HW.1 – Ch.10

P.13 d=0.2mm, A=0.08m^2, V=200V

a) E=V/d=200/0.2mm= 1* 10^6 V/m

b) Q= εAE=εo εr AE=8.85*10^-12 * 7 * 0,08*10^6 = 4.956μC

c) C= εr Co=7*(ε0A/d)=0.0248μF ,,or C=Q/V=0.024 μF

P.19

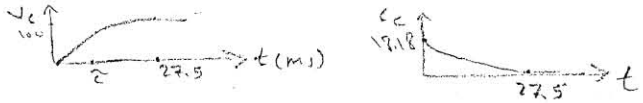
a) τ = RC = (R1+R2) C = (2.2K+3.3K)* 1 μF = 5.5ms

b) Vc= E(1-exp(-t/τ))=100(1-exp(-t/5.5ms))

c) At t = 1τ ,, Vc = 100(1-exp(-1)) = 63.21V.
At t = 3τ ,, Vc = 100(1-exp(-3)) = 95.02V.
At t = 5τ ,, Vc = 100(1-exp(-5)) = 99.33V.

d) ic = E/R exp(-t/τ)= 100/5.5K exp(-t/5.5ms)=18.18*10^-3 exp(-t/5.5ms)
$V_R = V_{(R=3.3k)}$ = RI = R ic =3.3K * 18.18*10^-3 = 60V, so VR= 60 exp(-t/5.5ms)

e) sketch of Vc & ic



P.21

a) τ = RC = (3K+2K)* 2 μF = 10 ms

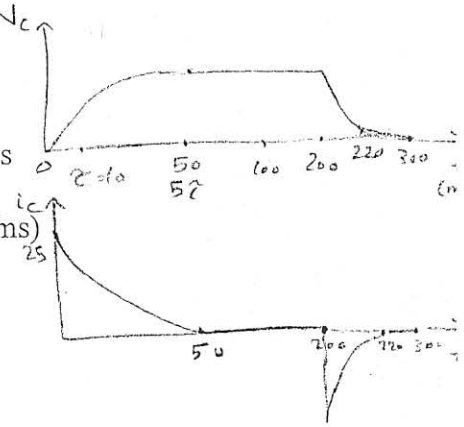
b) Vc= E(1-exp(-t/τ))= 50(1-exp(-t/10ms))

c) ic = E/R exp(-t/τ)= 50/5K exp(-t/10ms)=10*10^-3 exp(-t/10ms)

d) at t = 100ms ; 5τ =5*10ms=50ms ;;;so Vc=50V & ic = 0

e) at t = 200ms(discharge) , τ` = R2 C = 2k * 2μF = 4ms ,,5τ`=20ms
Vc = E exp(-t/ τ`) = 50 exp(-t/4ms)
ic = - E/R2 exp(-t/τ`)= -50/2K exp(-t/4ms)= -25*10^-3 exp(-t/4ms)

f) sketch of Vc & ic



P.25 C=1000 μF , V=6V , R=0.002Ω

a) $t_{(discharge)}$ = 5 τ = 5 RC = 5(0.002 * 1000 μF) = 10 μsec.

b) $i_{c\,(peak)}$ = E/R = V/R = 6/0.002 = 3000A

c) yes

P.29 t = ? when ic=1/2 ipeak = ½ * Im= ½ * 3000 = 1500 A
ic=E/R exp(-t/RC)→1500 = 3000 exp(-t/2 μsec)→ t = -1.386 μsec

P.31

τ = RC = 200 μF * R ,, t = τ Ln (E/(E-Vc)) → τ = 10.91sec

R = τ/C = 10.91/200 μF = 54.567 KΩ

P.33 τ = RC = 1 M * 0.2 μF = 0.2 sec.

a) Vc= E(1-exp(-t/τ))
At t = 0.5s ,, Vc = 60(1-exp(-.5/.2)) = 55.075V.
At t = 1s ,, Vc = 60(1-exp(-1/.2)) = 59.59V.
ic = E/R exp(-t/τ)= 60/1M exp(-t/0.2s)

At t = 0.5s ,, ic = 60/1M * (exp(-.5/.2)) = 4.92 μA

At t = 1s ,, ic = 60/1M * (exp(-1/.2)) = 0.4038 μA

VR1 = E exp(-t/τ)

At t = 0.5s ,, VR1 = 60* (exp(-.5/.2)) = 4.92 V

At t = 1s ,, VR2 = 60/1M * (exp(-1/.2)) = 0.4038 V

P.23 $\tau = L/RTh = 10mH/1.5K = 6.67\mu s$

a) $RTh = R1 \,||\, R2 = 1.498 = 1.5k\Omega$ & $Eth = VR2 = E.R2/(R1+R2) = 5.45V$

