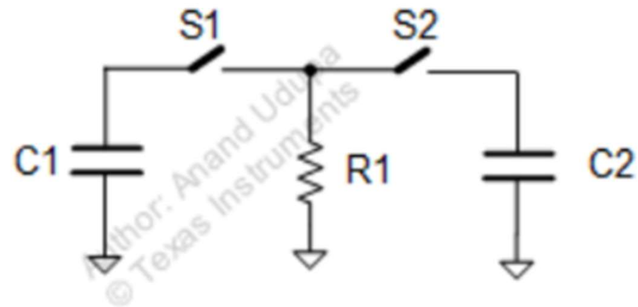
TI BYTE Simulation Exercise

Bonus Simulation Questions

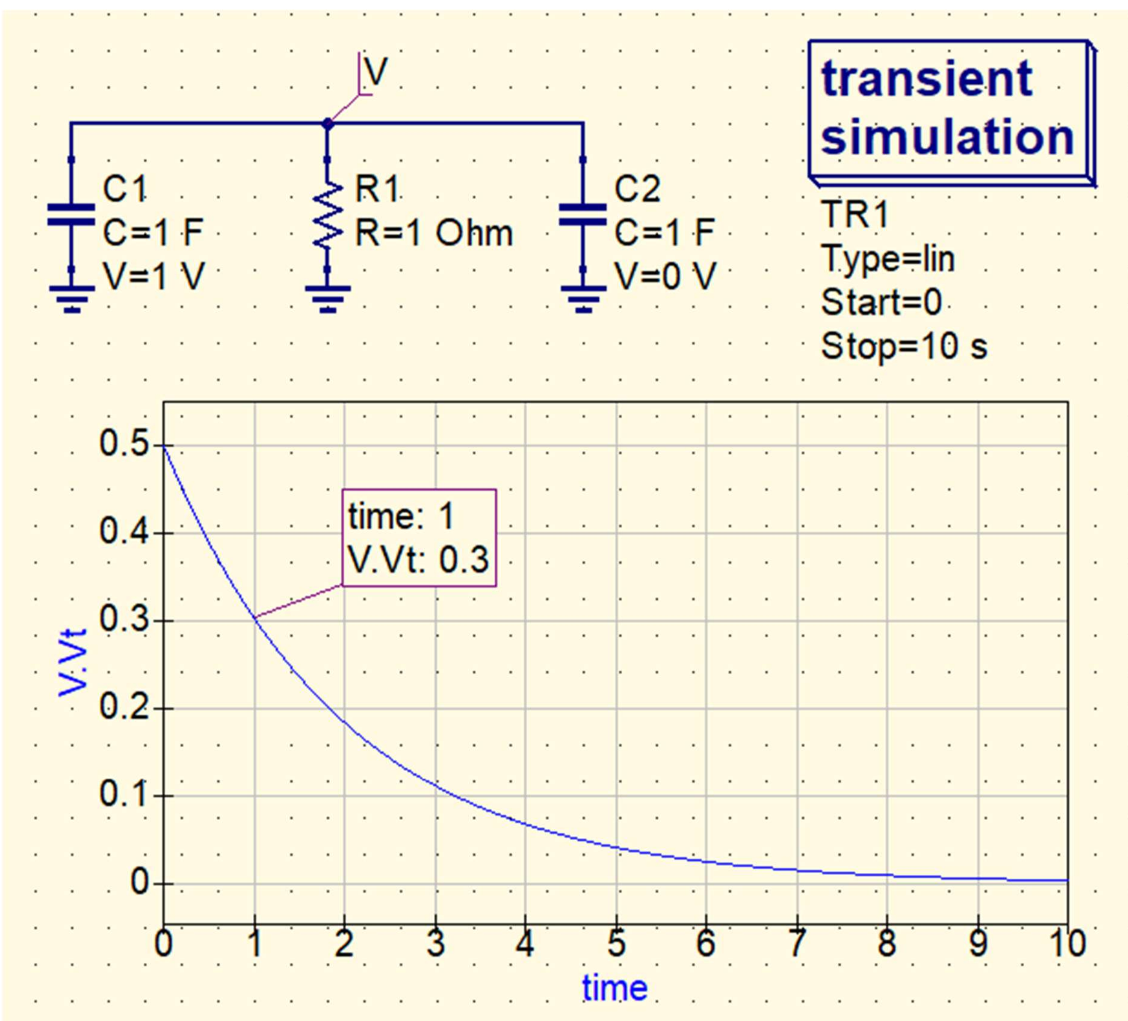
- **Question 1:**

408. C1=1F, C2=1F, R1=1Ω. Initial charge on the caps is Q1=1C, Q2=0C. Both switches are closed at t=0. The voltage across the resistor at t=1sec is:

