



SUMMER – 2022 EXAMINATION

Subject Name: Mechanical Engineering Measurement

Model Answer

Subject Code:

22443

Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.
- 8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		Attempt any FIVE	5 X 2 = 10
	(a) ANS	State the working principle of RVDT This is called as Rotary Variable Differential Transformer (RVDT) and is used for measurement of angular displacement. Iron core is having angular motion and is having windings. Two secondary and one primary winding is used in RVDT. Input supply is given to primary winding and output is taken across secondary winding. Output is the difference of voltage across two secondary windings. This output depends on the movement of central iron cores angular displacement.	2 Mark
	(b) ANS	Name different Torque Measuring Instruments. i) Inline Torque Measurement ii) Reaction Torque Measurement iii) Slip Ring iv) Rotary Transformer	2 Mark for any four points

- v) Infrared Sensor
- vi) FM Transmitter

(c) **State the law of Intermediate Temperature.**

ANS If a simple thermocouple circuit develops an emf e_1 , when its junctions are at temperature T_1 and T_2 , and an emf e_2 when its junctions are at temperature T_2 and T_3 , it will develop an emf $e_1 + e_2$ when its junctions are at temperature T_1 and T_3 .

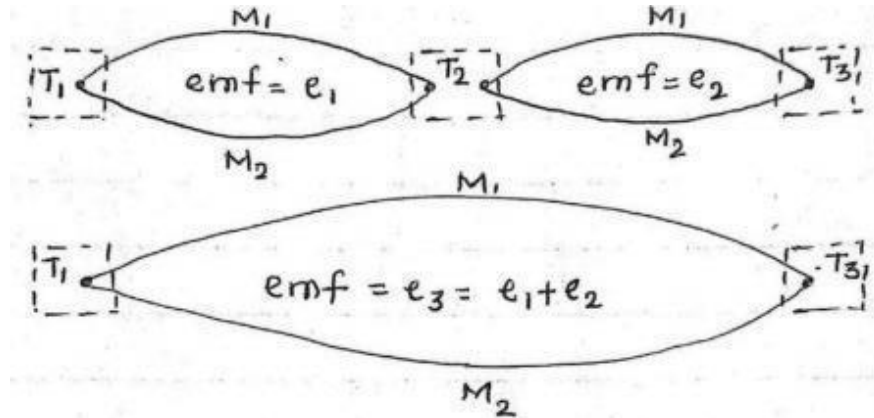


Figure: Law of Intermediate Temperature

1Mark for Statement

1 Mark for Fig.

(d) **Enlist types of flow meters.**

- ANS**
- i) Orifice meter
 - ii) Venturi meter
 - iii) Rotameter
 - iv) Hot wire Anemometer
 - v) Hot film Anemometer
 - vi) Electromagnetic Flowmeter
 - vii) Ultrasonic Flowmeter.
 - viii) Turbine flow meter.

2Marks for Any four types.



		ix) Vortex shedding Flow meter.	
(e) ANS	Define term Natural Frequency. The frequency at which a system tends to oscillate in the absence of any driving or damping force is called as Natural Frequency.		2 Marks
(f) ANS	Enlist types of speed measurement devices. i) Mechanical Counter ii) Revolution counter. iii) Tachoscope iv) Mechanical Tachometer (Hand Speed Indicator) v) Slip-Ring Clutch Tachometer vi) Centrifugal-Force Tachometer vii) Vibrating Read Tachometer. viii) Electrical Tachometer:- D.C. or A.C. tachometer generator ix) Photoelectric tachometer x) Toothed rotor Variable Reluctance Tachometer. xi) Stroboscopic tachometer.		2Marks for any four types.
(g) ANS	List desirable characteristics for force measuring sensor. i) Nominal Force ii) Sensitivity iii) Zero signal iv) Nominal displacement v) Stiffness vi) Fundamental frequency		2 Marks for any four types.



2

Attempt any THREE

3 X 4 = 12

(a) Differentiate between Accuracy and Precision.

