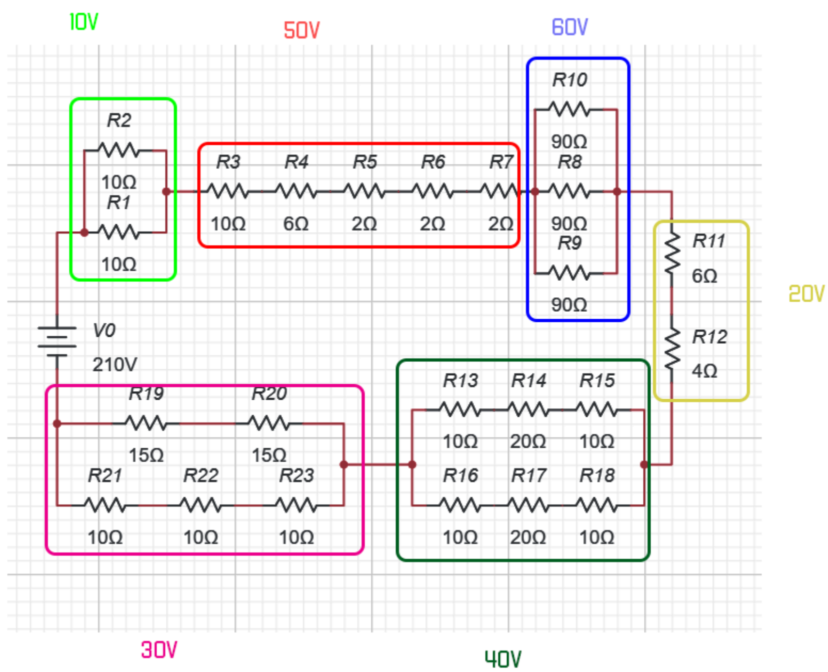
Problem 01

(a) This is just 1 of the possible solutions. Place the Loads across the Equivalent Resistances.



(b) Remove L4 from across the 40V Equivalent Resistors. Place it in parallel with L3. Keep the 40V Resistors to maintain the voltage division across the circuit.

(c) (i) $V = IR$. If Voltage decreases, then Resistance should be decreased.

(ii) No, because if we decrease R across 1 Load, it will change the overall voltage division over the circuit. The same amount of voltage is being divided across the circuit. Other loads will receive more voltage.

(iii) Use a battery with a smaller Voltage Supply.

Problem 02

(a) $i_1 = \frac{V_1}{R_1}$, $i_2 = \frac{V_2}{R_2}$, $i_3 = \frac{V_3}{R_3}$
$I_0 = i_1 + i_2 + i_3$; $I_0 = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}$
$V_1 = V_2 = V_3$

(b) We know that $i = \frac{V}{R}$, and that V is the same for all R.So, the larger the resistance R, the smaller will be the amount of current i passing through it.

(i) $i_3 > i_2 > i_1$; Green

(ii) $i_2 = i_3$, $i_2 > i_1$; Blue and Green (any shade of blue/green is acceptable)

(iii) $i_2 = i_3$, $i_3 < i_1$; Red

(iv) $i_2 = i_3$, $i_2 < i_1$; Red

(v) $i_1 = i_2 = i_3$; Red and Blue and Green = White

(c) The answers are the same. In both cases $i_2 = i_3$. If one of them is less than i_1, it means that both of them are. So, R_1 will have the largest amount of current flowing through it. The conditions are equivalent.

Problem 03

(a) Connection 3. For the first 10 seconds the potential of the two terminals rises and then becomes constant. If they were connected, then the graph would not have become constant at different values.

