```
(%i1) kill(all);
```
(%o0) *done*

1 Eq. (1)

1.1 with variable omega(u)

```
(%i1) depends([u,r],phi);
```
(%o1) $[u(\varphi), r(\varphi)]$

```
(%i2) E1: diff(u,phi,2)+u=omega(u)/(1+epsilon*cos(phi));
```
(%o2) $$\frac{d^2}{d\varphi^2}u+u=\frac{\omega(u)}{\epsilon\cos(\varphi)+1}$$

```
(%i3) ode2(E1,u,phi);
```
(%o3) false

1.2 with constant omega_u

```
(%i4) E1: diff(u,phi,2)+u=omega_u/(1+epsilon*cos(phi));
```
(%o4) $$\frac{d^2}{d\varphi^2}u+u=\frac{\omega_u}{\epsilon\cos(\varphi)+1}$$

```
(%i5) assume(epsilon^2-1<0);
```
(%o5) $[\epsilon^2<1]$

```
(%i6) ode2(E1,u,phi);
```
(%o6) $$u=\left(\sqrt{1-\epsilon^2}\left(2\,\omega_u\sin(\varphi)\,\mathrm{atan}\left(\frac{\sin(\varphi)}{\cos(\varphi)+1}\right)+\omega_u\cos(\varphi)\log(\epsilon\cos(\varphi)+1)\right)-2\,\omega_u\sin(\varphi)\,\mathrm{atan}\left(\frac{\sqrt{1-\epsilon^2}\sin(\varphi)}{(\epsilon+1)\cos(\varphi)+\epsilon+1}\right)\right)/\left(\epsilon\sqrt{1-\epsilon^2}\right)+\%k1\sin(\varphi)+\%k2\cos(\varphi)$$

2 Eq. (2)

```
(%i7) E2: diff(u,phi,2)+u=1/alpha*(1+omega_u/u);
```
(%o7) $$\frac{d^2}{d\varphi^2}u+u=\frac{\frac{\omega_u}{u}+1}{\alpha}$$

(%i8) `ode2(E2,u,phi);`

(%o8) $$[-\int \frac{1}{\sqrt{\frac{2\,\omega_u\,\log(u)-\alpha\,u^2+2\,u-2\,\%k1}{\alpha}}}du=\varphi+\%k2,\ \int \frac{1}{\sqrt{\frac{2\,\omega_u\,\log(u)-\alpha\,u^2+2\,u-2\,\%k1}{\alpha}}}du=\varphi+\%k2]$$

3 Eq. (5)

(%i9) `E5: diff(u,phi,2)+u=omega_u*(1-epsilon*cos(phi));`

(%o9) $$\frac{d^2}{d\,\varphi^2}\,u+u=\omega_u\,(1-\epsilon\,\cos(\varphi))$$

(%i10) `res: ode2(E5,u,phi);`

(%o10) $$u=-\frac{\epsilon^2\,\omega_u\,\varphi\,\sin(\varphi)+(\epsilon^2+1)\,\omega_u\,\cos(\varphi)-2\,\epsilon\,\omega_u}{2\,\epsilon}+\%k1\,\sin(\varphi)+\%k2\,\cos(\varphi)$$

(%i11) `res1: expand(ev(res,[phi=%pi/2, %k1=0]));`

(%o11) $$u=\omega_u-\frac{\pi\,\epsilon\,\omega_u}{4}$$