(a) 0.5V
(b) 0.61V
(c) 0.30V
(d) 0.37V
(e) 0.07V
(f) 0V
(g) 1V
(h) 0.14V



➤ **QUCS Circuit:**



- V is used to label the node and find the voltage at that node.
- Both the capacitors are of 1F. Capacitor C2 is initially uncharged while C1 has an initial charge of 1C.
- At t = 0, since both the switches are closed, they are replaced with short-circuits.

➢ QUCS Result:

Therefore, from the simulation, we get our answer as:

At t = 1s, V = 0.30 V

Answer: (c)

➢ Conclusion:

- In the circuit, at t = 0 when the switches are closed, the capacitors share their charges. So, the common voltage of the two capacitors becomes,

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} = \frac{1 \times 1 + 1 \times 0}{1+1} = 0.5\ V$$

- Therefore, $V_i = 0.5$ V
- Now, after ample amount of time, the capacitors discharge through the resistor R1 and thus $V_f = 0$ V
- For the given circuit, $R_{eq} = 1\ \Omega$ and $C_{eq} = 2$ F.
- Therefore, the voltage eqn. of the can be written as:

$$V(t) = V_f + (V_i - V_f)e^{-t/\tau}$$

where V_f is the final voltage, V_i is the initial voltage and τ is the time constant = RC = 2 s.

- Therefore, at t = 1 s,

$$V(t) = [0+(0.5-0)e^{\frac{-1}{2}}]$$

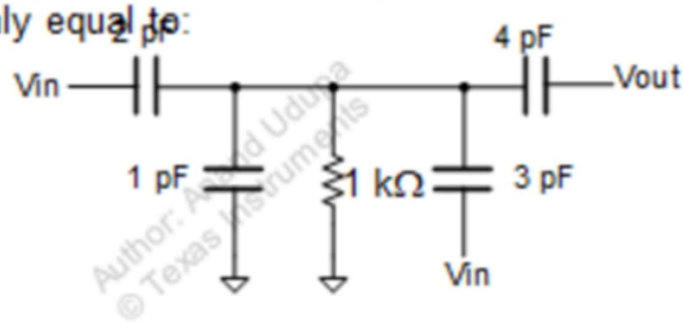
$$= 0.5e^{-0.5} = 0.303\ V \approx 0.30\ V$$

- The simulation result almost matches with our calculations.