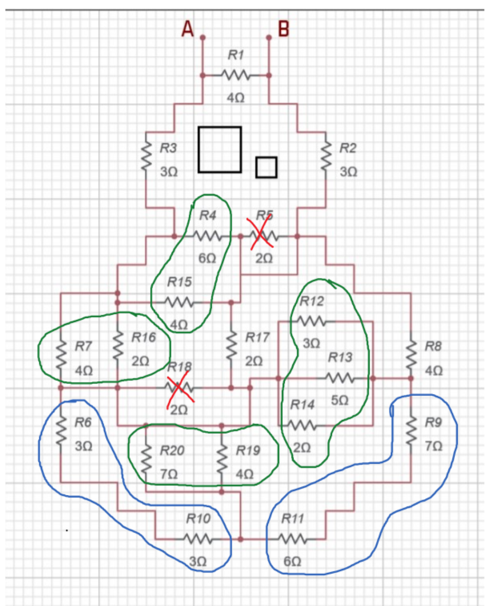
(b) The current will flow from the positive terminal of Battery 01 to terminal A and from the positive terminal of Battery 02 to terminal B.

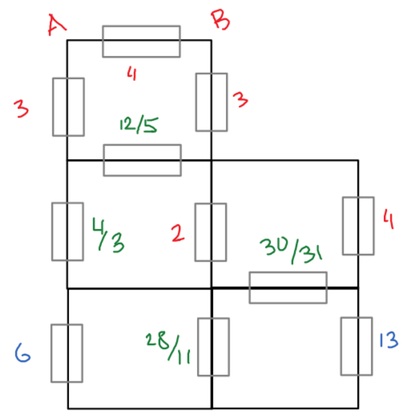
(c) $V_1 = 10V$, $V_2 = 12V$
V_1 relates to Terminal A and V_2 relates to terminal B.

