M Ű E G Y E T E M 1 7 8 2

FLUID MECHANICS
TESTS

Attention: there might be more correct answers to the questions.

Chapter 3: Euler and Bernoulli equations

T.3.1.1 Choose the correct answer!

a, The local acceleration in a steady flow is zero everywhere.

b, The local acceleration in an unsteady flow is zero everywhere.

c, The convective acceleration in an unsteady flow is always and everywhere zero.

d, The convective acceleration is zero if all the elements of the derivate tensor are zero.

e, Total acceleration is the sum of the local and the convective acceleration vectors.

The answer is:

T.3.1.2 Find the incorrect equations!

a, $\left(\underline{\underline{D}} - \underline{\underline{D}}^T\right)\underline{v} = \underline{v} \times \mathrm{rot}\underline{v}$

b, $\underline{\underline{D}}^T\underline{v} = \mathrm{grad}\frac{\underline{v}^2}{2}$

c, $\underline{\underline{D}}^T\underline{v} = \mathrm{grad}\frac{\underline{v}^2}{2} - \underline{v} \times \mathrm{rot}\underline{v}$

d, $\left(\underline{\underline{D}} - \underline{\underline{D}}^T\right)\underline{v} = \mathrm{rot}\underline{v} \times \underline{v}$

e, $\underline{\underline{D}}\underline{v} = \mathrm{grad}\frac{\underline{v}^2}{2}$

The answer is:

T.3.2.1 The Euler equation of the form $\frac{\mathrm{d}\underline{v}}{\mathrm{d}t} = -\frac{1}{\rho}\mathrm{grad}p + \underline{g}$

a, is only valid for inviscid fluids.

b, is also valid for vortex-free flows.

c, is only valid for fluids of constant density.

d, can also be used in a rotating coordinate system.

e, is only valid for a potential field of force.

The answer is:

T.3.2.2 The Euler equation expresses that at each point of the flow domain

a, the mass inflow equals the mass outflow.

b, the force acting on a unit mass is equal to the acceleration of the mass.

c, the energy of the fluid is constant.

d, the momentum of the flow is constant.

e, None of the above are correct.

The answer is:

T.3.2.3 The terms on the right hand side of the Euler equation

a, express forces acting on a unit mass.

b, express forces acting on a unit volume.

c, express energy per unit mass.

d, express energy per unit volume.

e, express unit energy per unit weight.

The answer is:

T.3.3.1 The Bernoulli equation term $\int_1^2 \underline{v} \times \mathrm{rot}\underline{v}\mathrm{d}\underline{s}$ equals zero if

a, the velocity field is potential.

b, integration is carried out along a streamline.

c, velocity $\underline{v}$ *and* rot$\underline{v}$ *vectors are parallel to each other along the entire length of the path* d$\underline{s}$.

d, integration is carried out along a path d$\underline{s}$*, which is perpendicular to the plane defined by vectors* $\underline{v}$ *and* rot$\underline{v}$.

e, integration is carried out along a vortex line.

The answer is:

T.3.3.2 The expression of dynamic pressure is (v [m/s], p [Pa], g [N/kg], ρ [kg/m^3])

$a, \frac{\rho}{2g} v^2$

$b, \frac{p}{\rho}$

$c, \frac{\rho}{2} v^2$

$d, p\ v$

$e, \frac{v^2}{\rho g}$

The answer is:

T.3.3.3 The Bernoulli equation of the form

$$\int_1^2 \frac{\partial \underline{v}}{\partial t} \mathrm{d}\underline{s} + \left[\frac{v^2}{2}\right]_1^2 - \int_1^2 \underline{v} \times \mathrm{rot}\underline{v} \mathrm{d}\underline{s} + \int_1^2 \frac{\mathrm{d}p}{\rho(p)} + [U]_1^2$$

cannot be simplified if only the following assumption is fulfilled:

a, the flow is unsteady.

b, density is a function of pressure.

c, the flow has vortices.

d, local acceleration is nonzero.

e, the flow is potential.