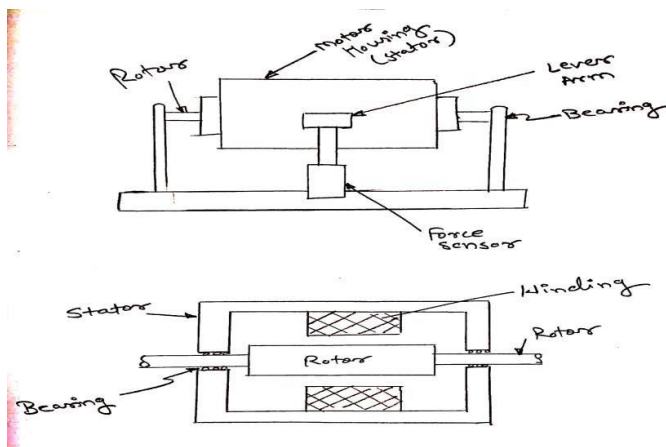
Accuracy	Precision
It is the closeness with which an instrument reading approaches to the true value of the quantity being measured.	It is the degree of reproducibility among several independent reading of the same true value under specified condition.
It is expressed as the limit of error of a measuring device	It is composed of two characteristics, conformity and no of significant digits
Accuracy of measurement means conformity of the truth.	Precision refers to degree of agreement within group of measurement.
Expressed on the basis of % actual scale or full scale reading. Accuracy necessarily is with precision	Precision in measurement does not guaranty accuracy
Measurements are dependent on the systematic errors	Measurements are dependent on the random errors.
Determined by proper calibration	Determined by statistical analysis.

Any 04
difference
(01 mark
each)

(b) Explain working principle of Slip Ring with neat sketch.

ANS

The principle is based on torsion part of shaft and its torsion. Measurement of torsion of the shaft is possible in several ways. For a torque measurement we must place these strain gauge in this way. For pressure, tension and bending measurement the position of strain gauges are different for the transfer of the signal from moving rotor to stator terminals the slip rings are used in this way the signal is partly interfered. It is also possible to use instead of slip rings the special contacts with mercury or contactless telemetry datatransfer.



2 Marks for
Explanation

2 Marks for
Fig.

(c) Compare Radiation and Optical Pyrometer.

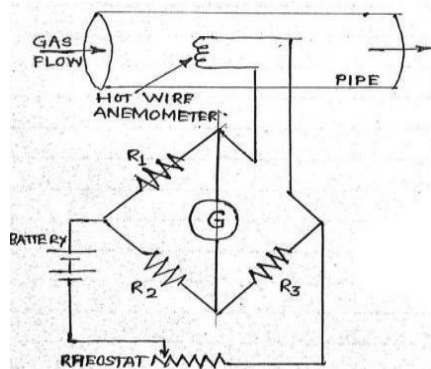
ANS

Radiation pyrometer	Optical Pyrometer
Temp Range: 15° C to 3000° C	Temp Range: 700 to 4000° C
Sensitivity is fair	Sensitivity is good
Calibration by comparing with standard optical pyrometer.	Calibration against standard tungsten strip lamp
All radiations are considered	Monochromatic radiation
More Accurate	Comparatively less Accurate

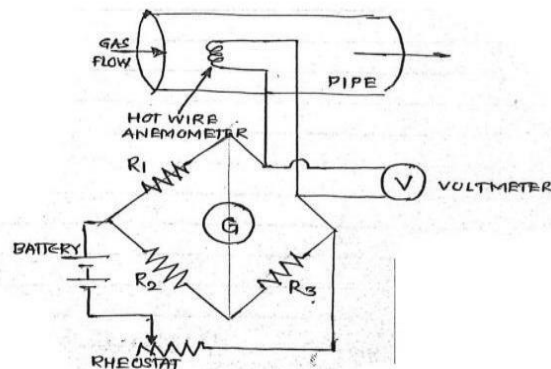
Any 4 Pts (1 Mark for each)

(d)

Explain the working of Hot Wire Anemometer.



Constant Current Method



Constant Temperature Method

2 Marks for Fig.

Hot wire anemometer measure the mean and fluctuating flow of **gases**. The sensor is a 5 micron diameter platinum-tungsten wire welded between the two prongs. This wire heated electrically as part of a wheat-stone bridge circuit. When the probe is introduced into the flowing fluid, it tends to be cooled by instantaneous velocity. So, tendency for the electrical resistance to diminish.