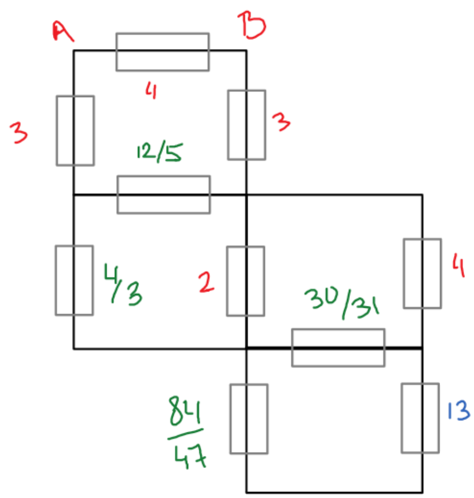
(d) **Question removed**

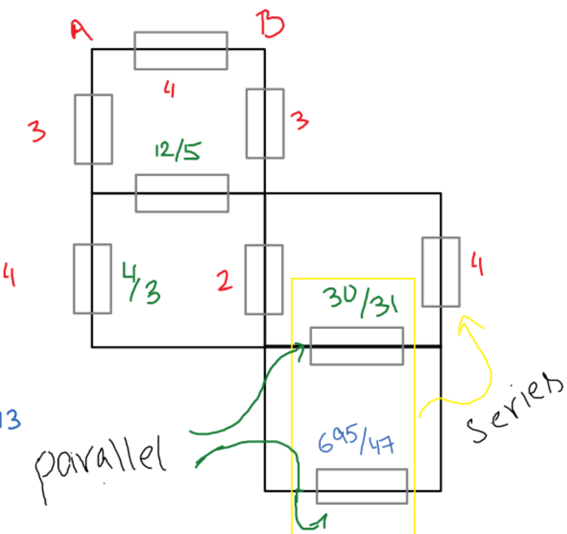
Problem 04

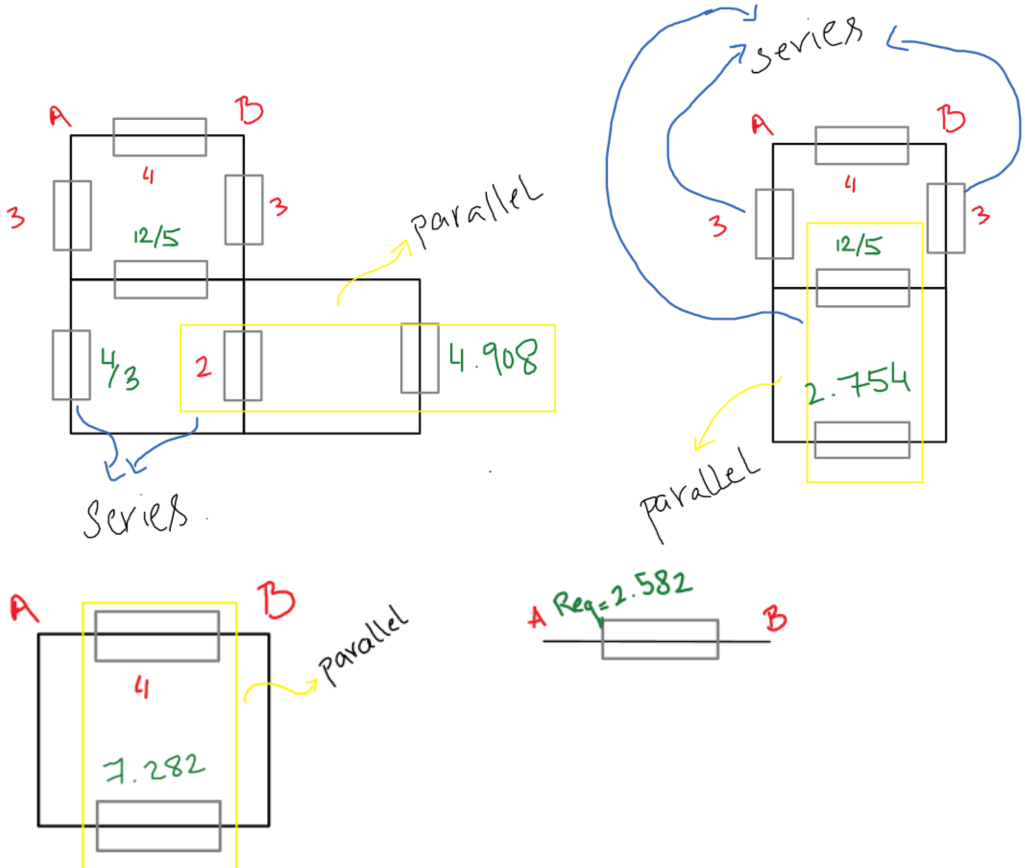
(a)


A
B
R1
4Ω
R3
3Ω
R2
3Ω
R4
6Ω
R5
2Ω
R15
4Ω
R12
3Ω
R7
4Ω
R16
2Ω
R17
2Ω
R13
5Ω
R8
4Ω
R18
2Ω
R14
2Ω
R6
3Ω
R9
7Ω
R20
7Ω
R19
4Ω
R10
3Ω
R11
6Ω


A
B
4
3
3
12/5
4/3
2
30/31
4
6
28/11
13


A
B
4
3
3
12/5
4/3
2
30/31
4
84/47
13


A
B
4
3
3
12/5
4/3
2
30/31
4
695/47
parallel
series



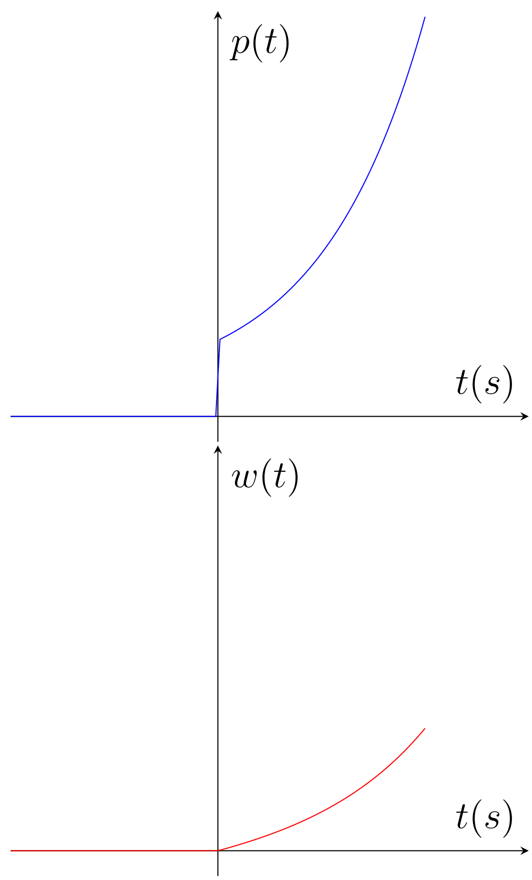
(b) Since $R_1 = 0$ will result in a short-circuit, $R_{eq} = 0$.

