Department of Aeronautical Engineering

U20AE816 Experimental Aerodynamics

Year/Sem: IV/VIII

Part A

Unit 1 Basics Measurements in Fluid Mechanics

1. What is impact pressure?

   Impact pressure is the dynamic pressure is the difference between total pressure and static pressure.

2. What are the objectives of experimental studies?

   From the design point of view, experiments have two principal objectives:

   - They make it possible to determine the influence of various features of design and modifications to them, in a safe, quick, direct and relatively expensive manner.
   - They provide information on a fundamental nature, usually in conjunction with theoretical work, by this means, the theory is confirmed or extended thereby laying the foundation of future design improvements of a fundamental character.

3. What are three important concepts for visual or describing a flow field?

   - Direct measurements
   - Analogue methods
   - Flow visualization

4. State the significance of flow visualization.

   - Experimental investigating the flow patterns be means of pressure and velocity surveys, fluid flows lend themselves to numerous visualization techniques.
   - Fluid flow analysis with smoke, tuft, chemical coating, interferometer, schlieren and shadowgraph.

5. What is mean by Clauser chart?

   It is a chart used to determine the wall shear stress. Boundary layer profile can plot in a semi-log, and fit the "law of the wall" with the data.

6. What do you understand by direct measurements? -It is used to determine the forces on scaled models.

   Forces such as lift and drag acting on the model being tested are known to obey the following law of similitude.

$$F = \frac{1}{2} \rho v^2 S C_N$$

7. Define Reynolds number and Mach number

   Reynolds number:

   It is a non dimensional number, ratio of inertial force to viscous force

$$\frac{\text{Inertial force}}{\text{Viscous force}} = \frac{\rho v \iota}{\mu}$$

   Mach number:

   It is a non dimensional number, ratio of inertial force to elastic force

$$\frac{\text{Inertial force}}{\text{Elastic force}} = \frac{\text{Velocity of Aircraft}}{\text{Velocity of Sound}}$$

8. What are main components of measuring systems?

   - The sensing element
   - The signal converter
   - The display

9. What is mean by signal converter?

   A signal converter is a device to convert the output from the sensing element to a desired form and feed the same to the display unit.

10. What is mean by lower critical and upper critical Reynolds number?

    - The lower critical Reynolds number is that Reynolds number below which entire flow is laminar.
    - The Reynolds number above which the entire flow is turbulent is termed as upper critical Reynolds number.

11. Define accuracy.

    The accuracy of a measuring device may be defined as the extent to which the reading given by it is close to the exact value.

12. Define Error.

The error is the difference between the measured value and the true value of the quantity being measured.

13. Define Reliability.

The Reliability of a measuring system is the probability that it will operate with an agreeable accuracy under the conditions specified for its operation.

14. What is mean by dead space?

The dead space of measuring device is the range of values of the quantity being measured for which it gives no reading.

15. What is mean by Threshold?

Threshold is the minimum level of the quantity that is being measured, which has to be reached before the instruments response and gives a detectable reading. In other words, it is just a dead space that occurs when an instrument is used for reading from the minimum limit of its range.

16. Comment on hydrostatic pressure distribution.

- Hydrostatic pressure is the pressure that is exerted by a fluid at equilibrium at a given point within the fluid due to the force of gravity.
- It increases in proportion to depth measured from the surface because of the increasing weight of fluid exerting downward from above.

17. What is Hysteresis?

The Hysteresis is that characteristic which makes an instrument give different readings for the same value of a measured quantity depending on whether the value has been reached by a continuously increasing change or a continuously decreasing change.

18. What is Compressibility?

The change in volume of a fluid associated with change in pressure is called Compressibility, when a fluid is subjected to pressure it gets compressed and its volumes changes.

19. Define viscosity of a fluid.

The property which characterizes the resistance that a fluid offers to applied shear force is termed a viscosity.

20. State Newton's Law of Viscosity.

The stress which oppose the shearing of a fluid or proportional to the rate of shear strain.

$$\tau \alpha \frac{\partial u}{\partial y}$$

UNIT-2 Wind Tunnel Measurements

1. Define Energy Ratio.

The ratio of the energy of the air stream at the test section to the input energy to the driving unit is a measure of the efficiency of a wind tunnel.

$$ER = \frac{\text{Kinetic energy of jet}}{\text{Energy loss}}$$

2. List out the disadvantages of blow down tunnels.
    - They are the simplest among the high-speed tunnel types and most economical to build.
    - Large-size test-sections and high Mach numbers (up to M=4) can be obtained.
    - Constant blowing pressure can be maintained and running time of considerable duration can be achieved.