The rate of cooling of wire depends upon the -

- Dimension and physical properties of wire
- Diff. of the temp. between wire and the fluid
- Physical properties of the fluid
- Stream velocity under measurement

First three conditions are effectively constant and the instrument response is then a direct measurement of the velocity change.

Depending on the electronic equipment, hot wire may be operated in two ways;

- Constant current mode:

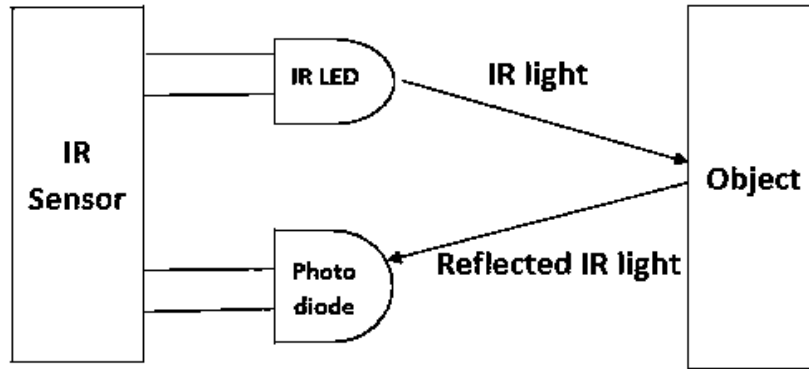
2 Marks for Explanation



	<p>→ Constant temperature mode: Constant current mode:</p> <p>The heating current i.e. voltage across the bridge is kept constant. Initially the circuit is adjusted such that the galvanometer reads zero when the heated wire is in stationary air.</p> <p>When the air flows, the hot wire cools and resistance changes and the galvanometer deflects.</p> <p>The galvanometer deflection is amplified, measured and correlated with air velocity</p> <p>Constant temperature mode:</p> <p>Temperature of filament is kept constant. Hot wire loses heat (decreases temperature) by the flowing fluid. The external bridge voltage is applied to the wire to maintain a sensibly constant temp. The bridge voltage is varied so as to bring the galvanometer needle to zero. The reading on the voltmeter is recorded and correlated with air velocity.</p>	
3	<p>Attempt any THREE</p>	
	<p>(a) Explain term drift and sensitivity.</p> <p>Drift: Drift is an undesired gradual departure of instrument output over a period of time that is not related to change in inputs or load. It is nothing but undesired reading shown by instrument. Factors responsible to cause drift such as long time uses without calibration, friction and environmental factors.</p> <p>Sensitivity : It is defined as the faster response given by instrument after changing input. It is the ratio of the magnitude of output signal to the magnitude of input signal. Represented by (K). $K = \frac{\text{Change in output signal}}{\text{Change in Input signal}}$</p>	<p>3 X 4 = 12</p> <p>2 marks</p> <p>2 marks</p>
	<p>(b) Draw block diagram of generalized measurement system</p> <pre> graph LR A[Physical variable to be measured] -- Input signal --> B[Primary sensing Element] B --> C[Variable conversion element] C --> D[Variable manipulation element] D --> E[Data processing element] E --> F[Data presentation element] F --> G[Observer] </pre>	<p>4 marks for fig.</p>

(c)

Explain infra-red sensor with neat sketch



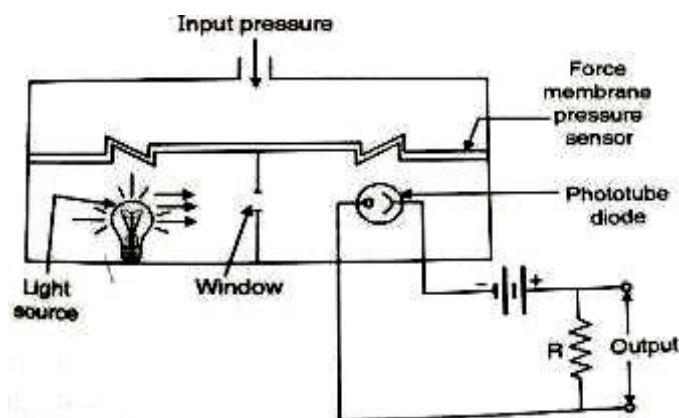
2 marks for fig.

