King Abdullah II School of Engineering

EE21221
Electric Circuits (1)
Section #4

Quiz #4
Tuesday 28/12/2021

Name: ……………………………………………………………….

Q.1) Sketch the voltage which develops across the terminals of a 2.5 F capacitor in response to the current waveforms that is shown in Figure Q.1. [3-Points]

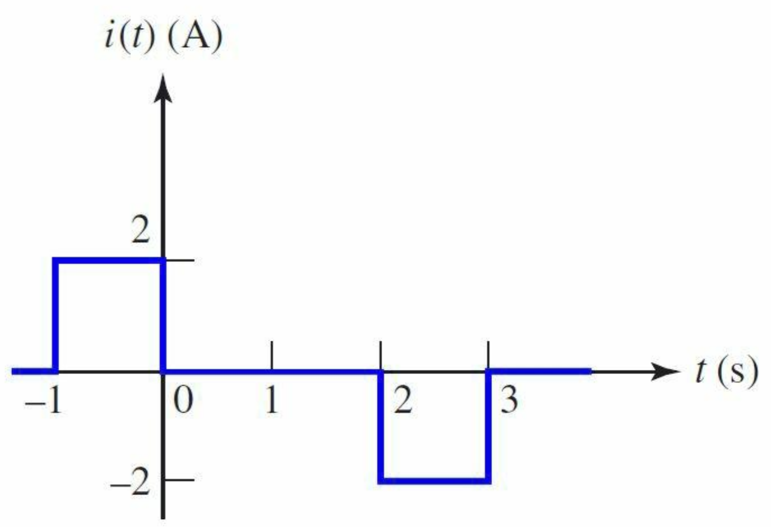
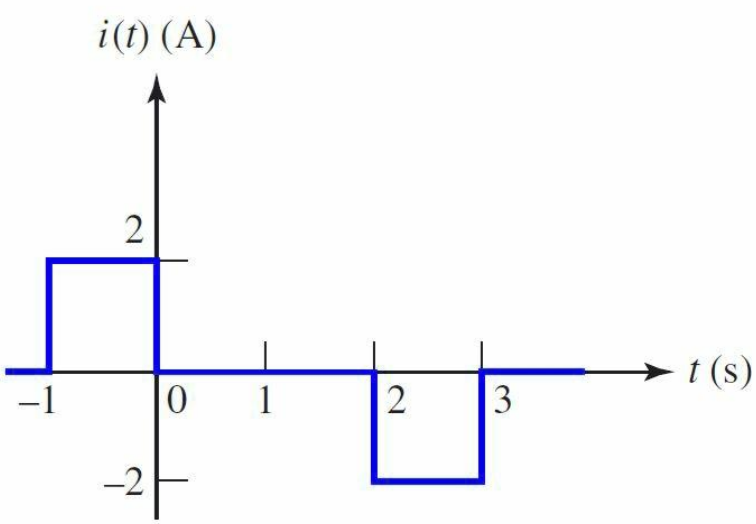
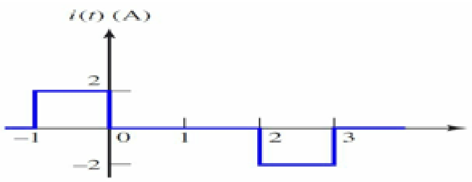


Figure Q.1

Solution:





