**SUMMER – 2022 EXAMINATION**

**Subject Name:** Industrial Transducers **Model Answer** **Subject Code:** 22432

**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 |
|---|---|---|---|
| **Q.1** | | **Attempt any FIVE of the following:** | **10 Total Marks** |
| | **a)** | **List any two specification of strain load cell** | **2M** |
| | **Ans:** | Specifications of Strain gauge load cell:<br>1. range of measurement<br>2. material used<br>3. sensitivity<br>4. accuracy<br>5. temperature compensation<br>6. over range | **any two**<br>**1 M for each** |
| | **b)** | **Define speed. State its unit.** | **2M** |

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|---|---|---|---|
| | **Ans:** | Speed as a variable refers to the revolution per minute of some rotating equipment.<br><br>**Units:**<br>I. Meter/ second<br>II. Revolution per minute (RPM)<br>III. Feet per minute<br>IV. Miles per hour<br>V. Yard per minute<br>VI. Production unit per unit time | **definition - 1M**<br><br>**one unit - 1 mark** |
| | **c)** | **List application of L.V.D.T. (any two)** | **2M** |
| | **Ans:** | 1. LVDT is used to measure the physical quantities such as Force, Tension, Pressure, Weight, etc.<br>2. It is mostly used in industries as well as a servomechanism.<br>3. It is also used in Industrial Automation, Aircraft. Turbine, Satellite, hydraulics, etc.<br>4. It is used for thickness measurement | **1M - each application** |
| | **d)** | **State types of vibration.** | **2M** |
| | **Ans:** | **The types of vibrations are**<br>• Free or Natural Vibration<br>• Forced Vibration<br>• Damped Vibration | |
| | **e)** | **Define:**<br>i) **Sound pressure and**<br>ii) **Sound Power** | **2M** |
| | **Ans:** | i) **Sound pressure:** Sound pressure or acoustic pressure is the local pressure deviation from the ambient (average or equilibrium) atmospheric pressure, caused by a sound wave.<br><br>ii) **Sound Power:** the rate at which sound energy is emitted, reflected, transmitted or received, per unit time.<br><br>**OR**<br><br>It is defined as "through a surface, the product of the sound pressure, and the component of the particle velocity, at a point on the surface in the direction normal to the surface, integrated over that surface." | **Sound pressure -1M**<br>**Sound Power- 1M** |
| | **f)** | **List common causes of vibration (any two)** | **2M** |