- Infra Red (IR) sensor is an electronic device that emits the light in order to sense some objects of the surrounding.
- An IR sensor can measure the heat of an object as well as detects the motion.
- The radiations are invisible to our eyes but IR sensors can detect these radiations.
- IR sensors available in two types
 - Active IR sensor and
 - Passive IR sensor
- An IR sensor consists of an IR LED and IR photodiode
- Infrared LED emits infrared radiations and infrared photodiode detects the radiation from an IR LED
- When the IR transmitter emits radiation it reaches the object and some of the radiation reflects back to the IR receiver based on the intensity of the reception by the IR receiver the output of the sensor defines.

2 marks

(d)

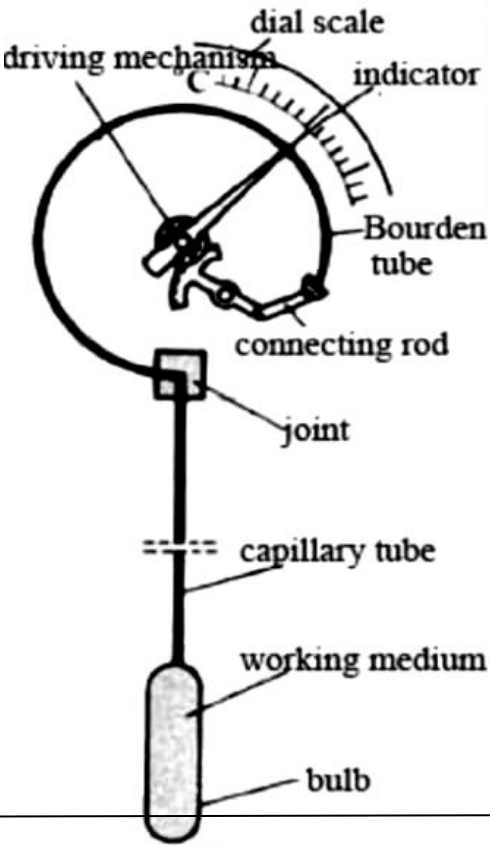
Explain working principle of Photo electric pressure transducer with sketch.
Photoelectric pressure transducer



2 marks for fig.



	<p style="text-align: center;">Figure: Photoelectric pressure transducer</p> <p>It consist of port for input pressure ,Pressure sensing member like diaphragm ,light source a small window, a photo tube with output circuit. The function of pressure sensing element is to control the aperture of small window. The amount of output is entirely depends upon the amount of incident light falling on phototube. When the pressure to be measured is applied through port to the pressure sensing member, it changes the positionof window. As the light source and phototube are separated by a window it changes the amount of light falling on phototube, causing change in the current. This change in currentis approximately linear with displacement of window i.e applied pressure. The current in phototube is amplified by a suitable output circuit. A meter connected across output terminal can directly calibrate in terms of pressure measurement. An A.C Modulated light or stable source of light can be used for incident light.</p> <p>Advantages:</p> <ol style="list-style-type: none">1. It can measure both static & dynamic pressure.2. It is highly efficient3. Easy portability4. Compact size.	2 marks
4.	Attempt any THREE	3 X 4 = 12
(a)	<p>Draw creep curve for force transducer.</p> <p>Creep of a force transducer is usually define as the change of output with time following a step increase in force from one value to another</p> <p style="text-align: center;">Creep recovery</p>	4 marks For fig.
(b)	<p>Enlist any four applications of Optical pyrometer.</p> <ol style="list-style-type: none">1. It is useful to measure furnace temperature.	4 marks for four Applica