For $0 \le t \le 2$

$$v(t) = \frac{1}{2.5}\int_0^t 0.dt + v(0) = 0.8$$

$$v(t) = 0.8 \;, 0 \le t \le 2$$

For $-\infty \le t \le -1$

$$i(t) = 0, -\infty \le t \le -1$$

$$v(t_o) = v(-\infty) = 0$$

$$v(t) = \frac{1}{2.5}\int_{-\infty}^t 0.dt + v(-\infty)$$

$$v(t) = 0, -\infty \le t \le -1$$

For $0 \le t \le 2$

$$v(t) = \frac{1}{2.5}\int_0^t 0.dt + v(0) = 0.8$$

$$v(t) = 0.8 \;, 0 \le t \le 2$$

For $2 \le t \le 3$

$$v(t) = \frac{1}{2.5}\int_2^t -2.dt + v(2)$$

$$= \frac{-2}{2.5} t|_2^t + v(2) = -0.8\,(t-2) + v(2)$$

$$v(2) = 0.8$$

$$v(t) = -0.8\,t + 2.4 \;, 2 \le t \le 3$$

For $-1 \le t \le 0$

$$i(t) = 2, -1 \le t \le 0$$

$$v = \frac{1}{2.5}\int_{-1}^t 2.dt + v(-1)$$

$$= \frac{2}{2.5} t|_{-1}^t + v(-1)$$

$$= 0.8\,(t+1) + v(-1)$$

$$v(-1) = 0$$

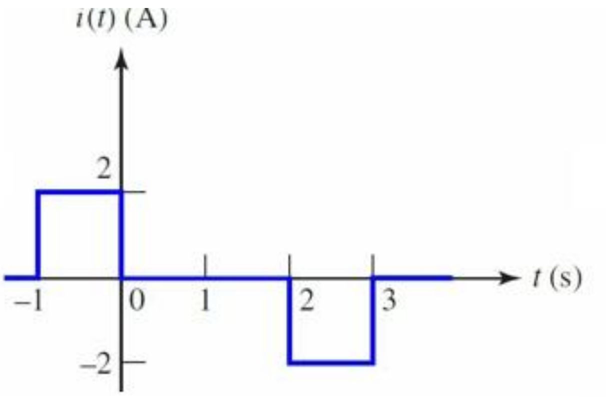
$$v(t) = 0.8\,(t+1)\,, -1 \le t \le 0$$

For $t \ge 3$

$$v(t) = \frac{1}{2.5}\int_3^t 0.dt + v(3)$$

$$v(3) = 0$$

$$v(t) = 0 \,, t \ge 3$$



$v(t) = 0, -\infty \leq t \leq -1$

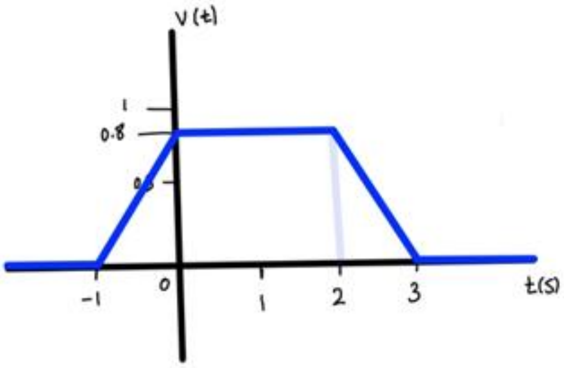
$v(t) = 0.8\,(t+1)\,, -1 \leq t \leq 0$

$\mathrm{v(t)} = -0.8\,\mathrm{t} + 2.4\ \ , 2 \leq \mathrm{t} \leq 3$

$v(t) = 0\,, t \geq 3$

$v(t) = 0.8\ \ , 0 \leq t \leq 2$

$$V(t) = \begin{cases} 0 & , \ t \leqslant -1 \\ 0.8(t+1) & , \ -1 \leqslant t \leqslant 0 \\ 0.8 & , \ 0 \leqslant t \leqslant 2 \\ -0.8t + 2.4 & , \ 2 \leqslant t \leqslant 3 \\ 0 & , \ t \geqslant 3 \end{cases}$$



Q.2) Obtain the equivalent resistance R_{ab} in the circuit shown in Figure Q.2 then use it to find i. [4-Points]

