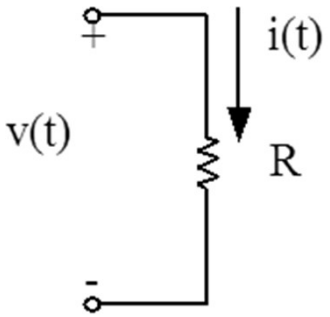
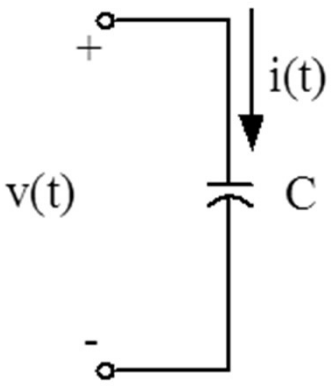
# Resistor's Laplace Impedance




$$v_R(t) =$$

$$Z_R(s) =$$

# Capacitor's Laplace Impedance




$i_C(t) =$

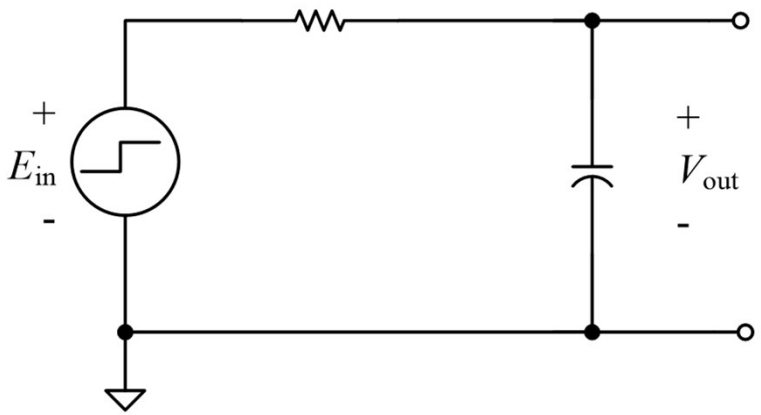
**TABLE A-1** *(continued)*

| No. | $F(S)$ | |
|---|---|---|
| 7. | $\frac{As}{s^2+\omega^2}$ | $A\cos\omega t$ |
| 8. | $aF(s)$ | $af(t)$ |
| 9. | $\frac{n!}{s^{n+1}}$ | $t^n$ |
| 10. | $sF(s)-f(0)$ | $\frac{df(t)}{dt}$ |
| 11. | $s^2F(s)-sf(0)-\frac{df(0)}{dt}$ | $\frac{d^2f(t)}{dt^2}$ |
| 12. | $\frac{F(s)}{s}$ | $\int f(t)\,dt$ |
| 13a. | $\frac{A}{\tau s+1}$ | $\frac{A}{\tau}e^{-t/\tau}$ |
| 13b. | $\frac{A}{s+a}$ | $Ae^{-at}$ |
| 14a. | $\frac{A}{}$ | $\frac{A}{}$ |