	<p>2. It is used to measure the temperature of highly heated materials.</p> <p>3. It is used to measure temperature of molten metal in heat treatment processes</p> <p>4. It is used in steel industries, plastic industries, glass manufacturing etc.</p> <p>5. It is used in critical process measurements of semi conductor, induction heat treating, crystal growth, medical etc.</p> <p>It is used in graphite rod manufacturing industry</p>	<p>-tions</p>
<p>(c)</p>	<p>Draw labeled diagram of Pressure Thermometer</p> 	<p>2marks for fig.</p> <p>2 Marks for labeled.</p>
<p>(d)</p>	<p>Explain the procedure of strain measurement of cantilever beam</p> <p><u>Strain measurement of cantilever beam</u></p> <ul style="list-style-type: none"> ○ Measuring the strain in cantilever beam can be done through the use of four resistance strain gauges. ○ 2 strain gauges mounted on top of the beam and two mounted below. ○ Static load will be incremented at different locations along the beam to produce measurable strains. ○ In many applications strain gauges are used with Wheatstone bridge circuit which consists of four resistors in an electrical circuit. ○ As the load is subjected to cantilever beam the strain get induced in the beam also the strain gauges get stretch tensile stress get developed resulting in change in resistance. 	<p>2 Marks for Explanation</p>



- The Wheatstone bridge circuit get unbalance due to change in resistance
- This change in resistance is calculated and can be taken as strain of the cantilever beam.
- With every increasing load the value of strain get changed.

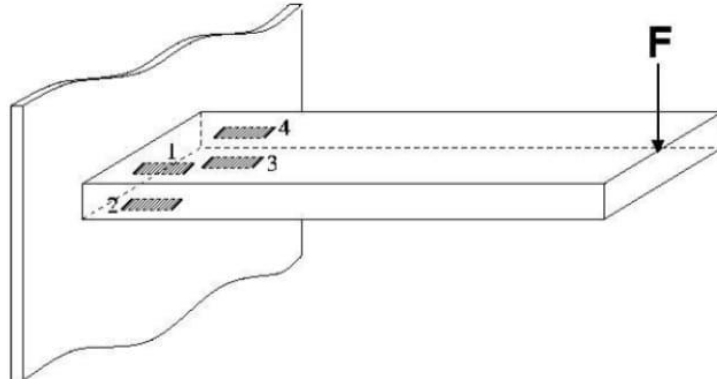


Fig. Cantilever beam with four strain gauges

2marks for fig.

(e)

Write sound level norms as per API

Four cylinder IC engine - 70-80 dB

Centrifugal pump - 80-85 dB

Lathe machine - 70-85 dB

Industrial exhaust fan - 85 dB

4 marks

1 mark for each

5.

Attempt any TWO

2 X 6 = 12

(a)

Write two application of following

i) Contact Transducer :

- Hand Tachometer is used for speed measurement of rotating member
- Thermometer is used to measure temperature
- Burdon tube pressure gauge is used to measure pressure
- veturimeter is used to measure flow of fluid

ii) Active transducer:

- Piezoelectric transducer is used to measure pressure, strain, torque etc.
- Dial Indicator is used for surface roughness, calibration, displacement etc.

2 Marks

(Any Two)

2Marks

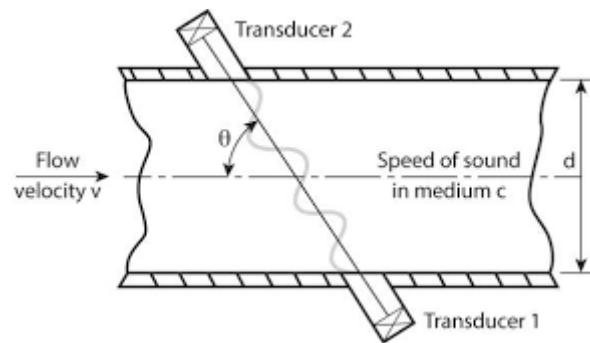
(Any Two)

- mercury thermometer to measure temperature
- Burdon tube pressure gauge is used to measure pressure
- Thermocouple is used for temperature measurement of gas turbine exhaust, diesel engines, and other industrial processes.
- **Non-Contact Transducer**
- Stroboscope is used to measure speed of rotating member
- Infrared thermometer is used to measure temperature of a body
- Optical Pyrometer is used for high temperature measurement
- Sound level meter is used to measure sound in dB.