3. Distinguish between open circuit and closed circuit tunnels.

Open Circuit Wind Tunnel	Closed Circuit Wind Tunnel
No guided return of air	Continuous path for the air.
Test section without side wall	Test section with side walls
The air passes through the test section is gathered from the room in which the tunnel is located	The air is conducted from the fan to the contraction section by a series of ducts and turning vanes

4. What are the losses in wind tunnel-Losses in cylindrical parts.
    - Losses in guide vanes at the corner (for closed type)
    - Losses in diffuser
    - Losses in contraction cone
    - Losses in honeycomb, screens and so on
    - Losses in test section (open tunnels)
    - Losses in exit (for open tunnels)

5. What is mean by pyramid-type balance?

    It is a balance where the forces and moments acting on the model are measured with respect to a single point (attachment point) and hence by locating this point at an advantageous position such as aerodynamics center of the model.

6. State the classification of high-speed wind tunnel.

    Based on the test section Mach number M, range, the high-speed tunnels are classified as follows

    $\rightarrow 0.8 < M < 1.2$ Transonic tunnel
    $\rightarrow 1.2 < M < 5$ Supersonic tunnel
    $\rightarrow M > 5$ Hypersonic tunnel

7. What is open circuit tunnel?

    An open circuit tunnel has no guided return of air, the tunnel draw air directly from the atmosphere, entirely fresh air flows constantly through the tunnel.

8. What is horizontal buoyancy?

    The resultant vertical force exerted on a body by a static fluid in which it is submerged or floating.

9. What are the major disadvantages of supersonic continuous supersonic tunnels?
    - Power required is very high
    - Temperature stabilization requires
    - Large size cooler
    - Compressor drive to be designed to match the tunnel characteristics
    - Tunnel design and operation are more complicated

10. What is mean by induction-type tunnels?

In this type of tunnel, a vacuum created at the downstream end of the tunnel is used to establish the flow in the test section.

11. What are the disadvantages of the blow down tunnels?

- Charging time to running time ratio will be very high for large-size tunnels.
- Stagnation temperature in the reservoir drops during the tunnel run, thus changing the Reynolds number of the flow in the test-section.
- Starting load is high
- Reynolds number of the flow is low due to low static pressure in the test section.

12. Define Contraction ratio.

Contraction ratio (n) it is a ration of Area at entry to convergent cone to Area at exit of cone convergent

n =Area at entry to convergent cone/Area at exit of cone convergent

13. What is test section?

The model to be tested is placed here in the airstream leaving the downstream end of the effuse and the required measurements and observations are made.

14. What are the process involved and calibration of wind tunnel?

- Speed setting
- Determining the floe angularity
- Turbulence level
- Velocity distribution
- Wake survey

15. Classify the wind tunnel balance based on its constructions.

- Wire-type
- Strut-type
- Platform-type
- Yoke-type
- Strain gauge-type

16. Write the disadvantages of wire-type wind tunnel balance.

- Large tare drag because of exposed wires
- Bearings and linkages cause zero error
- Wires have tendency to crystallize and break
- Space occupied is very large

17. How to maintain the turbulence at low level in the wind tunnel?

- Using maximum number of fan blades
- With anti-swirl vanes
- With a very long, gradual nacelle
- Providing the maximum possible distance between the propeller and test section

18. Write the advantage of strut-type wind tunnel balance?

- Deflections of strut are very small
- Tare and interference drag are minimized
- Interaction loads can be reduced to a small
- Weight of the support structure can be kept at very low

19. What is mean by balance calibration?

All the balances such as wire, strut, or strain gauge type are required to be calibrated after the assembly and to be checked periodically.

20. Write the advantage of induction tunnels.

- Stagnation pressure and stagnation temperature are constant
- No oil contamination in air, because the pump is at the downstream end
- Starting and shutdown operations are small

UNIT 3 Flow Visualisation and Analogue Methods

1. What are the various types of optical flow visualization?
    - Interferometer
    - Schlieren system
    - Shadowgraph

2. Is Hele-shaw apparatus is applicable to rotational flow?

    No, because the models kept in the slit must not allow any flow to take place between the model side surface and the apparatus wall.

3. State the difference methods of smoke production.
    - Wood smoke
    - Kerosene smoke generator
    - Titanium Tetrachloride usage
    - Use of Ammonia and Hydrochloric acid

4. What is shadow effect?

    If the screen is placed at a position close to the test section, the effect of ray deflection will be visible. This effect is termed as shadow effect.

5. What is schlieren method technique?

    Schlieren method is a technique for visualizing the density gradients in a transparent medium. It is a optical method light from a source is collimated by the first lens and passes through the test section.

6. What is Hydraulic Jumps?

    It is known that in “shooting” water under certain conditions, the velocity may decrease over short distances and the water depth suddenly increase. An unsteady motion of this type is known as hydraulic jump.

7. For getting good results, what are the qualities considered for the properties of the smoke?
    - The smoke should be white, dense, non-poisonous and non-corrosive.
    - Smoke should have nearly the same density as that of the surrounding air
    - Smoke particles should not disturb the flow in the wind tunnel by depositing over the surface of the models.

8. What is interferometer?

    The interferometer is an optical method most suited for qualitative determination of the density field of high-speed flows.

9. What the fundamental principle of the interferometer?

    The fundamental principle of the interferometer is, from wave theory of light we have $C = f\lambda$,

    $C \rightarrow$ Velocity propagation of light

    $f \rightarrow$ frequency

    $\lambda \rightarrow$ wavelength

10. What is hele shaw apparatus?

    The hele-shaw apparatus produces a flow pattern similar to that of potential flow pattern similar to that of potential flow. It is an analogy experiment known as the hele-shaw analogy.

11. What is mean by Electrolytic tank?

    It is an analogy method used to solve the potential flow problems. The equations governing incompressible potential flow and distribution of the electrical potential lines are same, in their form to establish an analogy between two fields.

12. What is Tufts?

    It is used to visualize the flow fields in the speed range from 40 to 150 m/s. This technique is usually employed to study boundary layer flow, wake flow, flow separation, stall spread and so on.

13. What is Shadowgraph method of flow visualization?

Shadowgraph method of flow visualization technique meant for high-speed flows with transonic and supersonic Mach numbers. This is employed for fields with strong shock waves.

14. What is mean by smoke flow visualization method?

It is one of the popular technique used in low-speed flow fields with velocities up to about 30 m/s. Smoke visualization is used to study problems such as boundary layers, air pollution problems design of exhaust systems of locomotives, cars and ships.

15. What is mean by kerosene smoke generator method?

In this method, smoke is produced by evaporation and atomization of kerosene in an airstream. The system is compact and electrically operated. Smoke can be generated within few minutes. No solid deposits are formed.

16. What is a Smoke tunnel?

A smoke tunnel is basically an open-circuit, low speed tunnel. The flow through the tunnel is induced by the suction, using a simple axial fan.

17. Write the principle used in flow visualization.

The general principal for flow visualization is a render the fluid elements visible either by observing motion of the fluid or by using an optical patterns.

18. Write the equation to express the increase of light intensity in a 2D flow

$$\Delta I = k\left(\frac{\partial^2 \rho}{\partial x^2} + \frac{\partial^2 \rho}{\partial y^2}\right)$$

K → Constant,
x & y → Co-ordinates in the plane normal to the light path.

19. Write the equation to measure the density change in the test section.

$$\rho_2 - \rho_1 = \rho_0 \frac{\tan\theta}{27.3\, p_0}.$$

20. Write the optical components for Schlieren system.
    - Schlieren mirrors
    - Light source
    - Condenser lens
    - Focusing lens
    - Knife-edge
    - Colour Schlieren
    - Short duration light source

Unit-4 Pressure, Velocity and temperature measurements

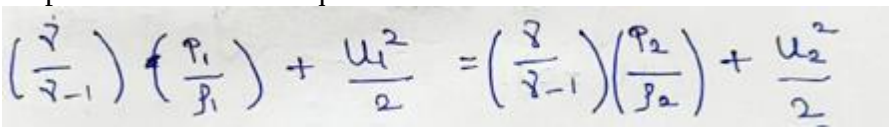
1. Define gauge pressure.

