**3. FLUID STATICS**

**PRESSURE:** Intensity of applied force per unit area. Or intensity of compressive work per unit volume is pressure.

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| **PRESSURE** | **STRESS** |
| Always Compressive in nature | It may be tensile or maybe compressive or shear. |
| It’s scalar Quantity. | It’s Tensor Quantity. |

Units:

**PRESSURE IN TERMS OF HEAD OF FLUID:** Height of a fluid column required to create a particular amount of pressure. E.g.

**STANDARD PRESSURES:**

1. **ABSOLUTE ZERO:** The pressure at which the molecular activity in matter completely stops.
2. **STANDARD ATMOSPHERIC:** The pressure exerted by atmosphere at mean sea level on earth.
3. **LOCAL ATMOSPHERIC PRESSURE:** the pressure exerted by atmosphere at particular location is local atmospheric pressure at that location. It’s non uniform reference.

**ABSOLUTE SCALE:** It’s measured w. r. t. absolute zero as reference. It’s always non negative.

**GAUGE SCALE:** it’s measured w. r. t. local atmospheric pressure as reference. It may be negative, 0 or positive.

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| **PASCAL’S LAW:** When constrained fluid is pressured, every point in the fluid experience a rise in pressure by same magnitude in all direction.  At equilibrium condition,  **REST:**  It’s valid for,   1. Always valid for ideal fluid (). 2. Real Fluid:  |  |  | | --- | --- | | Rest condition () | Rigid Body motion () | | Question #27796 | Socratic |
| **PASCAL’S MACHINE:** Any machine which functions on principle of pascal’s law is known as pascal’s machine. E.g. Hydraulic lift. |  |

Pressure at a point in a fluid at rest,

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| 1. Uniform intensity in all direction | 1. Compressive in nature | 1. Zero shear stress. |

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| **HYDROSTATIC LAW:**  **Aim:** To identify the rate of change in pressure w. r. t. elevation for fluid at rest. |  |
| Hydrostatic Law is valid for compressible and incompressible law. | |

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| **HYDROSTATIC LAW FOR** | |
| **INCOMPRESSIBLE FLUID** | **COMPRESSIBLE FLUID** |
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| **VARIATION OF PRESSURE IN ATMOSPHERE FOR** | | | | |
| **ISOTHERMAL CONDITION** | | **VARIATION THERMAL CONDITION** | | |
|  |  |  |  | Where, Lapse Rate,  Generally,  Std. Value |

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| **Step1:**  First Mark Reference.  **Step 2:**   |  |  | | --- | --- | | Going down |  | | Going up |  | | **PIEZOMETER:**  **Limitations:**   1. Not suitable for gases fluids. 2. Not suitable for high pressure measurement. 3. Not suitable for vacuum or suction pressure. | | | **C:\Users\Shiv\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.MSO\74935C67.tmp** |
| **SIMPLE MANOMETER** | | | | The width of the tube in manometer - Physics Stack Exchange |
| **Advantages** | | **Disadvantages** | |
| * Suitable for gas and slightly high pressure can be measure * Vacuum Pressure can be measure. | | * Very high pressure can’t measure. | |
| **DIFFERENTIAL MANOMETER** | | | **INVERTED DIFFERENTIAL/ “U” TUBE MANOMETER** | |
| **C:\Users\Shiv\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.MSO\60AB99A9.tmp** | | | **C:\Users\Shiv\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.MSO\122214A3.tmp** | |
| **Aim:** To measure difference in pressure between two point having relatively high pressure. | | | **Aim:** To measure relatively low pressure difference between two point. | |
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|  | | |  | |
| How to calculate with an inclined tube manometer - Quora | | | **INCLINED TUBE MANOMETER** | |
| Any manometer having at least one limb inclined w. r. t. the vertical plane.  **Advantage:** It increase sensitivity of pressure measurement.  **Sensitivity:** Ability of sense least amout of change. | |

