RC Circuit Step Response I

Find the differential equation that describes the circuit below:

\[ \frac{1}{1\Omega} u(t) + \frac{1}{2\Omega} y(t) + \frac{1}{1F} e_1 = y(t) \]

Press “1” on your PRS remote when you are finished.
The differential equation that describes the circuit is

\[ \frac{d}{dt} e_1(t) + 1.5e_1(t) = u(t) \]

My answer

1. Was completely correct
2. Was mostly correct, with one or two minor errors
3. Had many errors
4. Was completely incorrect
Limits of Integration

The system $G$ has impulse response

$$g(t) = e^{-1.5t} \sigma(t)$$

If the input to the system is

$$u(t) = e^{-t} \sigma(t)$$

the output can be found using the convolution integral as

$$y(t) = \int_{-\infty}^{\infty} g(t - \tau) u(\tau) d\tau$$

$$= \int_{-\infty}^{\infty} e^{-1.5(t-\tau)} \sigma(t - \tau) e^{-\tau} \sigma(\tau) d\tau$$

$$= \int_{-\infty}^{?} e^{-1.5(t-\tau)} e^{-\tau} d\tau$$

What should the limits of integration be if $t > 0$?
Limits of Integration I

In the integral,

\[ y(t) = \int_{-\infty}^{\infty} e^{-1.5(t-\tau)} \sigma(t - \tau) e^{-\tau} \sigma(\tau) \, d\tau \]

= \int_{?}^{?} e^{-1.5(t-\tau)} e^{-\tau} \, d\tau

what should the limits of integration be if \( t > 0 \)?

1. \( \int_{-\infty}^{\infty} \)
2. \( \int_{-\infty}^{t} \)
3. \( \int_{t}^{\infty} \)
4. \( \int_{0}^{\infty} \)
5. \( \int_{0}^{t} \)
6. \( \int_{-\infty}^{0} \)
7. \( \int_{0}^{0} \)
Limits of Integration I

In the integral,

\[ y(t) = \int_{-\infty}^{\infty} e^{-1.5(t-\tau)} \sigma(t - \tau) e^{-\tau} \sigma(\tau) \, d\tau \]

what should the limits of integration be if \( t > 0 \)?

The correct answer is:

1. \( \int_{-\infty}^{\infty} \)

2. \( \int_{-\infty}^{t} \)

3. \( \int_{t}^{\infty} \)

4. \( \int_{0}^{\infty} \)

5. \( \int_{0}^{t} \)

6. \( \int_{-\infty}^{0} \)

7. \( \int_{0}^{0} \)
Limits of Integration II

In the integral,

\[ y(t) = \int_{-\infty}^{\infty} e^{-1.5(t-\tau)} \sigma(t - \tau)e^{-\tau} \sigma(\tau) \, d\tau \]

\[ = \int_{?}^{?} e^{-1.5(t-\tau)} e^{-\tau} \, d\tau \]

what should the limits of integration be if \( t < 0 \)?

1. \( \int_{-\infty}^{\infty} \)
2. \( \int_{-\infty}^{t} \)
3. \( \int_{t}^{\infty} \)
4. \( \int_{0}^{\infty} \)
5. \( \int_{0}^{t} \)
6. \( \int_{-\infty}^{0} \)
7. \( \int_{0}^{0} \)
Limits of Integration II

In the integral,

\[ y(t) = \int_{-\infty}^{\infty} e^{-1.5(t-\tau)} \sigma(t - \tau)e^{-\tau} \sigma(\tau) \, d\tau \]

\[ = \int_{?}^{?} e^{-1.5(t-\tau)} e^{-\tau} \, d\tau \]

what should the limits of integration be if \( t < 0 \)?

The correct answer is:

1. \( \int_{-\infty}^{\infty} \)

2. \( \int_{-\infty}^{t} \)

3. \( \int_{t}^{\infty} \)

4. \( \int_{0}^{\infty} \)

5. \( \int_{0}^{t} \)

6. \( \int_{-\infty}^{0} \)

7. \( \heartsuit \int_{0}^{0} \)