   It is a pressure relative to atmospheric pressure. Gauge pressure is positive for pressures above atmospheric pressure and negative for pressures below it.

2. What is the theoretical sensitive of thermocouple?

   Thermocouples consists of two dissimilar metals joined together at two points, one point being the place where the temperature is to be measured and the other point being a place where the temperature is known.

3. Write Compressible Bernoulli equation



4. Define the term Doppler shift.

   A moving particle illuminated by a light beam scatter light at a frequency different from that of the original incident beam. This difference in frequency is known as Doppler shift and is proportional to the velocity of the particle.

5. List the errors associated with pitot tube. • Turbulence
    - Velocity gradient
    - Vibration
    - Viscosity
    - Wall proximity

6. Brief on MPX Sensor.

    It is monolithic silicon pressure sensor, is designed to operate with positive differential pressure applied with P1 > P2. Bipolar processing to provide an accurate high level analog output signal that is proportional to the applied pressure.

7. What is thermal shunting?

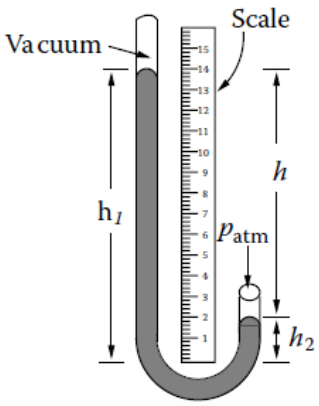
    An act of altering the measurement temperature by inserting a measurement transducer is termed as thermal shunting.

8. What are the factors influencing pitot tube performance?
    - Misalignment effect
    - Viscosity effect
    - Vibration effect
    - Turbulence
    - Velocity gradient effect

9. What is Syphon Barometer?

    Syphon Barometer is essentially a U-tube of glass with one limb much shorter that the other. The short limb is open to the atmosphere and the long limb end is closed. It is used to measure the atmospheric pressure easily.

10. Provide the schematic sketch of Syphon Barometer



11. Define Overheat ratio.

It is ratio of the resistance of the heated wire at its operating temperature to the resistance of the sensor at the temperature of the ambient fluid.

12. Write principle used in the manometer.

The basic measuring principle is that the pressure applied is balanced by the weight of a liquid column. The sensitivity of the instrument depends on the density of manometric fluid used.

13. What is pressure transducers?

It is an electromechanical device that convert pressure to electrical signals that can be recorded with a data acquisition systems such as that used for recording strain-gauge signals.

14. Write the principle used in linear differential transformer.

It works on induction principle, like any other transformer, but with a movable core fixed to the diaphragm. This instrument is capable of detecting displacements of the order of a few microns.

15. What is total pressure?

It is a pressure which results when a flow is decelerated to rest isentropically.

16. Write Rayleigh Supersonic pitot formula

$$\frac{p_1}{p_{02}} = \frac{\left[\frac{2\gamma}{\gamma+1}M_1^2 - \frac{\gamma-1}{\gamma+1}\right]^{\frac{1}{(\gamma-1)}}}{\left(\frac{\gamma+1}{2}M_1^2\right)^{\frac{\gamma}{(\gamma-1)}}}.$$

17. Write the advantages of LDA.
    - Measurement is absolute
    - It is applicable to a wide range of flow velocities, say 10-4 to 103 m/s
    - High frequency response
    - It has negligible probe interference

18. What is photomultiplier?

    Doppler shift is detected by a device called photo-multiplier which gives an electrical output whose frequency is proportional to the velocity of scattering particles.

19. What are the common scattering substances used in LDA.
    - Micro polythene spheres
    - Diluted milk droplets
    - Diluted smoke particles
    - Aerosol
    - Fine alumina powder
    - Water-glycerin mixture droplets

20. Write the governing equation for LDA.

$$\boxed{\nu_D = \frac{n}{\lambda_0}\overline{V}(\bar{l}_1 - \bar{l}_2)}$$

UNIT-5 Special flows and Uncertainty Analysis

1. What is mean by gross error?

   Gross errors are the mistakes that make the measurement very far off of the known or accepted value.

2. What is Ekman suction?

   Ekman layers are divergent and this creates a suction directed toward the interior whose magnitude is proportional to the vorticity of the flow above this layer. This is known as Ekman suction.

