

## APPENDIX PRELIMINARIES

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#### C-0. APPENDIX PRELIMINARIES

# Laplace Transform F(s)Time Function f(t)1 Unit-impulse function $\delta(t)$ $\frac{1}{s}$ Unit-step function $u_s(t)$ 1 Unit-ramp function t $\overline{s^2}$ $t^n(n = positive integer)$ $\overline{S^{n+1}}$ $e^{-\alpha t}$ $te^{-\alpha t}$ $\frac{n!}{\left(s+\alpha\right)^{n+1}}$ $t^n e^{-\alpha t}$ (n = positive integer) $rac{1}{\left( s+lpha ight) \left( s+eta ight) }$ $rac{1}{eta-lpha}ig(e^{-lpha t}-e^{-eta t}ig)\,(lpha eqeta)$ $rac{1}{eta-lpha}ig(eta e^{-eta t}-lpha e^{-lpha t}ig)\,(a eqeta)$ $\frac{1}{s\left(s+\alpha\right)}$ $\frac{1}{\alpha} (1 - e^{-\alpha t})$ $rac{1}{s{(s+lpha)}^2}$ $\frac{1}{\alpha^2} \left(1 - e^{-\alpha t} - \alpha t e^{-\alpha t}\right)$ $rac{1}{s^{2}\left( s+lpha ight) }$ $\frac{1}{\alpha^2} (\alpha t - 1 + e^{-\alpha t})$ $\frac{1}{s^2(s+lpha)^2}$ $rac{1}{lpha^2}iggl[t-rac{2}{lpha}+\left(t+rac{2}{lpha} ight)e^{-lpha t}iggr]$ $\frac{s}{\left(s+lpha ight)^2}$ $(1-\alpha t)e^{-\alpha t}$

### Laplace Transform F(s)

### Time Function f(t)

$\frac{\omega_n}{s^2+\omega_n^2}$	$\sin \omega_n t$
$\frac{s}{s^2+\omega_n^2}$	$\cos \omega_n t$
$rac{\omega_n^2}{s\left(s^2+\omega_n^2 ight)}$	$1-\cos\omega_n t$
$rac{\omega_{n}^{2}\left(s+lpha ight)}{s^{2}+\omega_{n}^{2}}$	$\omega_n \sqrt{lpha^2 + \omega_n^2} \sin{(\omega_n t +  heta)} \  ext{where} \  heta =  an^{-1} \left( \omega_n / lpha  ight)$
$\dfrac{\omega_n}{\left(s+lpha ight)\left(s^2+\omega_n^2 ight)}$	$rac{\omega_n}{lpha^2+\omega_n^2}e^{-lpha t}+rac{1}{\sqrt{lpha^2}+\omega_n^2}\sin{(\omega_n t- heta)} \  ext{where}\  heta= an^{-1}\left(\omega_n/lpha ight)$
$\frac{\omega_n^2}{s^2+2\zeta\omega_ns+\omega_n^2}$	$rac{\omega_n}{\sqrt{1-\zeta^2}}e^{-\zeta\omega_n t}\sin\omega_n\sqrt{1-\zeta^2 t}\left(\zeta<1 ight)$
$rac{\omega_{n}^{2}}{s\left(s^{2}+2\zeta\omega_{n}s+\omega_{n}^{2} ight)}$	$1-rac{1}{\sqrt{1-\zeta^2}}e^{-\zeta\omega_n t}\sin\left(\omega_n\sqrt{1-\zeta^2}t+ heta ight) \  ext{where }  heta=\cos^{-1}\zeta\left(\zeta<1 ight)$
$\frac{s\omega_n^2}{s^2+2\zeta\omega_ns+\omega_n^2}$	$rac{-\omega_n^2}{\sqrt{1-\zeta^2}}e^{-\zeta\omega_n t}\sin\left(\omega_n\sqrt{1-\zeta^2}t- heta ight) \  ext{where }  heta=\cos^{-1}\zeta\left(\zeta<1 ight)$
$rac{\omega_{n}^{2}\left( s+lpha ight) }{s^{2}+2\zeta\omega_{n}s+\omega_{n}^{2}}$	$\omega_n\sqrt{rac{lpha^2-2lpha\zeta\omega_n+\omega_n^2}{1-\zeta^2}}e^{-\zeta\omega_n t}\sin\left(\omega_n\sqrt{1-\zeta^2}t+ heta ight) \  ext{where }  heta= an^{-1}rac{\omega_n\sqrt{1-\zeta^2}}{lpha-\zeta\omega_n}(\zeta<1)$
$rac{\omega_n^2}{s^2\left(s^2+2\zeta\omega_ns+\omega_n^2 ight)}$	$t-rac{2\zeta}{\omega_n}+rac{1}{\omega_n\sqrt{1-\zeta^2}}e^{-\zeta\omega_n t}\sin\left(\omega_n\sqrt{1-\zeta^2}t+ heta ight) \  ext{where }  heta=\cos^{-1}\left(2\zeta^2-1 ight)(\zeta<1)$

#### Citation

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