Problem 05

(a) $p(t) = \frac{dW}{dt} = \frac{dW}{dq}\frac{dq}{dt}$
$\frac{dW}{dq} = 6(25e^{34t} + 81 + 90e^{17t})$
$\frac{dW}{dq} = 6(5e^{17t} + 9)^2$
$p(t) = 6(5e^{17t} + 9)$

(b) $w(t) = \int_{-\infty}^{t} p(t)dt$
$w(t) = \int_{-\infty}^{t} 6(5e^{17t} + 9)dt$
$w(t) = 6[\frac{5}{17}e^{17t} - \frac{5}{17} + 9t]$

(c) $w(t)$ represents the area under the graph of $p(t)$.



Problem 06

(a) Capacitance is equal to the slope of the graph i.e. 1.5 F.

(b) $C = \frac{E_0 A}{d}$
$1.5 = 8.84 * 10^{-12} \frac{A}{d}$
$\frac{A}{d} = 1.70 * 10^{11}$
This means that perpendicular distance between the plates is $1.70 * 10^{11}$ times their cross-sectional surface area.

(c) The graph will always pass through the origin. Given the equation, $q = cV$, we can see that the y-intercept is zero.

(d) (i) $C = \frac{E_0 A}{d}$; twice its value

(ii) $E = \frac{V}{d}$; twice its value

(iii) $E = \frac{q}{AE_0}$; twice its value

Problem 07

(a) Find N using $B = \frac{\mu_0 Ni}{l}$; $N = \frac{Bl}{\mu_0 i}$
$N = \frac{1.15(4.25)(10^{-2})}{4\pi(10^{-7})(3.2*10^{-3})}$; $N = 0.1215 * 10^8$
Find A using $A = \pi r^2$
$A = \pi(0.5 * 10^{-2})^2$; $A = 0.7855 * 10^{-4} m^2$
Find L using $L = \frac{N\phi}{i}$, where $\phi = BA$
$L = \frac{(0.1215*10^8)(1.15)(0.7855*10^{-4})}{3.2*10^{-3}}$; $L = 0.3429 * 10^6 H$

(b) $t = \frac{l}{N}$; $t = \frac{4.25*10^{-2}}{0.1215*10^8}$; $t = 3.498 * 10^{-9} m$
$A = \pi r^2$; $A = \pi(\frac{3.498*10^{-9}}{2})^2$; $A = 9.61 * 10^{-18} m^2$

(c) (i) thicker/thinner

(ii) Yes. Given $t = \frac{l}{N}$,if we use a thicker/thinner wire, there will be less/greater number of loops i.e. N. The same battery cell is used so l is constant.Given $n = \frac{N}{l}$, n will decrease/increase as N will decrease/increase.

(iii) Yes.Flux ψ is directly proportional to n. If n will decrease/increase then ψ will also decrease/increase. We can conclude that a greater number of turns N leads to a larger flux ψ being induced.

(d) (i) By increasing the diameter of the solenoid, the cross-sectional area A will increase. We know that ψ is directly proportional to A. So, the flux will increase as well.

(ii) If the rest of the quantities are kept constant, then an increase in the cross-sectional area A will lead to an increase in flux ψ.