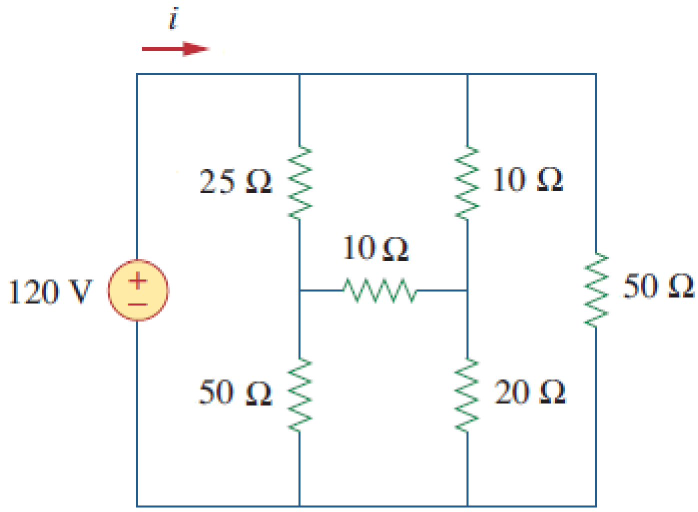
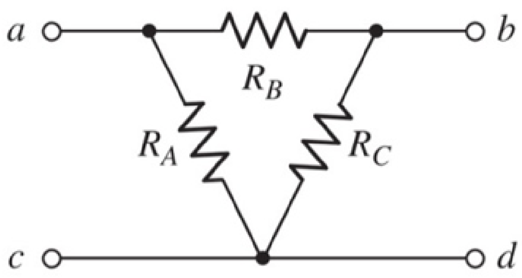
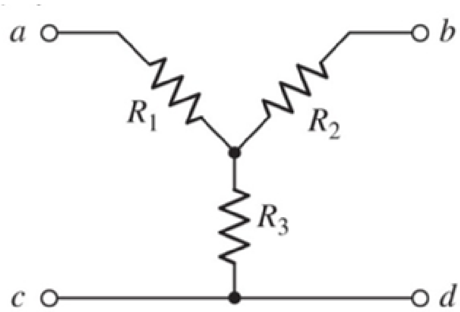


Figure Q.2



this Δ is equivalent to the Y if

$$R_A = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$
$$R_B = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$
$$R_C = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$



this Y is equivalent to the Δ if

$$R_1 = \frac{R_AR_B}{R_A + R_B + R_C}$$
$$R_2 = \frac{R_BR_C}{R_A + R_B + R_C}$$
$$R_3 = \frac{R_CR_A}{R_A + R_B + R_C}$$

Solution:

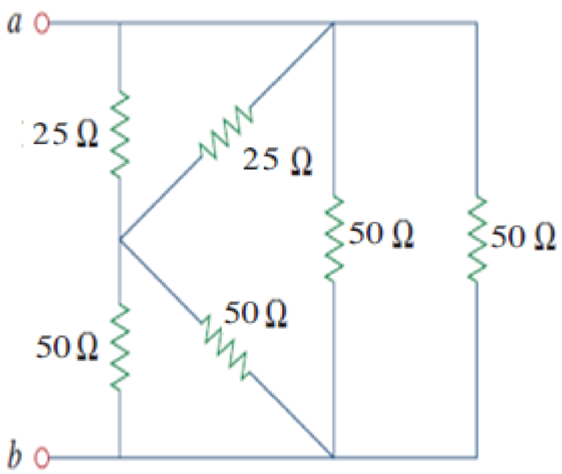
i= [ ]

R1=10 Ω, R2=20 Ω, and R3=10 Ω

Ra=500/20=25 Ω

Rb=500/10=50 Ω

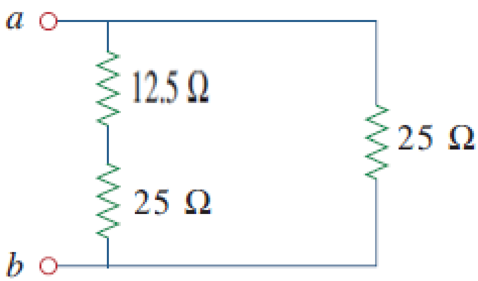
Rc=500/10=50 Ω



50//50=25Ω

25//25=12.5Ω

50//50=25Ω



12.5+25=37.5Ω

37.5//25=15 Ω

i=120/15=8A

Q.3) Obtain the energy stored in the 2 mF capacitor that is shown in Fig. Q.3 under dc conditions. [3-Points]