**FORCES ON INCLINED SUBMERGED BODY IN THE FLUID:**

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|  |  |
| --- | --- |
| When (Centre of Pressure = Centre of Gravity),   1. Plate is in horizontal condition. 2. Plate is considered at very high depth. | **C:\Users\Shiv\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.MSO\F2F9E7D2.tmp** |
| **PRESSURE PRISM DIAGRAM:**   1. Volume of pressure prism indicates net force. 2. The projection of centroid of pressure prism on the surface of place represents centre of pressure.   **Note:** When area is not uniform to the page of plate avoid this method. |

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| **CURVED SURFACE** | | | Forces on Submerged Surface Study Notes for Mechanical Engineering : ESE &  GATE ME |
| **HORIZONTAL FORCE** | | **VERTICAL FORCE** |
|  | |  |
| is concentrated at the centre of pressure of projected area. | | is weight equivalent thrust of the fluid above curved surface. |
|  |  |  |

* Volume should be measured form the interface to the curved surface, regardless of the presence of fluid.
* passes through the centroid of the volume considered.

**BUOYANCY:** Upward force exerted by fluid on a completely or partially submerged object in the fluid is buoyancy.

**ARCHIMEDES PRINCIPLE: “**Buoyance force is equal to the weight of the fluid displaced.**”**

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|  | passes through centroid of the volume of fluid displaced. |

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| **APPARENT WEIGHT** | | New Bern High School Naval Junior ROTC Sailing: Buoyancy and Stability  (basic, part 1) |
|  |  |

**EQUILIBRIUM AND STABILITY:**

**EQUILIBRIUM:** Condition in which the net unbalanced force & net unbalanced moments equal to zero.

**STABILITY:** Ability of a body to restore initial equilibrium after disturbance.

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| **TYPES OF EQUILIBRIUM BASED ON STABILITY** | | |
| **STABLE EQUILIBRIUM** | **UNSTABLE EQUILIBRIUM** | **NEUTRAL EQUILIBRIUM** |
| It Gains original state | Further disturb itself | Finds new equilibrium state |
| E.g. | E.g. |  |

**CONDITIONS REQUIRES FOR EQUILIBRIUM:**

|  |  |
| --- | --- |
|  | should have same line of action |

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| **STABILITY OF NEUTRALLY BUOYANT BODY** | | |
| **BOTTOM HEAVY BODY** | **TOP HEAVY BODY** | **HOMOGENOUS BODY** |
| Definition of Stability Of Submerged And Floating Bodies | Chegg.com | Definition of Stability Of Submerged And Floating Bodies | Chegg.com | Definition of Stability Of Submerged And Floating Bodies | Chegg.com |

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| **STABILITY OF FLOATING BODY:**  Here, Metacentre,  Metacentric Radius,  Metacentric Height.  If metacentric Height is positive equilibrium is stable equilibrium. B-G-M   |  |  | | --- | --- | | Stable & Neutral | Unstable | |  |  | | C:\Users\Shiv\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.MSO\5221A182.tmp |

**METACENTRE:**

Point about which a floating body experiences simple harmonic oscillation when given small angle disturbs.

**METACENTRIC RADIUS:**

|  |  |
| --- | --- |
| AMOI of Top view in the waterline about rolling axis,  Volume of fluid displaced, | RAO Calculator | vessel response amplitudes | CalQlata |
| 1. Valid for only Simple harmonic Motion only & 2. Metacentric Height Depends on geometry of ship, density of fluid and ship. 3. Metacentric Height of particular body in a particular fluid is a constant. | |

**TIME PERIODS OF ROLLING/ OSCILLATIONS:**

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| **EXPERIMENT** |  |  |  |

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| **RIGID BODY MOTION** | |
| **TRANSLATION** | **ROTATION** |
| E.g. Below Mentioned Cases, etc… | E.g. Vortex Motion. |

**TRANSLATION RIGID BODY MOTION:**

**CASE-I: Vertical Translation**

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| --- | --- | --- |
|  |  | Vertical Translation in upward direction. |

**CASE-II: Vertical Translation**

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**CASE-III: Translation Along Slope**

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|  | We can use same method like case II for derivation with | Vertical upward Translation on slope of angle |