2 Marks
(Any Two)

(b)

Draw and explain working of ultrasonic flow meter



The working principle of ultrasonic flow meter is, it uses sound waves to resolve the velocity of a liquid within a pipe. There are two conditions in the pipe like no flow and flowing. In the first condition, the frequencies of ultrasonic waves are transmitted into a pipe & its indications from the fluid are similar. In the second condition, the reflected wave's frequency is dissimilar because of the Doppler Effect.

Whenever the liquid flows in the pipe quickly, then the frequency shift can be increased linearly. The transmitter processes the signals from the wave & its reflections determine the flow rate. Transit time meters transmit & receive ultrasonic waves in both the directions within the pipe. At no-flow condition, the time taken to flow in between upstream & downstream in between the transducers is the same.

Under these two flowing conditions, the wave at upstream will flow with less speed than the downstream wave. As the liquid flows faster, the distinction between the up & downstream times raises. The times of the upstream & downstream processed by the transmitter to decide the flow rate.

2 Marks
(Dig.)

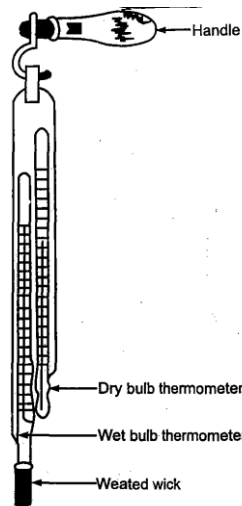
(4 Marks for Working)

(c)

Draw the constructional details of 'sling psychrometer'. Write the procedure of measuring air properties using sling psychrometer and Psychrometric chart

Construction details :

- The equipment used to measure dry bulb and wet bulb temperature simultaneously is known as 'Psychrometer'.
- The sling psychrometer consists of two mercury thermometers mounted on frame, which has handle provided for rotation of psychrometer.



- One bulb among the two is covered with the wet cotton to read wet bulb temperature. And the other shows the dry bulb temperature.
- After getting both the temperature find relative humidity by using psychrometric chart, the method of measurement is explain bellow.

Humidity Measurement By Dry And Wet Bulb Thermometer - Psychrometric Chart

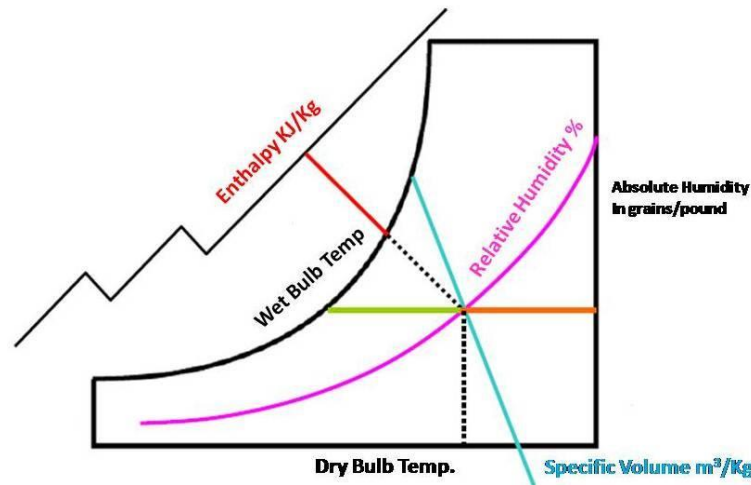
- The absolute and relative humidity is determined by a psychrometer, a device containing two thermometers.
- The temperature sensing bulb of one measure the environmental temperature indicates the dry bulb temperature.
- Around the bulb of other thermometer wet cloth is wound which evaporate water to produce cooling which indicates the web bulb temperature.
- For this reason, the psychrometer is known as dry and wet bulb thermometer.
- Relative humidity is related to the difference between the dry and wet bulb thermometer.
- Also, the key to humidity measurement is the psychrometric chart, which graphically describes the properties of moist air.

(2 Marks for const.)

(1 Marks Dig.)

(2 Marks Expl.)

- The relationship between various humidity variables such as wet and dry bulb temperatures, dew point and percent relative humidity and grains of moisture per cubic meter of air etc. at specified atmospheric pressures are given in the form of chart known as the psychrometric chart shown in Fig.



(1 marks dig.)

As shown in Fig.