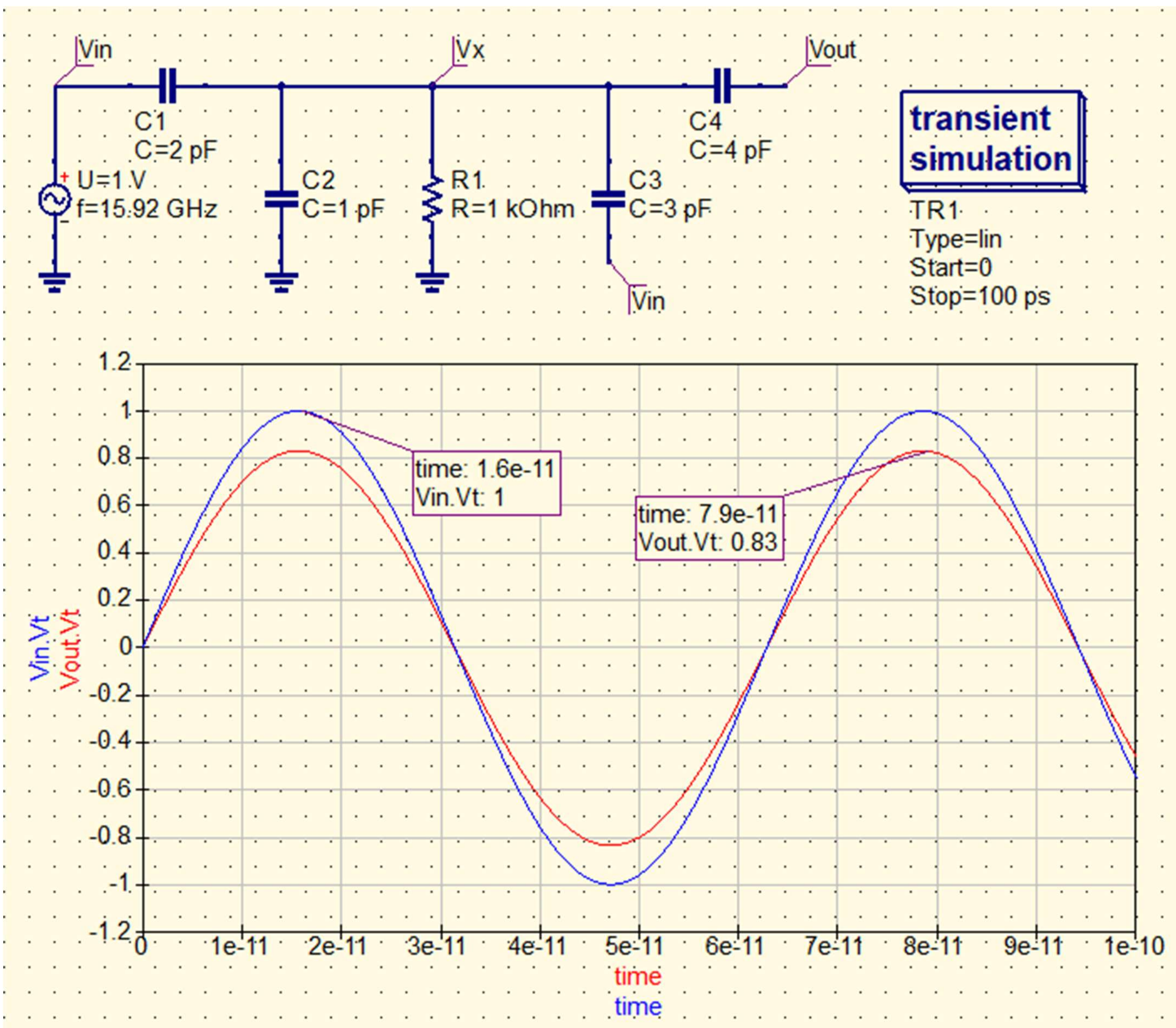
- **Question 2:**

711. A sine wave of amplitude 1V and frequency 100 Grad/s is applied at VIN. The amplitude at VOUT is roughly equal to:

(a) 1 V
(b) 0.33 V
(c) 0.5 V
(d) 0 V
(e) 0.99 V
(f) 0.25 V
(g) 0.63 V
(h) 0.83 V



➢ **QUCS Circuit:**



- V_{in} is a sinusoidal input given to the circuit with an amplitude of 1V and frequency of 100 Grad/s = 15.915 GHz
- V_{out} is used to label the output node and find the voltage at that node.
- All the capacitors are uncharged.

➢ **QUCS Result:**

Therefore, from the simulation, we get our answer as:

Amplitude of V_{out} = 0.83 V

Answer: (h)

➢ **Conclusion:**

- Given that the frequency of the input signal(ω) is 100 Grad/s,

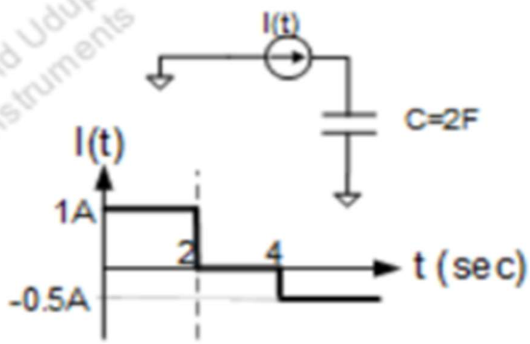
$$f = \frac{\omega}{2\pi} = 15.92\ GHz$$

- At this frequency, the 4 pF capacitor essentially acts as a short-circuit, so $V_{out} = V_x$.
- Now, the 2 pF and the 3 pF capacitors are then essentially in parallel between V_{in} and V_x. (C' = 2 pF + 3 pF = 5 pF)
- So, Vx is thus the voltage division between the 1 pF capacitor and the 5 pF capacitor.
- So, $V_{out} = V_x = \frac{5\ pF}{1\ pF + 5\ pF} \times V_{in} = {}^{5}/_{6}\,V = 0.8333\,V \approx 0.83\,V$
- The simulation result almost matches with our calculations.

