Good luck. May the +c be with you.

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

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

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

$$\frac{d^2x}{dt^2} + \frac{\beta}{m}\frac{dx}{dt} + \frac{k}{m}x = f(t)$$

$$2\lambda = \frac{\beta}{m} \text{ and } \omega^2 = \frac{k}{m}$$

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

$$\lambda^2 - \omega^2 = 0$$
$$m_{1,2} = 0$$
$$x(t) = e^{-\lambda t}(c_1 + c_2 t)$$

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

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

$$\text{Given } a_2(x)\frac{d^2y}{dx^2} + a_1(x)\frac{dy}{dx} + a_0(x)y = 0$$

Has radius of convergence given by distance from analysis point to roots of $a_2(x)$

$$y = \sum_{n=0} c_n x^n$$
$$y' = \sum_{n=1} n c_n x^{n-1}$$
$$y'' = \sum_{n=2} n(n-1) c_n x^{n-2}$$

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

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

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

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

Even = Cosine Series

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

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

Odd = Sine Series

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