$iL = ETh/RTh\,(1-exp(-t/\tau)) = 3.63*10^{-3}(1-exp(-t/6.67\mu s))$

$VL = ETh(exp(-t/\tau)) = 5.45(exp(-t/6.67\mu s))$

b) at $t = 10\ \mu s$, $iL = 2.82mA$, $VL = 1.21V$

c) $iL = Ii\,(exp(-t/\tau`)$ since $\tau` = L/R2 = 10/4.7k = 2.128\ \mu s$

$iL = 0.8..2*10^{-3}(exp(-t/2.128\mu s))$

$VL = Vi\,(exp(-t/\tau`)$ since $Vi = Ii\ R2 = 2.128\ \mu s * 4.7k = 13.25V$

$VL = -13.25(exp(-t/2.128\mu s))$ (($5\tau = 33.35$))

d) sketch of iL & VL

P.33 R: 5.7KΩ & 9.1KΩ ,,,, L: 4H & 2 H as in the circuit shown.

P.37

$RT = 25\ \Omega$

$I1 = I_T = E/R_T = 50/25 = 2A$

$I2 = 6\ I_T/(6+3) = 12/9 = 1.33A$

V1 = 10V. by KVL or $(3+2)*2 = 10V$

P.40

$WL1 = \frac{1}{2}\ L1.I_{L1}^2 = \frac{1}{2} * 0.5 * (2)^2 = 1\ J$

$WL2 = \frac{1}{2}\ L2.I_{L2}^2 = \frac{1}{2} * 4 * (1.33)^2 = 3.54\ J$

P.23 $\tau = L/RTh = 10mH/1.5K = 6.67\mu s$

a) $RTh = R1 \,||\, R2 = 1.498 = 1.5k\Omega$ & $Eth = VR2 = E.R2/(R1+R2) = 5.45V$

$iL = ETh/RTh\,(1-exp(-t/\tau)) = 3.63*10^{-3}(1-exp(-t/6.67\mu s))$

$VL = ETh(exp(-t/\tau)) = 5.45(exp(-t/6.67\mu s))$

b) at $t = 10\ \mu s$, $iL = 2.82mA$, $VL = 1.21V$

c) $iL = Ii\,(exp(-t/\tau`)$ since $\tau` = L/R2 = 10/4.7k = 2.128\ \mu s$

$iL = 0.8..2*10^{-3}(exp(-t/2.128\mu s))$

$VL = Vi\,(exp(-t/\tau`)$ since $Vi = Ii\ R2 = 2.128\ \mu s * 4.7k = 13.25V$

$VL = -13.25(exp(-t/2.128\mu s))$ (($5\tau = 33.35$))

d) sketch of iL & VL

P.33 R: 5.7KΩ & 9.1KΩ ,,,, L: 4H & 2 H as in the circuit shown.

P.37

$RT = 25\ \Omega$

$I1 = I_T = E/R_T = 50/25 = 2A$

$I2 = 6\ I_T/(6+3) = 12/9 = 1.33A$

V1 = 10V. by KVL or $(3+2)*2 = 10V$

P.40

$WL1 = \frac{1}{2}\ L1.I_{L1}^2 = \frac{1}{2} * 0.5 * (2)^2 = 1\ J$

$WL2 = \frac{1}{2}\ L2.I_{L2}^2 = \frac{1}{2} * 4 * (1.33)^2 = 3.54\ J$

HW.2 – Ch.12

P.9 $V = L\, di/dt$, L=200mH = 0.2H

t = 0 › 3 ms ,,, V = 0

t = 3 › 8 ms ,,, V = 0.2 * 40m/5m = 1.6V

t = 8 › 13 ms ,,, V = 0.2 * -40m/5m = -1.6V

t = 13 › 14 ms ,,, V = 0

t = 14 › 15 ms ,,, V = 0.2 * 40m/1m = 8V

t = 15 › 16 ms ,,, V = 0.2 * -40m/1m = -8V

t = 16 >0 ,,, V = 0

((sketch of VL))

P.13

a) $\tau = L/R = 5mH/2.2K = 2.27\mu s$

b) $iL = E/R(1-exp(-t/\tau)) = 12/2.2k(1-exp(-t/2.27\mu s)) = 5.45*10^{-3}(1-exp(-t/2.27\mu s))$

c) $VL = E(exp(-t/\tau)) = 12(exp(-t/2.27\mu s))$

$VR = E(1-exp(-t/\tau)) = 12(1-exp(-t/2.27\mu s))$

d) At $t = 1\tau$,,iL= 3.45mA , VL = 4.414V.

At $t = 3\tau$,,iL= 5.179mA ,VL = 0.597V.