The answer is:

T.3.4.1 For steady flow, when streamlines are straight and parallel, and no fields of force act on the flow, the pressure in the planes perpendicular to the streamlines is constant

a, because the flow is potential.

b, if the $\mathrm{div}(\rho \underline{v}) = 0$ *condition is fulfilled*

c, since according to the normal component of the Euler equation $\frac{\partial p}{\partial n} = 0$

d, because the convective acceleration is nonzero.

e, because $grad \frac{v^2}{2} = -\underline{v} \times \mathrm{rot}\, \underline{v}$

The answer is:

T.3.4.2 In the case of concentric circular streamlines, if $\underline{v}$ is only a function of *r*, the convective acceleration

a, is always zero.

b, is always tangential.

c, always points inward, towards the centre.

d, always points outward.

e, could point inward or outward depending on the function $\underline{v}(r)$.

The answer is:

TZ.3.1 Which form of the Euler equation is correct?

a, $\frac{\partial \underline{v}}{\partial t} + \mathrm{grad}\frac{v^2}{2} - \underline{v} \times \mathrm{rot}\underline{v} = -\frac{1}{\rho}\mathrm{grad}\, p + \underline{g}$

b, $\frac{\mathrm{d}\underline{v}}{\mathrm{d}t} = -\frac{1}{\rho}\mathrm{grad}\, p + \underline{g}$

c, $\frac{\mathrm{d}\underline{v}}{\mathrm{d}t} = -\frac{1}{\rho}\mathrm{grad}\, p - \mathrm{grad}\, U$ *(assuming* $\underline{g}$ *is potential)*

d, $\frac{\partial v_x}{\partial t} + v_x \frac{\partial v_x}{\partial t} + v_y \frac{\partial v_y}{\partial y} = -\frac{1}{\rho}\frac{\partial p}{\partial x} - \frac{\partial U}{\partial x}$ *(for component x in a 2D flow, if* $\underline{g}$ *is potential)*

e, $v \frac{\partial v}{\partial e} = -\frac{1}{\rho}\frac{\partial p}{\partial e} + g_e$ *(the tangential component in the natural coordinate system(streamwise coordinate system)).*

The answer is:

TZ.3.2 Convective acceleration is calculated as:

a, $\underline{a}_c = \underline{\underline{D}}\underline{v}$

b, $\underline{a}_c = \text{grad}\frac{v^2}{2} - \underline{v} \times \text{rot}\,\underline{v}$

c, $a_{cx} = v_x \frac{\partial v_x}{\partial x} + v_y \frac{\partial v_y}{\partial y}$; $a_{cy} = v_x \frac{\partial v_y}{\partial x} + v_y \frac{\partial v_y}{\partial y}$ *(in a 2D flow)*

d, $a_{ce} = v \frac{\partial v}{\partial e}$; $a_{cn} = -\frac{v^2}{r}$ *(in the natural coordinate system (streamwise coordinate system) where "e" refers to tangential and "n" to normal directions and r is the path radius)*

The answer is:

TZ.3.3 A flow is characterised by straight streamlines above a horizontal flat surface. The streamlines are parallel to the surface. Velocity at the surface wall is zero and increases upwards. The flow is steady. If point 1 is taken on the surface and point 2 is taken right above point 1 at a given height, the following terms of the Bernoulli equation

$$\int_1^2 \frac{\partial \underline{v}}{\partial t} \mathrm{d}\underline{s} - \int_1^2 \underline{v} \times \text{rot}\underline{v}\mathrm{d}\underline{s} + \frac{v_2^2 - v_1^2}{2} + \frac{p_2 - p_1}{\rho} + (U_2 - U_1) = 0$$

can be neglected:

a, First term.

b, Second term.

c, Third term.

d, Fourth term.

e, Fifth term.

The answer is:

TZ.3.4 Choose the correct equations!

a, $\underline{\underline{D}}\underline{v} = \text{grad}\frac{v^2}{2} - \underline{v} \times \text{rot}\,\underline{v}$

b, $\left(\underline{\underline{D}} - \underline{\underline{D}}^T\right)\underline{v} = \text{grad}\frac{v^2}{2}$

c, $\frac{\mathrm{d}\underline{v}}{\mathrm{d}t} = \frac{\partial \underline{v}}{\partial t} + \text{grad}\frac{v^2}{2} - \underline{v} \times \text{rot}\,\underline{v}$

d, $v\frac{\partial v}{\partial e} = -\frac{1}{\rho}\frac{\partial p}{\partial e} + g_e$

e, $v\frac{\partial v}{\partial e} = -\frac{1}{\rho}\text{grad}p - \text{grad}\,U$

The answer is: