Therefore

$$\boxed{\frac{\partial u}{\partial t} + mu\frac{\partial u}{\partial \xi} + mv\frac{\partial u}{\partial \eta} + \Omega\frac{\partial u}{\partial s} - \left\{f + mn\left[v\frac{\partial}{\partial \xi}\left(\frac{1}{n}\right) - u\frac{\partial}{\partial \eta}\left(\frac{1}{m}\right)\right]\right\}v + m\frac{\partial P}{\partial \xi} = F_\xi}$$

(4.3)

The η-component of (4.2) is then

$$\frac{\partial v}{\partial t} + \left\{f + mn\left[\frac{\partial}{\partial \xi}\left(\frac{v}{n}\right) - \frac{\partial}{\partial \eta}\left(\frac{u}{m}\right)\right]\right\}u + \Omega\frac{\partial v}{\partial s} + n\frac{\partial}{\partial \eta}\left(P + \tfrac{1}{2}u^2 + \tfrac{1}{2}v^2\right) = F_\eta$$

The rotation term can be expanded as

$$mn\left[\frac{\partial}{\partial \xi}\left(\frac{v}{n}\right) - \frac{\partial}{\partial \eta}\left(\frac{u}{m}\right)\right]u = mn\left[v\frac{\partial}{\partial \xi}\left(\frac{1}{n}\right) - u\frac{\partial}{\partial \eta}\left(\frac{1}{m}\right)\right]u + mn\left[\frac{1}{n}\frac{\partial v}{\partial \xi} - \frac{1}{m}\frac{\partial u}{\partial \eta}\right]u$$

$$mu\frac{\partial v}{\partial \xi} - nu\frac{\partial u}{\partial \eta}$$

The pressure gradient term can be expanded as

$$n\frac{\partial}{\partial \eta}\left(P + \tfrac{1}{2}u^2 + \tfrac{1}{2}v^2\right) = n\frac{\partial P}{\partial \eta} + nu\frac{\partial u}{\partial \eta} + nv\frac{\partial v}{\partial \eta}$$

The η-component of (4.2) becomes

$$\frac{\partial v}{\partial t} + mu\frac{\partial v}{\partial \xi} + nv\frac{\partial v}{\partial \eta} + \Omega\frac{\partial v}{\partial s} + \left\{f + mn\left[v\frac{\partial}{\partial \xi}\left(\frac{1}{n}\right) - u\frac{\partial}{\partial \eta}\left(\frac{1}{m}\right)\right]\right\}u + n\frac{\partial P}{\partial \eta} - nu\frac{\partial u}{\partial \eta} + nv\frac{\partial u}{\partial \eta} = F_\eta$$

Therefore

$$\boxed{\frac{\partial v}{\partial t} + mu\frac{\partial v}{\partial \xi} + nv\frac{\partial v}{\partial \eta} + \Omega\frac{\partial v}{\partial s} + \left\{f + mn\left[v\frac{\partial}{\partial \xi}\left(\frac{1}{n}\right) - u\frac{\partial}{\partial \eta}\left(\frac{1}{m}\right)\right]\right\}u + n\frac{\partial P}{\partial \eta} = F_\eta}$$

(4.4)