Chapter 10

1. (a) $\mathscr{E} = k\frac{Q_1}{r^2} = \frac{(9\times10^9)(4\,\mu\text{C})}{(1\text{ m})^2} = \mathbf{36\times10^3\ N/C}$

(b) $\mathscr{E} = k\frac{Q_1}{r^2} = \frac{(9\times10^9)(4\,\mu\text{C})}{(1\text{ mm})^2} = \mathbf{36\times10^9\ N/C}$

$\mathscr{E}$(1 mm): $\mathscr{E}$ (2 m) = 36×10^9: 36×10^3 = $\mathbf{1\times10^6}$

2. $\mathscr{E} = \frac{kQ}{r^2} \Rightarrow \sqrt{\frac{kQ}{\mathscr{E}}} = \sqrt{\frac{(9\times10^9)(2\mu\text{C})}{72\text{ N/C}}} = \mathbf{15.81\ m}$

3. $C = \frac{Q}{V} = \frac{1200\,\mu\text{C}}{24\text{ V}} = \mathbf{50\ \mu F}$

4. $Q = CV = (0.15\ \mu\text{F})(120\text{ V}) = \mathbf{18\ \mu C}$

5. a. $1''\left[\frac{1\text{ m}}{39.37''}\right] = 25.4\text{ mm}$

$\mathscr{E} = \frac{V}{d} = \frac{500\text{ mV}}{25.4\text{ mm}} = \mathbf{19.69\ V/m}$

b. $\frac{25.4\text{ mm}}{100} = 0.254\text{ mm}$

$\mathscr{E} = \frac{V}{d} = \frac{500\text{ mV}}{0.254\text{ mm}} = \mathbf{1.97\ kV/m}$

6. $V = \frac{Q}{C} = \frac{160\,\mu\text{C}}{6.8\,\mu\text{F}} = 23.53\text{ V}$

$\mathscr{E} = \frac{V}{d} = \frac{23.53\text{ V}}{5\text{ mm}} = \mathbf{4.71\ kV/m}$

7. $0.1''\left[\frac{1\text{ m}}{39.37''}\right] = 2.54\text{ mm}$

$C = 8.85\times10^{-12}\varepsilon_r\frac{A}{d} = 8.85\times10^{-12}(1)\frac{(0.1\text{ m}^2)}{2.54\text{ mm}} = \mathbf{348.43\ pF}$

8. $C = 8.85\times10^{-12}\,\varepsilon_r\frac{A}{d} = 8.85\times10^{-12}(2.5)\frac{(0.1\text{ m}^2)}{2.54\text{ mm}} = \mathbf{871.06\ pF}$

9. $C = 8.85\times10^{-12}\varepsilon_r\frac{A}{d} \Rightarrow d = \frac{8.85\times10^{-12}(4)(0.15\text{ m}^2)}{2\,\mu\text{F}} = \mathbf{2.66\ \mu m}$

10. $C = \varepsilon_r C_o \Rightarrow \varepsilon_r = \dfrac{C}{C_o} = \dfrac{6.8\text{ nF}}{1360\text{ pF}} = \mathbf{5\ (mica)}$

11. a. $C = 8.85 \times 10^{-12}(7)\dfrac{(0.08\text{ m}^2)}{0.2\text{ mm}} = \mathbf{24.78\ nF}$

b. $\mathscr{E} = \dfrac{V}{d} = \dfrac{80\text{ V}}{0.2\text{ mm}} = \mathbf{400\ kV/m}$

c. $Q = CV = (24.78\text{ nF})(200\text{ V}) = \mathbf{4.96\ \mu C}$

12. a. $C = \dfrac{1}{2}(4.7\ \mu\text{F}) = \mathbf{2.35\ \mu F}$

b. $C = 2(4.7\ \mu\text{F}) = \mathbf{9.4\ \mu F}$

c. $C = 20(4.7\ \mu\text{F}) = \mathbf{94\ \mu F}$

d. $C = \dfrac{(4)\left(\dfrac{1}{3}\right)}{\left(\dfrac{1}{4}\right)}(4.7\ \mu\text{F}) = \mathbf{25.1\ \mu F}$

13. $d = \dfrac{8.85\times10^{-12}\varepsilon_r A}{C} = \dfrac{(8.85\times10^{-12})(5)(0.02\text{ m}^2)}{6800\text{ pF}} = 130.15\ \mu\text{m}$

$$d = 130.15\ \mu\text{m}\left[\frac{10^{-6}\text{ m}}{1\ \mu\text{m}}\right]\left[\frac{39.37\text{ in.}}{1\text{ m}}\right]\left[\frac{1000\text{ mils}}{1\text{ in.}}\right] = 5.12\text{ mils}$$

$$5.12\text{ mils}\left[\frac{5000\text{ V}}{\text{mil}}\right] = \mathbf{25.6\ kV}$$