$Z_C(s) =$

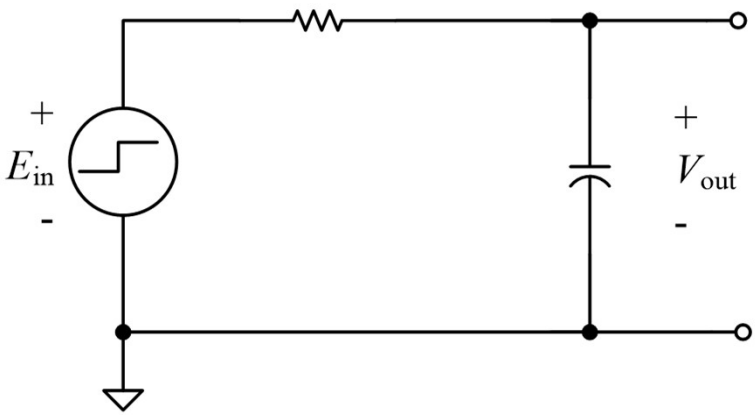
# RC Circuit – Transfer Function

$V_{\text{out}}(s) =$




$$\frac{V_{\text{out}}(s)}{E_{\text{in}}(s)} =$$

# RC Circuit – Response to 5 V step



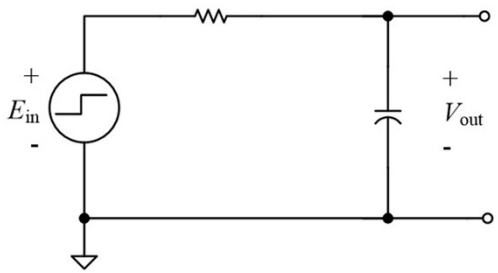

$$\frac{V_{out}(s)}{E_{in}(s)} =$$

$$V_{out} =$$

$$E_{in\ step} =$$

**TABLE A-1** LAPLACE TRANSFORMS

| No. | $F(S)$ | $f(t)$ | Comments |
|---|---|---|---|
| 1. | 1 | $\delta(t)$ | Unit impulse |
| 2. | $\frac{A}{s}$ | $A(t) = \begin{cases} 0 & t < 0 \\ A & t \geq 0 \end{cases}$ | Step |
| 3. | $\frac{1}{s}$ | $U(t) = \begin{cases} 0 & t < 0 \\ 1 & t \geq 0 \end{cases}$ | Unit step |
| 4. | $\frac{A}{s^2}$ | $At$ | Ramp |
| 5. | $\frac{2A}{s^3}$ | $At^2$ | Parabola |
| 6. | $\frac{A\omega}{s^2 + \omega^2}$ | $A \sin \omega t$ | Sine |




# RC Circuit – Response to 5 V step

$$V_{out}(s) =$$

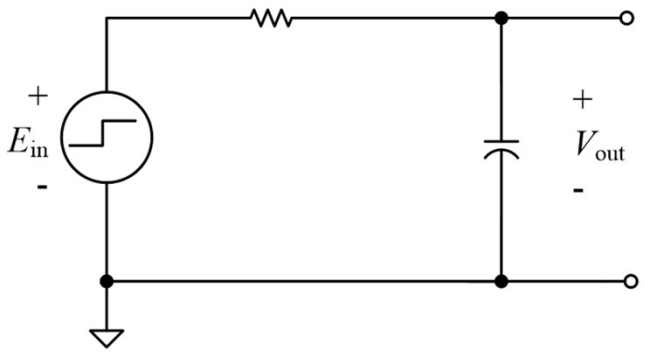
**TABLE A-1** *(continued)*

| No. | $F(S)$ | $f(t)$ | Comments |
|---|---|---|---|
| 7. | $\frac{As}{s^2+\omega^2}$ | $A\cos\omega t$ | Cosine |
| 8. | $aF(s)$ | $af(t)$ | |
| 9. | $\frac{n!}{s^{n+1}}$ | $t^n$ | |
| 10. | $sF(s)-f(0)$ | $\frac{df(t)}{dt}$ | |
| 11. | $s^2F(s)-sf(0)-\frac{df(0)}{dt}$ | $\frac{d^2f(t)}{dt^2}$ | |
| 12. | $\frac{F(s)}{s}$ | $\int f(t)\,dt$ | |
| 13a. | $\frac{A}{\tau s+1}$ | $\frac{A}{\tau}e^{-t/\tau}$ | Free response of first-order system |
| 13b. | $\frac{A}{s+a}$ | $Ae^{-at}$ | |
| 14a. | $\frac{A}{(\tau_1 s+1)(\tau_2 s+1)}$ | $\frac{A}{\tau_1-\tau_2}(e^{-t/\tau_1}-e^{-t/\tau_2})$ | Free response of second-order system ($\xi>1$) |
| 14b. | $\frac{A}{(s+a)(s+b)}$ | $\frac{A}{b-a}(e^{-at}-e^{-bt})$ | |
| 15a. | $\frac{A}{(\tau s+1)^2}$ | $\frac{At}{\tau^2}e^{-t/\tau}$ | Free response of second-order system ($\xi=1$) |
| 15b. | $\frac{A}{(s+a)^2}$ | $Ate^{-at}$ | |
| 16. | $\frac{A\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$ | $\frac{A\omega_n e^{-\zeta\omega_n t}}{\sqrt{1-\zeta^2}}\sin(\omega_n\sqrt{1-\zeta^2}t)$ | Second-order system, free response ($\xi<1$) |
| 17a. | $\frac{A}{s(\tau s+1)}$ | $A(1-e^{-t/\tau})$ | First-order system response to a step input |
| 17b. | $\frac{A}{s(s+a)}$ | $\frac{A}{a}(1-e^{-at})$ | |
| 18a. | $\frac{A}{s^2(\tau s+1)}$ | $A\tau\left(e^{-t/\tau}+\frac{t}{\tau}-1\right)$ | First-order system response to a ramp input |
| 18b. | $\frac{A}{s^2(s+a)}$ | $\frac{A}{a^2}(e^{-at}+at-1)$ | |

$$V_{out}(t) =$$

$$V_{out}(t=0+) =$$

$$V_{out}(t\to\infty) =$$




# RC Circuit – Response to 5 V step

$$V_{out}(s) =$$

$$V_{out}(t) =$$

```
clc
clear

s=tf('s')
R=
C=
tau=
Ein=


G=
Vout=

ltiview(Vout)
```

**TABLE A-1** LAPLACE TRANSFORMS

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| 3. | $\frac{1}{s}$ | $U(t) = \begin{cases} 0 & t < 0 \\ 1 & t \geq 0 \end{cases}$ | Unit step |