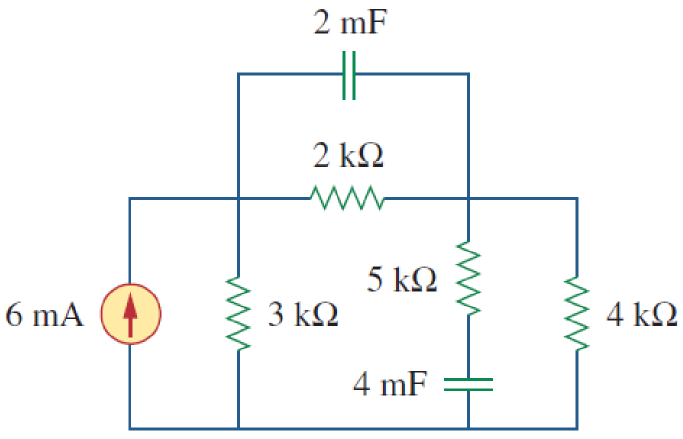
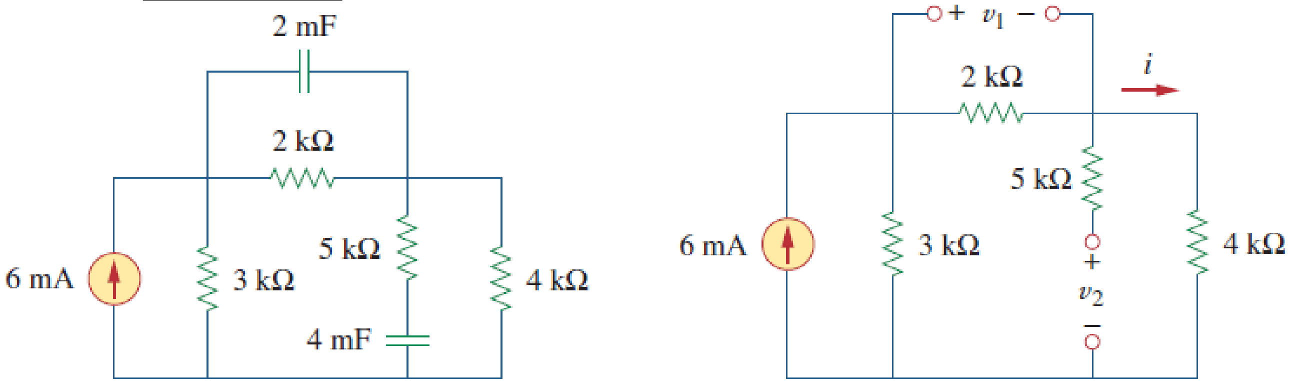


Figure Q.3

Solution:

W_{2mF}=



(a) (b)

Solution:

Under dc conditions, we replace each capacitor with an open circuit, as shown in Fig. 6.12(b). The current through the series combination of the 2-kΩ and 4-kΩ resistors is obtained by current division as

$$i = \frac{3}{3 + 2 + 4}(6 \text{ mA}) = 2 \text{ mA}$$

Hence, the voltages v_1 and v_2 across the capacitors are

$$v_1 = 2000i = 4 \text{ V} \qquad v_2 = 4000i = 8 \text{ V}$$

and the energies stored in them are

$$w_1 = \frac{1}{2}C_1 v_1^2 = \frac{1}{2}(2 \times 10^{-3})(4)^2 = 16 \text{ mJ}$$

$$w_2 = \frac{1}{2}C_2 v_2^2 = \frac{1}{2}(4 \times 10^{-3})(8)^2 = 128 \text{ mJ}$$