3. What is the Ekman boundary layer?

   In a rotating fluid the boundary layer formed on the floor of the tank has some special significance. This is termed as Ekman boundary layer and it is spiral in nature.

4. What is mean by uncertainty?

   The appropriate concept for expressing inaccuracies is uncertainty. An uncertainty is not the same as an error. An uncertainty is a possible value that the error might take on in a given measurement.

5. List the uses of uncertainty analysis.
   - It enforces a complete examination of the experimental procedure, including the potential sources of error
   - To minimize the instrument cost for a given output accuracy
   - To identify the instrument or procedure that controls accuracy
   - Allow design of probes for minimum uncertainty

6. State Proudman theorem

$$\frac{\delta}{\delta z}(u, v, w) = 0$$

   The above equation implies that the relative velocity field does not vary in the direction of the rotation axis and that the flow tends to be 2-D in planes perpendicular to the rotational axis.

7. Define the term geostrophic motion.

   In a slowly rotating fluid it can be shown theoretically that the Coriolis force is completely balanced by the pressure gradient induced by the centrifugal force is known as geostrophic motion.

8. What are significance of uncertainty analysis?

    - To provide the basis for guarantee of accuracy
    - To decide on when more experiments must be provided to further calibrate
    - Computations agree with data or lie outside acceptable limits

9. Define Rossby number.

    The Rossby number (Ro) is the ratio of inertial force to Coriolis force.

10. What is data conversion?

    It involves the conversion data from analog to digital or digital to analog.

11. What are the advantages of data conversions?
    - Gives noise immunity to the data during transmission
    - Determine the presence of a pulse in analog form
    - Error detection and error correction can be made easily

12. What is spin up time and spin down time?

    The time required to achieve the rigid condition is called spin-up time, the reverse is called spin-down time.

13. What is real aminarization?

    Reverse transition is a process in which a turbulent flow changes over to a laminar nature is called aminarization.

14. Write thew sequence of operation in Data Acquisition systems.

    - Generation of input signals by transducers
    - Signal conditioning
    - Multiplexing
    - Data conversion
    - Data storage and display
    - Data processing

15. What are the operations involved in signal conditioning?

- Amplification of the signal from the sensor
- Providing independence matching
- Correction of thermoelectric errors
- Performance of arithmetic operations

16. What are the errors likely to be associated with measured quantity?

- The external estimate error
- The internal estimate error

17. What is fixed error?

It makes the repeated measurements be in error by the same amount for each trail. This error is same for each reading and can be removed by proper calibration or correction.

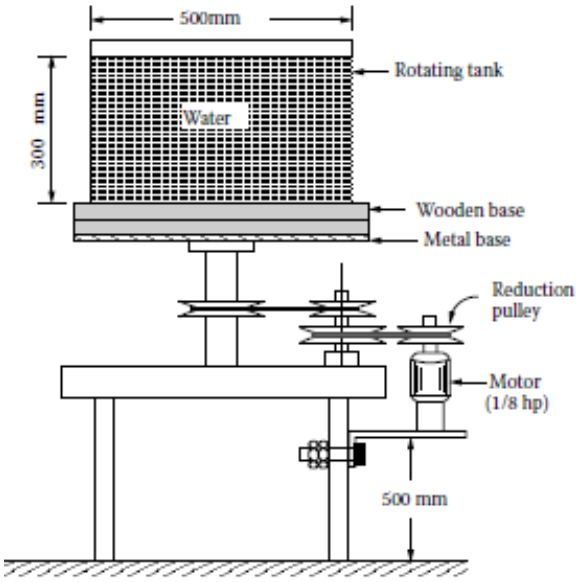
18. What is mean by random error?

Random error (non-repeatability) is different for every reading and hence cannot be re-moved. The factors that introduce random error are uncertain by their nature.