(e) current and flux-linkage

Problem 08

(a) Figure a

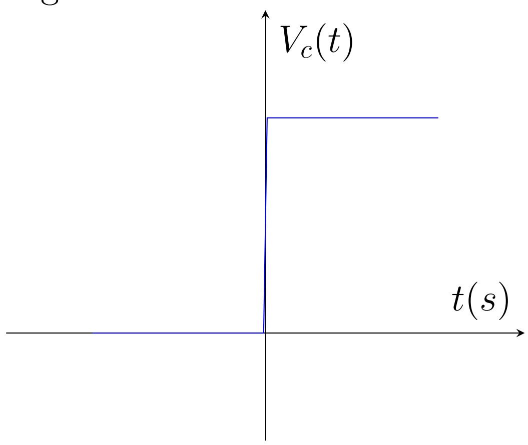
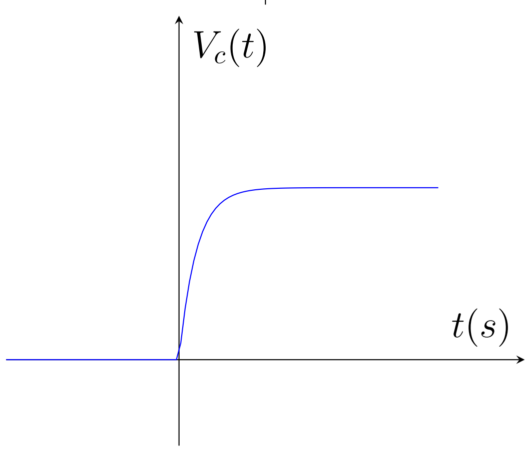


Figure b



(b) Apply $v(t) = \frac{1}{c}\int_{-\infty}^{t} i(t)dt$

$v_1(t) = 2\int_{-\infty}^{t} 0dt$; $v_1(t) = 0$

$v_2(t) = 2\int_{0}^{t} 3tdt$; $v_2(t) = 2(3\frac{t^2}{2})$; $v_2(t) = 3(t^2 - 0^2)$; $v_2(t) = 3t^2$

