$$L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + q\frac{1}{C} = E(t)$$

If $R \neq 0$ then $q_c(t)$ is transient

$E(t)$ is cos, sin, $c \to q_p(t)$ is steady-state

D^n; x^{n-1}

$(D-\alpha)^n$; $x^{n-1}e^{\alpha x}$

$[D^2 - 2\alpha D + \alpha^2 + \beta^2]^n$; $x^{n-1}e^{\alpha x}\cos\beta x$

$f(t)$	$F(s)$
1	$\frac{1}{s}$
t^n	$\frac{n!}{s^{n+1}}$
$t^{-\frac{1}{2}}$	$\sqrt{\frac{\pi}{s}}$
$t^{\frac{1}{2}}$	$\frac{\sqrt{\pi}}{2s^{\frac{3}{2}}}$
$\sin(kt)$	$\frac{k}{s^2+k^2}$
$\cos(kt)$	$\frac{s}{s^2+k^2}$
$\sin^2(kt)$	$\frac{2k^2}{s(s^2+4k^2)}$
$\cos^2(kt)$	$\frac{s^2+2k^2}{s(s^2+4k^2)}$
e^{at}	$\frac{1}{s-a}$
$\sinh(kt)$	$\frac{k}{s^2-k^2}$
$\cosh(kt)$	$\frac{s}{s^2-k^2}$
$\sinh^2(kt)$	$\frac{2k^2}{s(s^2-4k^2)}$
$\cosh^2(kt)$	$\frac{s^2-2k^2}{s(s^2-4k^2)}$
$t\sin(kt)$	$\frac{2ks}{(s^2+k^2)^2}$
$t\cos(kt)$	$\frac{s^2-k^2}{(s^2+k^2)^2}$
$\sin(kt)+kt\cos(kt)$	$\frac{2ks^2}{(s^2+k^2)^2}$
$\sin(kt)-kt\cos(kt)$	$\frac{2k^3}{(s^2+k^2)^2}$
$\delta(t-t_0)$	e^{-st_0}

$f(t)$	$F(s)$
$t\sinh(kt)$	$\frac{2ks}{(s^2-k^2)^2}$
$t\cosh(kt)$	$\frac{s^2+k^2}{(s^2-k^2)^2}$
$\frac{e^{at}-e^{bt}}{a-b}$	$\frac{1}{(s-a)(s-b)}$
$\frac{ae^{at}-be^{bt}}{a-b}$	$\frac{s}{(s-a)(s-b)}$
$1-\cos(kt)$	$\frac{k^2}{s(s^2+k^2)}$
$kt-\sin(kt)$	$\frac{k^3}{s^2(s^2+k^2)}$
$\frac{a\sin(bt)-b\sin(at)}{ab(a^2-b^2)}$	$\frac{1}{(s^2+a^2)(s^2+b^2)}$
$\frac{\cos(bt)-\cos(at)}{a^2-b^2}$	$\frac{s}{(s^2+a^2)(s^2+b^2)}$
$\sin(kt)\sinh(kt)$	$\frac{2k^2s}{s^4+4k^4}$
$\sin(kt)\cosh(kt)$	$\frac{k(s^2+2k^2)}{s^4+4k^4}$
$\cos(kt)\sinh(kt)$	$\frac{k(s^2-2k^2)}{s^4+4k^4}$
$\cos(kt)\cosh(kt)$	$\frac{s^3}{s^4+4k^4}$
$\frac{e^{bt}-e^{at}}{t}$	$\ln\left(\frac{s-a}{s-b}\right)$
$e^{at}f(t)$	$F(s-a)$
$\mathcal{U}(t-a)$	$\frac{e^{-as}}{s}$
$f(t-a)\mathcal{U}(t-a)$	$e^{-as}F(s)$
$f*g=\int_0^t f(\tau)g(t-\tau)\,d\tau$	$F(s)G(s)$
$g(t)\mathcal{U}(t-a)$	$e^{-as}\mathcal{L}\{g(t+a)\}$

$$\begin{aligned}\lambda^2-\omega^2 &> 0\\ m_{1,2} &= -\lambda \pm \sqrt{\lambda^2-\omega^2}\\ x(t) &= e^{-\lambda t}\left(c_1 e^{\sqrt{\lambda^2-\omega^2}t} + c_2 e^{-\sqrt{\lambda^2-\omega^2}}\right)\end{aligned}$$

$$\begin{aligned}\lambda^2-\omega^2 &= 0\\ m_{1,2} &= 0\\ x(t) &= e^{-\lambda t}(c_1+c_2t)\end{aligned}$$

$$\begin{aligned}F &= kx\\ m\frac{d^2x}{dt^2}+2\lambda\frac{dx}{dt}+\omega^2x &= f(t)\\ \lambda^2-\omega^2 &< 0\\ m_{1,2} &= -\lambda \pm \sqrt{\omega^2-\lambda^2}i\\ A &= \sqrt{\omega^2-\lambda^2}\\ x(t) &= e^{-\lambda t}\left(c_1\cos At + c_2\sin At\right)\end{aligned}$$

$$\begin{aligned}W &= mg\\ \text{Spring Parallel: } k_eff &= k_1+k_2\\ \text{Spring Series: } k_eff &= \frac{k_1k_2}{k_1+k_2}\\ \frac{d^2x}{dt^2}+\omega^2x &= 0\\ x(t) &= c_1\cos\omega t + c_2\sin\omega t\\ &= A\sin(\omega t+\phi)\end{aligned}$$

Given $a_2(x)\frac{d^2y}{dx^2}+a_1(x)\frac{dy}{dx}+a_0(x)y=0$
Has radius of convergence given by distance
from analysis point to roots of $a_2(x)$

$$\begin{aligned}y &= \sum_{n=0} c_nx^n\\ y' &= \sum_{n=1} nc_nx^{n-1}\\ y'' &= \sum_{n=2} n(n-1)c_nx^{n-2}\end{aligned}$$

$$\begin{aligned}k_1 &= f(x,y)\\ k_2 &= f\left(x+\frac{h}{2}, y+\frac{h\cdot k_1}{2}\right)\\ k_3 &= f\left(x+\frac{h}{2}, y+\frac{h\cdot k_2}{2}\right)\\ k_4 &= f(x+h, y+h\cdot k_3)\\ RK4 &= y+h\left(\frac{k_1}{6}+\frac{k_2}{3}+\frac{k_3}{3}+\frac{k_4}{6}\right)\\ O(h^n) &= y^{(n)}(c)\frac{h^n}{n!}\end{aligned}$$

$O(h^4)$ for global truncation on $RK4$
$O(h^5)$ for local truncation on $RK4$

Even if $f(-x)=f(x)$
Even = Cosine Series

$$\begin{aligned}f(x) &= \frac{a_0}{2}+\sum_{n=1}^{\infty} a_n\cos\frac{n\pi}{p}x\\ a_0 &= \frac{2}{p}\int_0^p f(x)\,dx\\ a_n &= \frac{2}{p}\int_0^p f(x)\cos\frac{n\pi}{p}x\,dx\\ b_n &= 0\end{aligned}$$

Odd if $f(-x)=-f(x)$
Odd = Sine Series

$$\begin{aligned}f(x) &= \sum_{n=1}^{\infty} b_n\sin\frac{n\pi}{p}x\\ a_0 &= 0\\ a_n &= 0\\ b_n &= \frac{2}{p}\int_0^p f(x)\sin\frac{n\pi}{p}x\,dx\end{aligned}$$

Good luck. May the +c be with you.