19. Write the general expression for estimating the uncertainties

$$u_R = \pm \left[\left(\frac{x_1}{R} \frac{\partial R}{\partial x_1} u_1 \right)^2 + \left(\frac{x_2}{R} \frac{\partial R}{\partial x_2} u_2 \right)^2 + \cdots + \left(\frac{x_n}{R} \frac{\partial R}{\partial x_n} u_n \right)^2 \right]^{1/2}.$$

20. Sketch the rotating tank facility of Taylor-Proudman theorem



Department of Aeronautical Engineering

Question Bank (Part-B)

U20AE816 EXPERIMENTAL AERODYNAMICS

Year: IV **Sem: VIII**

UNIT-I Basic Measurements in Fluid Mechanics

1. Discuss in detail about static and dynamic characteristics of a measurement system. (Nov/Dec 2018)
2. Explain the following: model studies and direct measurements. (Nov/Dec 2018)
3. State and explain the main components of measurement system. (Apr/May 2018)
4. What are the types of fluid flow analysis? (Apr/May 2018)
5. Describe the graphical of fluid motion with sketches. (Nov/Dec 2017)
6. Explain in detail about the performance terms associated with measurement system. (Nov/Dec 2019)
7. Explain the different types of properties of fluids and determine the absolute viscosity of air at temperature 0°c, 5°c and 10°c (April May 19)
8. A subsonic open circuit wind tunnel runs with a test section speed of 40 m/s. The temperature of the lab environment is 16^0c. If a turbulent sphere measures the turbulence factor tf of the tunnel as 1.2, determine the sphere diameter. Assume the test section pressure as the standard sea-level pressure (Nov Dec 19)
9. (i) an open jet test section of a subsonic wind tunnel expands freely into a still environment. The test section length is 1.5 times the diameter of the contraction cone exit. The friction co-efficient for the free jet is 10 times that of the closed throat with a smooth wall. If the friction co-efficient of the smooth wall is 0.008, determine the increase of loss when the jet is open, treating the jet as a cylindrical duct.

   (ii) an open circuit subsonic wind tunnel of test section 1.2 m x 0.9 m is run by a 110 kw motor. If the test section speed is 90 m/s, calculate the energy ratio of the tunnel. Also, find the total loss in the tunnel in terms of test section kinetic energy. Take the air density as the standard sea-level value

10. A closed return type wind tunnel of large contraction ratio has air at standard sea level conditions in the settling chamber upstream of the contraction to the test section. Assuming isentropic compressible flow in the tunnel, estimate the speed and the kinetic energy per unit area in the working section when the Mach number is 0.75

UNIT-II Wind Tunnel Measurements

1. Discuss on various types of tunnels in detail. (Nov/Dec 2018)
2. Explain the working principle of continuous supersonic wind tunnels with neat sketches
   (Nov Dec 17)
3. Describe various power losses in wind tunnel? (Apr/May 2018)
4. Explain the working principle of continuous supersonic wind tunnels with neat sketches. (Nov/Dec 2017)
5. Describe wind tunnel boundary correction procedure for low speed and high speed wind tunnel with necessary profiles. (Nov/Dec 2017)
6. Explain in detail about the calibration procedure of supersonic wind tunnel with appropriate equations. (Nov/Dec 2019)
7. Explain in detail about the instrumentation and calibration of the wind tunnel
8. What is mean by wind tunnel balance and explain all the types on wind tunnel balance with neat sketches
9. A continuous wind tunnel operates at Mach 2.5 at the test section with static conditions corresponding to 10,000 m altitude. The test section is 150mm x 150 mm in cross-section, with a supersonic diffuser downstream of the test section. Determine the power requirements of the compressor during start up and during steady state operation. Assuming the compressor inlet temperature to be the same as the test section stagnation temperature
10. Determine the minimum possible diffuser contraction ratio and the power required for a two-stage compressor to run a closed-circuit supersonic tunnel at $m = 2.2$. The efficiency of the compressor is 85 percent, $p_{01} = 4$ atm, $t_0 = 330$ k, and $a_{ts} = 0.04 m^2$

UNIT-III Flow Visualization and Analogue Methods

1. Explain about various flow visualization techniques with respect to tunnel design. (Nov/Dec 2018)
2. What are analogy methods? Explain the basic principle behind electrolytic tank and discuss how does it helps to solve potential flow problems. (Apr/May 2018)
3. Explain different depth measurement techniques. (Nov/Dec 2019)
4. Explain the working principle of hele-shaw apparatus. (Apr/May 2019)
5. Explain in detail about the fringe displacement method (Nov Dec 17)
6. Describe the working principle of schlieren system with suitable example (April May 19)
7. Explain in detail about the shadowgraph method of flow visualization
8. With neat sketches explain in detail about the working of Mach-zhender interferometer
9. Explain in detail about the hydraulic jumps with neat sketches.
10. What is mean by hydraulic analogy? And explain the analogy between shallow water with a free surface and two-dimensional gas flow