$v_3(t) = 2\int_{6}^{t} 18dt + 3(6^2)$; $v_3(t) = 2(18(t-6)) + 108$

$v_3(t) = 36t - 108$

$v_4(t) = 2\int_{10}^{t} -12dt + 36(10) - 108$; $v_4(t) = 2(-12(t-10)) + 252$

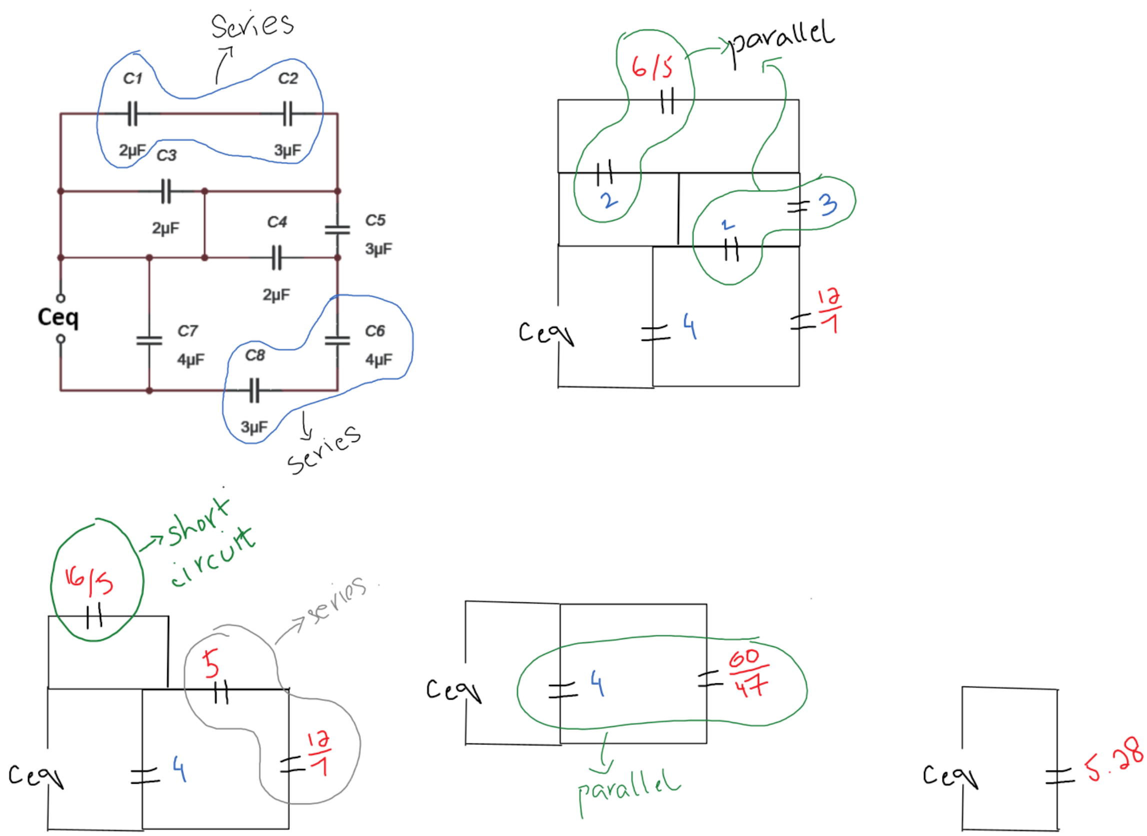
$v_4(t) = -24t + 492$

$v_5(t) = 2\int_{15}^{\infty} 0dt - 24(15) + 492$; $v_4(t) = 132$

$$V_c(t) = \begin{cases} 0 & t < 0 \\ 3t^2 & 0 \le t < 6 \\ 36t - 108 & 6 \le t < 10 \\ -24t + 492 & 10 \le t < 15 \\ 132 & 15 \le t \end{cases}$$

(c) It is for the circuit in Figure b. The voltage keeps changing and is not constant.

(d) Solving for C_{eq}



Problem 09

(a) Using $i(t) = \frac{1}{L}\int_{-\infty}^{t} v(t)dt$

$i_1(t) = (0.5 * 10^{-2})\int_{-\infty}^{t} 0dt$; $i_1(t) = 0$

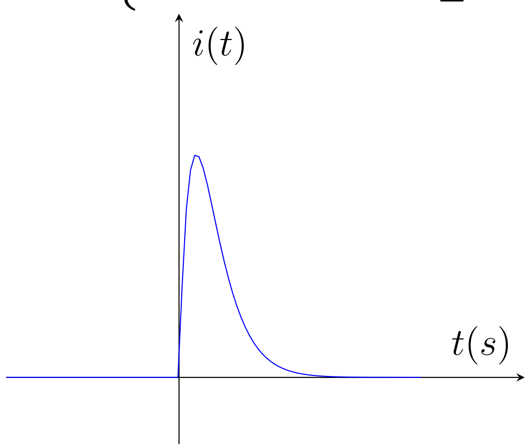
$i_2(t) = (0.5 * 10^{-2})\int_0^t (1-2t)e^{-2t}dt + 0$

$i_2(t) = (0.5 * 10^{-2})[\frac{1-2t}{-2}e^{-2t} - \int_0^t \frac{e^{-}2t}{-2}(-2)dt]$

$i_2(t) = (0.5 * 10^{-2})[\frac{1-2t}{-2}e^{-2t} - \frac{e^{-}2t}{-2}]$

$i_2(t) = 0.5 * 10^{-2}te^{-2t}$

$$i(t) = \begin{cases} 0 & t < 0 \\ 0.5 * 10^{-2}te^{-2t} & t \geq 0 \end{cases}$$



(b) (i) An inductor when connected directly to a *current* source causes instantaneous change in *current* due to the infinite presence of another *voltage*.

(ii) This cannot be true in practice. Supplying infinite voltage is not possible. We are considering an ideal inductor which provides zero resistance, which is not possible in real life application.

(c) Solving for L_{eq}