- The dry bulb temperature lines are vertical, and dry bulb temperature read at the bottom of the chart.
- The wet bulb and dew point temperature lines run diagonally downward to right, and their values are read at the left where the lines intersect with the 100% relative humidity line.
- The percent lines of relative humidity curve upwards to the right, with the percent values indicated on the lines themselves.
- The absolute humidity in grains per pound of air is read on the vertical scale at the horizontal line that leads from intersection of a wet bulb or dew point temperature line with a dry bulb line.

6.

Attempt any TWO

2 X 6 = 12

(a)

Write any two applications of following

Orifice meter:

- It is used to measure the flow rate of fluids in their single state (i.e. gaseous state or liquid state).
- It can also be used to measure the flow rate of fluids in a mixed state (both gaseous and liquid states) such as, wet steam, or natural gas with water.
- Also used where robust construction of device is required.

ii. Venturi meter:

- Used where the permanent pressure loss is main problem and where the maximum accuracy is desired in the measurement of high viscous fluids.
- Used to handle slurries and dirty liquids.

iii. Pitot tube:

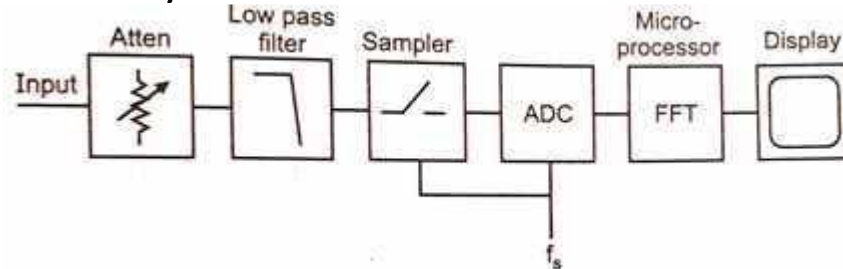
- It is a device used for measuring the velocity of flow at any point in a pipe or a channel.

(2 Marks for each)

- Used to determine flow in very large pipes or ducts.
- Used in aircrafts and missiles.

(b)

Draw flow diagram of FFT analyzer. Enlist any four applications of FFT
Flow diagram of FFT Analyzer:-



Application of FFT Analyzer:-

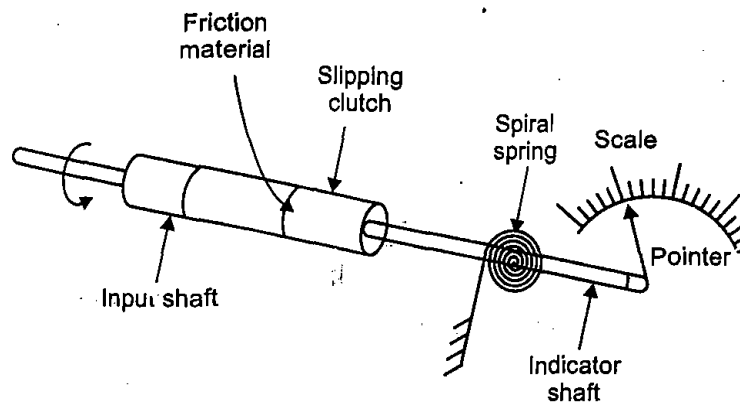
- 1) To measure the transfer function of a mechanical system.
- 2) In forensics, laboratory for measuring the wavelength of light at which a material will absorb in the infrared rays.
- 3) For analysis of sound and vibrations.
- 4) Vibration analysis of various drives and machines.
- 5) It is measure all frequency components at the same time

(2 Marks Dig.)

(4x1 Mark for each application)

(c)

Explain with neat sketch the construction of slipping clutch tachometer



Slipping Clutch Tachometer

- It is mechanical type tachometer.
- It uses mechanical movements for measurement speed.
- A rotating shaft whose speed is to be measured is connected to indicator shaft with the help of slipping clutch.
- Friction material is used to avoid metal contact.
- During the engagement of clutch, the shaft speed is transferred to indicator shaft

3 Marks dig.)

(Explanation 3 Marks)



and spring attached to it.

- The torque on the spring is calibrated in terms of speed which is indicated by pointer moving over a calibrated scale.

END