UNIT-IV Pressure, Velocity and Temperature Measurements

1. Describe the working principle of constant temperature hot-wire anemometers. (Nov/Dec 2018)
2. Explain the working of ultrasonic flow meter with suitable diagram. .(Nov/Dec 2018)
3. Explain. The various temperature measurements used in wind tunnel and their calibration. (Nov/Dec 2017)
4. (i) Calculate. The dynamic pressure of a flow with v_∞=200 m/s, p_∞=1 atm, and t_∞=300 k. What will be the percentage of error if the flow is treated as incompressible?

   (Nov/Dec 2019)

   (ii) Agas thermometer was calibrated by placing the bulb in melting ice at 0°c and the difference in height of the mercury column was 820 mm. The bulb was then placed in steam at 100°c and the mercury column was adjusted to be 1300 mm. The bulb was then placed in a fluid of unknown temperature and after adjustment, the difference in height of the mercury column was 97 cm. Determine the temperature of the fluid.

5. With suitable diagram explain the working principle of pitot static tube and also explain the correction factors for the pitot tube in supersonic flows. (Apr/May 2019)
6. Explain the working principle of laser Doppler anemometer with suitable diagram and also state its advantages. (Apr/May 2019)
7. What is mean by pressure transducer? And explain all the types of it with neat sketches
8. What is mean by PIV? With neat sketches explain how it is used to measure the velocity
9. How the temperatures can be measured by electrical effects? Explain each method briefly with neat sketches
10. (i) Find the pressure that would be read by a mercury manometer connected to a static pressure tap located at the wall of a convergent nozzle where the flow Mach number is 0.8he nozzle is connected to a tank at a pressure of 3 atmospheres absolute

    (ii)A McLeod gauge with V_B = 100 cm^3 and capillary diameter 1 mm measures the pressure of a vacuum chamber as 10 mm of mercury. Calculate the chamber pressure in Pa.

    (iii) A total temperature probe measures the temperature of a Mach 2 air stream as 600 K. if the probe recovery factor is 0.98, determine the stream static temperature

UNIT-V Special Flows and Uncertainty Analysis

1. Describe experimental procedure on spin-up and spin-down in the rotating system. (Nov/Dec 2018)
2. Describe uncertainty analysis calculation and explain the procedure and mention the uses of uncertainty analysis (Nov/Dec 2018)
3. Explain in detail about estimation of measurement errors and external estimate of the error and internal estimate of error. (Apr/May 2018)
4. With suitable sensors, design a computer based DAQ system for wind tunnel. (Nov/Dec 2017)
5. Explain the signal conditioning in das? (Apr/May 2019)
6. Explain in detail about measurement in boundary layers with suitable examples. (Apr/May 2019)
7. (i) Obtain an expression for the uncertainty in determine the Mach number of a flow from measurements of total pressure p_t and the ambient pressure p_a

    (ii) Explain the working of multichannel digital multiplexer system

8. (i) Estimate the settling chamber pressure and the temperature and the area ratio required to operate a Mach 2 tunnel under standard sea-level conditions. Assume the flow to be one-dimensional and the tunnel operating with correct expansion
   (ii) Find the test-section temperature for a hypersonic stream of air at Mach 7 with stagnation temperature at 700 k.
9. Explain in detail about the experiment in Taylor Proudman theorem and Ekman layer
10. (i) Determine the running time for a Mach 2 blowdown wind tunnel with test section cross section of 300 mm x 300 mm. The storage tank volume is 20 m^3 and the pressure and the temperature of air in the tank are 20 atm and 25°c, respectively. The tank is provided with a heat sink material inside. Take the starting pressure ratio required for Mach 2 to be 3, the loss in pressure regulating valve (prv) to be 50 percent and the polytropic index n = 1
    (ii) A subsonic wind tunnel of square test-section runs at 30 m/s, with pressure 97.325 k pa and temperature 22°c, in the test section. A turbulence sphere with theoretical surface finish offering 4 percent blockage experiences critical reynolds number at this state. Determine the test-section height