**MECH-322 FLUID MECHANICS**

**DEFINITIONS**

***"How can One Seek the UNNOWNS, Without Knowing the KNOWNS"***

## 1.0 DEFINITIONS


### a. What is the definition of Fluid Mechanics and viscosity?

Fluid mechanics is the study of fluid behavior (liquids, gases, blood, and plasmas) at rest and in motion, and the forces they produce.

Viscosity is a measure of a fluids resistance to deform under a shear stress.

b. What is definition of an Incompressible Fluid?

Fluid density is not a function of pressure $(\rho = \text{Constant})$.

c. What is difference between the Law of Hydrostatics and Pascals Law?

**LAW OF HYDROSTATICS** says that pressure for an incompressible fluid is a linear function of depth. **PASCALS LAW** says that at any depth, pressure is not a function of lateral direction.

d. What is the definition of Stagnation Pressure?

For any blunt object placed into flow field, the STATIC and DYNAMIC PRESSURE components (which is energy) will be converted to a STAGNATION PRESSURE (or total energy) where the velocity comes to rest, i.e., 0 velocity.

e. What is difference between a static pressure tap and a stagnation pressure tap. Draw a picture and show me.

STATIC pressure tap is **PARALLEL** to the flow stream and STAGNATION pressure tap is **NORMAL** or perpendicular to the flow stream.

f. How can one measure the velocity of a jet aircraft?

A **PITOT** tube (manometer) measures the difference between the STAGNATION pressure and STATIC pressures and can be used with Bernoulli at constant velocity to determine velocity of craft.

g. What is the Bernoulli Equation **AND** When can It be applied?

Bernoulli is the oldest of the fluid equatons and represents the conservation of energy (or Pressure) along a fluid streamline. It can be used: ISIS (Incompressible, steady, Inviscid, Streamline) and no Shaft Work.

h. When does one need to consider Mass Conservation?

When there is a change in flow area.

i. What is the Point-to-Point Method for manometry and be **detailed**?

Also called the "BERRY" Point-to-Point Method is the application of the Law of Hydrostatics applied to a manometer with a single or several fluids to determine a pressure difference. Does not apply along a fluid streamline with moving particles.

j. What is the definition of TOTAL Pressure?

Total Pressure is the combination of Static Pressure, Dynamic Pressure, and Hydro Static Pressure. Along a streamline the total pressure is conserved for steady incompressible flow.

k. What is the difference between a Newtonian and a Non-Newtonian Fluid?

For a Newtonian fluid the shear stress is a linear function of the strain rate, or also the viscosity is a constant. For a Non-Newtonian fluid, the shear stress is a function of the shear rate raised to a power.

l. What is the definition of the Center of Pressure?

For pressure forces on submerged planar objects, it is the location of the resultant pressure force.

m. What is the definition of a free jet?

As a fluid streamline exits to the atmosphere, the pressure must EQUILIZE to the environment at 0-gauge pressure, or, 14.696 PSIA.

n. What is the definition of "yc", "yr", and "hc" for submerged surfaces?

For submerged planar objects, "yc" is the distance from the surface to the geometric centroid measured along the plate inclined axis, "yr" is the distance from the surface to the line of action of the resultant force measured along the plate inclined axis, and "hc" is the distance from the surface to the geometric centroid measured **VERTICAL** from the surface to the centroid.

o. What is the definition of a standard coordinate system?

There is NO definition of a standard coordinate system. On the space station Horizon One orbiting TITAN, a moon of Mars, the physical laws of Newtonian, Nature, Man, and GOD are applicable to all 3D orthogonal coordinate systems.

p. What are the **five (5)** best locations to identify points to solve problems requiring Bernoulli and Manometry?

Free surface, free jets, static point, stagnation point, interfaces of manometer fluids.

q. When must you consider Conservation of Momentum and/or Energy?

Momentum is important fluid stream's linear direction is altered by external device such as an elbow and results in an external reaction force. Energy is important when there is a change in elevation, velocity, pressure, or work done by the control volume.

r. What is difference between Laminar and Turbulent Flow?

Laminar flow has a steady and predictable velocity profile that is not a function of time. Turbulent flow has a very chaotic velocity profile that is very much a function of time.

s. What is the Friction Characteristic equation and what information is provided once solved?

The Friction Characteristic equation is an intrinsic equation that relates the friction factor to another variable such as flow rate, velocity or diameter. But these variables are also a function of the friction factor, so it must be solved with an iterative method. Once solved, the system pressure drop, flow rate, and work can be calculated.

t. Why is the golf ball "rough" and not "smooth"?

The rough golf ball has a lower Drag Coefficient and thus smaller losses due to friction extends distance travelled.

u. What are "minor" and "major" losses?

Minor losses are friction losses within components such as valves, elbows, joints and other components connecting straight section of pipes. Major losses are friction losses within straight section of pipes.

v. What is the MACH #, and at what value should we consider compressible flow effects.

The MACH # is the ratio of the speed of an object within a compressible fluid, to the speed of sound within the same fluid. If MA > 0.2, then compressibility effects could be important.

x. What is a normal shock wave?

A normal shock wave is a small region in which the fluid properties (i.e., density) change very quickly over a very small distance when travelling at MA >= 1.

y. Within a compressible flow **CONVERGING-DIVERGING** nozzle, what is the difference between what happens in the downstream section after the throat, if the upstream flow is supersonic or sub-sonic?

If the upstream flow prior to the throat is "SUB-sonic", the velocity will Accelerate into the throat section from the upstream "CONVERGING" section, and then Decelerate within the "DIVERGING" downstream section.

If the upstream flow prior to the throat is "SUPER-sonic", the velocity will Decelerate into the throat section from the upstream "CONVERGING" section, and then Accelerate within the "DIVERGING" downstream section.

If the upstream flow prior to the throat is "SUB-sonic", **AND**, if the velocity Accelerates into the throat section from the upstream "CONVERGING" section to reach **MA = 1** at the throat, then the compressible fluid will Accelerate within the "DIVERGING" downstream section.

z. What is the initial MA number of the Space Shuttle main engines at lift off and what is the initial re-entry MA number of the spacecraft.

Initially the main engine exhaust reaches a MA number of 4.54 and propel the craft to a final velocity of 17,500 MPH. The initial re-entry MA number is 25.