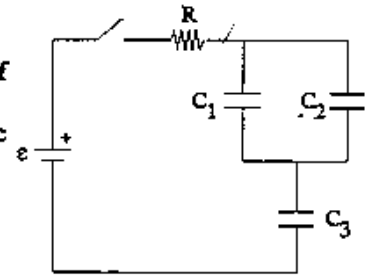
Name (print)_____ Name (signed)_____

Discussion Instructor (circle): Basko Chakhbazian DiCarlo Gundlach Romer Wei

Discussion Section # _____

SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Initially all capacitors are discharged.



(a) If the switch is closed at t = 0, calculate the current in R as a function of time, evaluating all numerical constants.

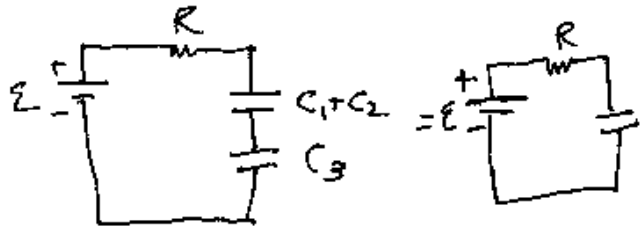
(b) After being closed a long time, the switch is opened, and then a dielectric with $\kappa = 4.25$ is inserted in C_2. Calculate the charge and potential on each capacitor after this event.

(c) After (b) the switch is closed again. How much additional charge flows from the battery to the the capacitors if you wait a long time?

$\varepsilon = 125$ V; $C_1 = 650$ pF; $C_2 = 275$ pF; $C_3 = 400$ pF; $R = 1.25 \times 10^5$ Ohms

(a)  $C_{eff} = \frac{(C_1+C_2)C_3}{C_1+C_2+C_3} = 2.79245\times10^{-10}\,F = \tau_{charge} = 3.49056\times10^{-5}\,s$

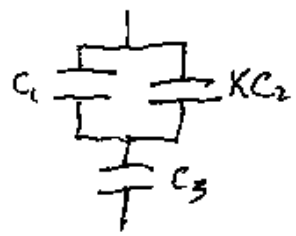
$$I_R(t) = \frac{\varepsilon}{R} e^{-t/\tau_c} = \boxed{1\,mA\; e^{-\left[\frac{t}{3.49\times10^{-5}\,s}\right]}}$$

Before (b) insertion 

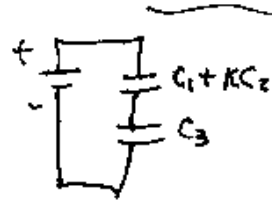
$\frac{(C_1+C_2)C_3}{C_1+C_2+C_3} = C_{eq} \Rightarrow q_{eq} = C_{eq}\varepsilon = 3.4905\times10^{-8}\,CU$

$V_{3b} = 87.3V$
$q_{3b} = 3.49\times10^{-8}C$

$V_2 \& V_3 = 37.7\,V$
$q_{2b} = 1.04\times10^{-8}\,CU$
$q_{1b} = 2.45\times10^{-8}\,CU$

(b) After insertion 

C_3	C_2	C_1
$q_3 = 3.49\times10^{-8}$ CU	$q_2 = 2.24\times10^{-8}$ CU	$q_1 = 1.25\times10^{-8}$ C
$V_3 = 87.3$ V	$V_2 = 19.2$ V	$V_1 = 19.2$ V

(c) 

$C_{eq}_{NOW} = 3.27887\times10^{-10}\,F \Rightarrow q_{eq} - q_{eq}_{NOW} = \boxed{6.08\times10^{-9}\,CU}$

$q_{eq}_{after} = 4.09859\times10^{-8}\,CU$