Revision Notes

# 1. Fluids in Equilibrium

Pressure variation within a stationary fluid  

Fluids in Uniform Linear Acceleration  

Fluids in Rigid Body Rotation

Total differential 

Lines of constant pressure (i.e. free surface of the fluid) are given by d*p*=0

# 2. Control Volume Analysis

Draw a CV so that the boundary crosses regions where you either know the properties or you want to know them.

The Mass Conservation Equation, MCE 

1D flow 

The Force Momentum Equation, FME 

steady 1D incompressible flow 

The Torque Angular Momentum Equation, TAME 

Steady 1D incompressible flow 

The Steady Flow Energy Equation 

# 3. Laminar Flow

For laminar flow  so 

Basic concepts  : Axisymmetric flow  : 2D flow 

Poiseulle’s equation  and 

Head loss and pressure loss 

1. draw a fluid element
2. balance the forces (pressure and shear stress)
3. substitute 
4. integrate to get velocity profile *u*=f(*y*)
5. apply boundary conditions.

# 4. External Flow

The *displacement thickness* and *momentum thickness* - ‘missing’ layers of fluid

The *boundary layer equation* describes the variation of *p* and *u* within a boundary layer

The *skin-friction coefficient, cf* and *drag coefficient, CD* - convenient ways of wiritng wall shear stress and drag force;  

Boundary layer on a flat plate (zero pressure gradient):

Laminar  

Turbulent  

Separation and drag on 2D and 3D bodies - qualitative description.

Empirical data for the drag coefficient for various shaped bodies

Nusselt and Prandtl Numbers  

Thermal boundary layer thickness 

Flow over a flat plate the relationship is:

Laminar:   when Re<5x105

Turbulent:   0.6<Pr<60 & 5x105<Re<10

# 5. Compressible Flow

  &   & 

Isentropic process 

Stagnation conditions *h0, T0,*  *p0* and *0* represent the pressure and density which would be achieved if flow were brought isentropically to rest.

   

If a process from 1 to 2 is *isentropic* , , , .

The Mach Number,  Velocity of sound 

  

*Critical Conditions*, the fluid properties when the flow is sonic (i.e. M=1)

*Subsonic* gas accelerates through converging duct & decelerates through diverging duct.

*Supersonic* gas accelerates through diverging duct & decelerates through converging duct.

*Choking* - flow is sonic at the throat of the nozzle; Mt=1, then 

*Shock wave* – sudden reduction in velocity and increase in static pressure. Use shock tables to determine properties before and after shock