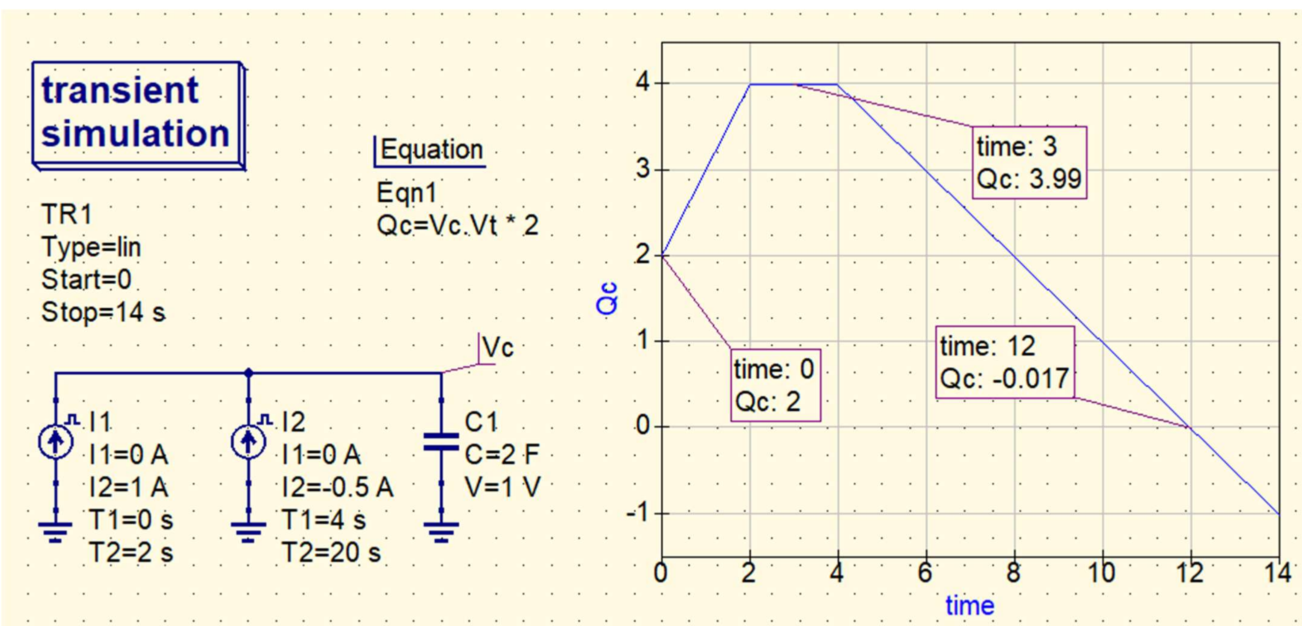
- ## Question 3:

109. A 2F cap has an initial charge of 2C at t=0. It is charged by a current source of value 1A for 2sec. The current source becomes 0A for the next 2sec. Then, the current source switches polarity and its value becomes -0.5A. At what time does charge on the capacitor become 0C?

(a) t=4sec
(b) t=6sec
(c) t=8sec
(d) t=10sec
(e) t=12sec
(f) t=16sec
(g) t=20sec
(h) Never



➢ QUCS Circuit:



- V_c is used to label the node and find the voltage at that node.
- The capacitor has an initial charge of 2C.
- The two current DC sources are used to implement the given current waveform. They are thus used to charge and discharge the capacitor.

➢ QUCS Result:

Therefore, from the simulation, we get our answer as:

At time t = 12 sec, the charge on the capacitor become 0C.

Answer: (e)

➢ Conclusion:

- The capacitor has an initial charge of 2C.
- For 2 sec, it is charged using a 1A current source. Thus, the total charge delivered to the capacitor = 1A × 2 s = 2C.
- So, the final charge on the capacitor after t = 2 sec, Q_c = 2C + 2C = 4C
- Since the current from t = 2 sec to t = 4 sec is zero, no further charge is delivered to the capacitor and it remains the same.
- After t = 4 sec, the current becomes -0.5 A. Thus, the capacitor begins to discharge.
- The total time required by the capacitor to discharge with the -0.5A current source is,

$$\Delta t = \frac{Q_c}{I} = \frac{4\ C}{0.5\ A} = 8\ s$$

- So, the final time when the capacitor charge becomes 0 is,

$$T = t + \Delta t = 4\ s + 8\ s = 12\ s$$

- The simulation result almost matches with our calculations.