At $t = 5\tau$,,iL= 5.413mA ,VL = 0.081V. (5τ=11.35μsec)

e) sketch of iL, VL & VR

P.15 $\tau = L/R1 = 5mH/6.8K = 0.735\mu s$

a) $iL = E/R1\,(1-exp(-t/\tau)) = 0.882*10^{-3}(1-exp(-t/0.735\mu s))$

$VL = E(exp(-t/\tau)) = 6(exp(-t/0.735\mu s))$

b) $iL = Im\,(exp(-t/\tau`))$ since $Im = E/R1 = 6/6.8k = 0.882mA$ & $\tau` = L/(R1+R2) = 0.33\ \mu s$

$iL = 0.882*10^{-3}(exp(-t/0.33\mu s))$

$VL = Vi\,(exp(-t/\tau`))$ since $Vi = (1 + R2/R1)\,E = 13.23V$

$VL = -13.23\,(exp(-t/0.33\mu s))$ ((5τ =3.675 & $5\tau` = 1.65$))

c) sketch of iL & VL

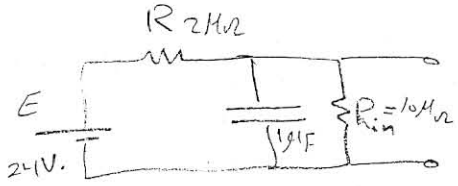
d) $VR2 = -R2/R1\,E\,(exp(-t/\tau`))$

$= -7.235\ exp(-t/0.33\mu s)$

sketch of VR2

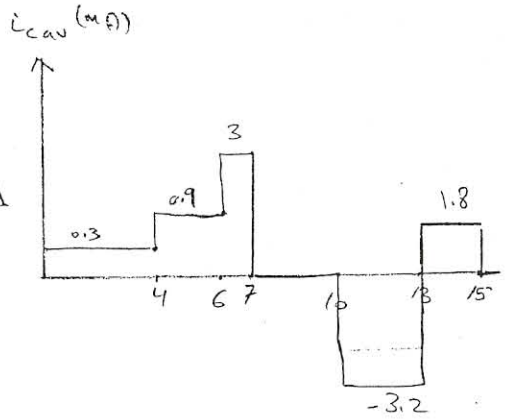
b) 10min=10*60=600s , 5τ=5*0.2=1 s ,,,i.e. full charged, $\tau_{discharge} = (R_1+R_2)C = 5M\Omega \times 0.2\mu F = 1$ s.
Find t when ic=8 μA ,, t = τ Ln (E/ic R) = 1 Ln (60/(8μ * 5M) = 0.405sec.
Find t when Vc= 10V,, t = τ Ln (E/Vc) = 1 Ln (60/(10) = 1.795 sec.

P.35

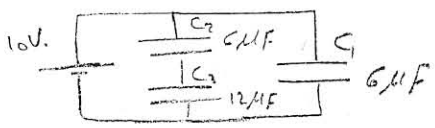


a) Vc =? At t = 4τ find RTh & Eth
Rth= R + Rin = 12M ,, ETh= 10M * 24/(10M+2M) = 20V
τ = RTh C = 12M * 1μF = 12s
Vc = ? at t = 4τ = 48 s
Vc = Eth (1-exp(-t/τ))= 20(1-exp(-4))= 19.633 V
b) t = ? ,,, ic = 3μA
t = τ Ln(Eth/ ic RTh) = 12 Ln(20/(3μ * 12 M)) = 7.053sec (not same as book answer)
c)) t = ? ,,, Vc = 10V
t = τ Ln(Eth/(Eth - Vc) = 12 Ln(20/(20-10)) = 8.3177sec (not same as book answer)

P.41 ic av = C ΔV/Δt
t= 0 → 4 ms ,,, ic = 0.06μ [20/4m] = 0.3 mA
t= 4 → 6 ms ,,, ic = 0.06μ [(50-20)/2m] = 0.9 mA
t= 6 → 7 ms ,,, ic = 0.06μ [(100-50)/1m] = 3 mA
t= 7 → 10 ms ,,, ic = 0
t= 10 → 13 ms ,,, ic = 0.06μ [(-50-100)/3m] = -3.2 mA
t= 13 → 15 ms ,,, ic = 0.06μ [0-(-60)/2m] = 1.8 mA
t>15 ms ,,, ic = 0



P.45(a)
C23 = C2C3/C2+ C3 = 4μF ,, CT = C1+C23 = 6+4=10μF
E = V23 = V1 = 10V
Q1 = V1 C1 = 10*6 μ = 60μC
V23 = V2 + V3 = 10V
Q23 = V23 C23 = 10 * 4 = 40 μC
Q23 = Q2 = Q3 = 40 μC
V2 = Q2/C2 = 40 μ/ 6 μ = 6.67 V
V3 = Q3/C3 = 40 μ/ 12 μ = 3.33 V



P.51 C = 1000 μF , V=100V
a) Wc = ½ C V^2 = 5 J
b) Q = C V = 0.1 C
c) t = 1/2000 s , ic av = C(ΔV/Δt) = 1000μ * 100/(1/2000) = 200 A
d) P = Wc / t = 5/ (1/2000) = 10,000 W = 10KW
e) imax= 10mA
imax = C·ΔV/Δt
10 mA = 1000 μ * 100/Δt
Δt = 10 sec.