14. mica: $\dfrac{1200\text{ V}}{\dfrac{5000\text{ V}}{\text{mil}}} = 1200\text{ V}\left[\dfrac{\text{mil}}{5000\text{ V}}\right] = 0.24\text{ mils}$

$$0.24\text{ mils}\left[\frac{1''}{1000\text{ mils}}\right]\left[\frac{1\text{ m}}{39.37\text{ in.}}\right] = \mathbf{6.10\ \mu m}$$

15. $\dfrac{200}{1\times10^6}(22\ \mu\text{F})/°\text{C} = 4400\text{ pF}/°\text{C}$

$$\frac{4400\text{ pF}}{°\text{C}}[\Delta T] = \frac{4400\text{ pF}}{°\text{C}}[80°\text{C}] = \mathbf{0.35\ \mu F}$$

16. J = ±5%, Size $\Rightarrow$ 40 pF ± 2 pF, **38 pF → 42 pF**

17. F = ±1%, Size $\Rightarrow 47 \times 10^1\ \mu\text{F} = 470\ \mu\text{F} \pm 4.7\ \mu\text{F}$, **465.3 μF → 474.7 μF**

18. K = ±10%, Size $\Rightarrow 18 \times 10^2$ pF = **1800 pF ± 180 pF, 1620 pF → 1980 pF**

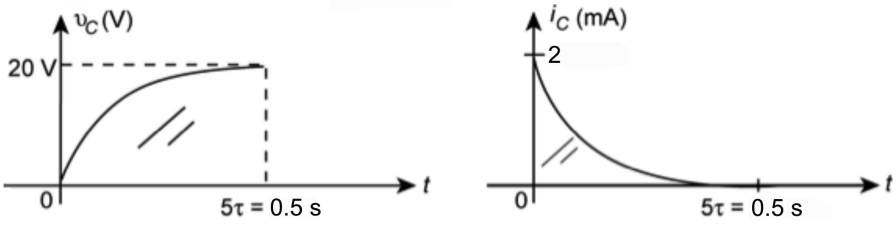
19. a. $\tau = RC = (10 \times 10^3\ \Omega)(10\ \mu\text{F}) = \mathbf{100\ ms}$

b. $\upsilon_C = E(1 - e^{-t/\tau}) = \mathbf{20\ V(1 - e^{-t/100\ ms})}$

c. $1\tau = 0.632(20\ \text{V}) = \mathbf{12.64\ V}$, $3\tau = 0.95(20\ \text{V}) = \mathbf{19\ V}$
$5\tau = 0.993(20\ \text{V}) = \mathbf{19.87\ V}$

d. $i_C = \dfrac{20\ \text{V}}{10\ \text{k}\Omega} e^{-t/\tau} = \mathbf{2\ mA}e^{-t/100\ \text{ms}}$
$\upsilon_R = Ee^{-t/\tau} = \mathbf{20\ V}e^{-t/100\ \text{ms}}$

e.



20. a. $\tau = RC = (100\ \text{k}\Omega)(10\ \mu\text{F}) = \mathbf{1\ s}$

b. $\upsilon_C = E(1 - e^{-t/\tau}) = \mathbf{20\ V(1 - e^{-t/1s})}$

c. $1\tau = \mathbf{12.64\ V}$, $3\tau = \mathbf{19\ V}$, $5\tau = \mathbf{19.87\ V}$

d. $i_C = \dfrac{20\ \text{V}}{100\ \text{k}\Omega} e^{-t/\tau} = \mathbf{200\ \mu A}\ e^{-t/1s}$
$\upsilon_R = Ee^{-t/\tau} = \mathbf{20V}\ e^{-t/1s}$

e. Same as problem 21 with $5\tau = 5$ s and $I_m = 200\ \mu\text{A}$

21. a. $\tau = RC = (2.2\ \text{k}\Omega + 3.3\ \text{k}\Omega)1\ \mu\text{F} = (5.5\ \text{k}\Omega)(1\ \mu\text{F}) = \mathbf{5.5\ ms}$

b. $\upsilon_C = E(1 - e^{-t/\tau}) = \mathbf{100\ V(1 - e^{-t/5.5\ ms})}$

c. $1\tau = \mathbf{63.21\ V}$, $3\tau = \mathbf{95.02\ V}$, $5\tau = \mathbf{99.33\ V}$

d. $i_C = \dfrac{E}{R_T} e^{-t/\tau} = \dfrac{100\ \text{V}}{5.5\ \text{k}\Omega} e^{-t/\tau} = \mathbf{18.18\ mA}e^{-t/5.5\ \text{ms}}$

$V_{R_2} = \dfrac{3.3\ \text{k}\Omega\ (100\ \text{V})}{3.3\ \text{k}\Omega + 2.2\ \text{k}\Omega} = 60\ \text{V}$

$\upsilon_{R_2} = \mathbf{60\ V}e^{-t/5.5\ \text{ms}}$

e.