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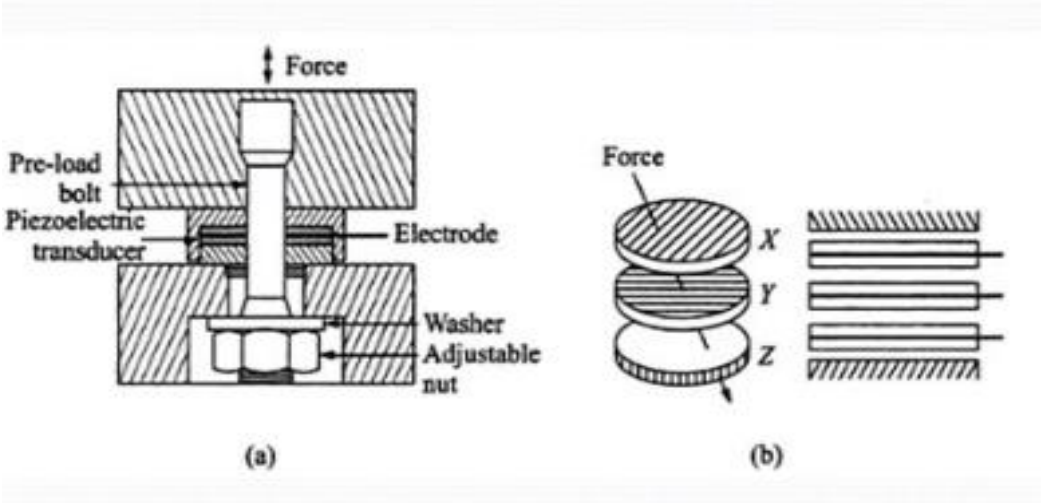
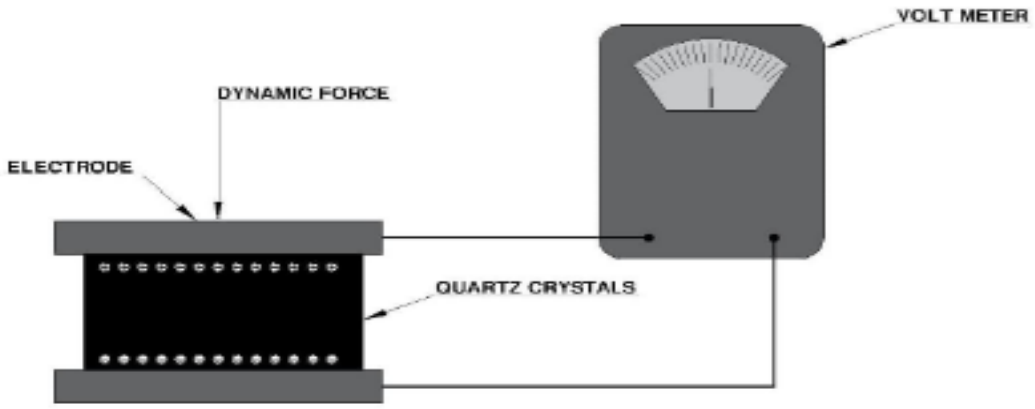
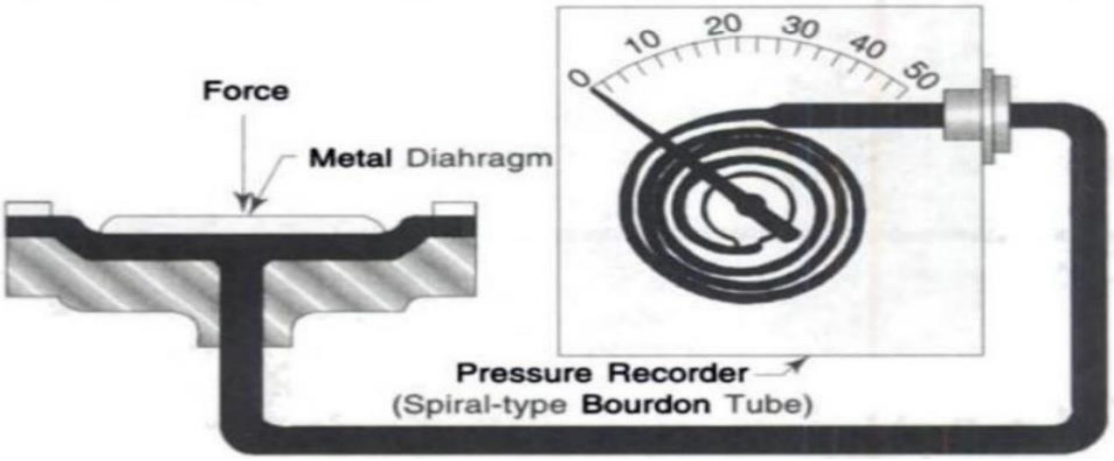
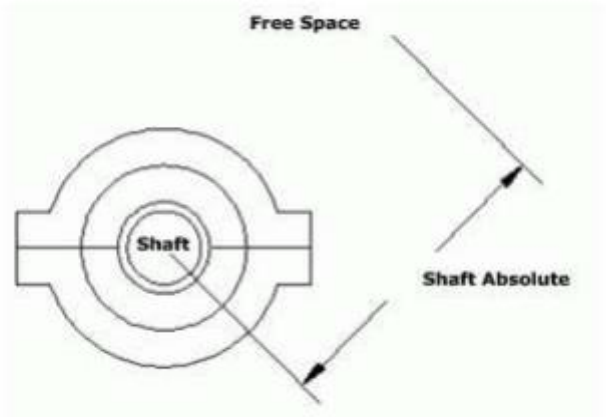
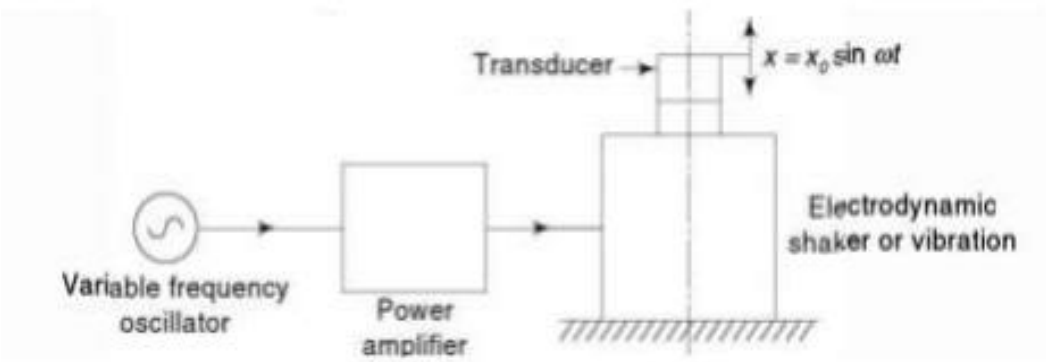
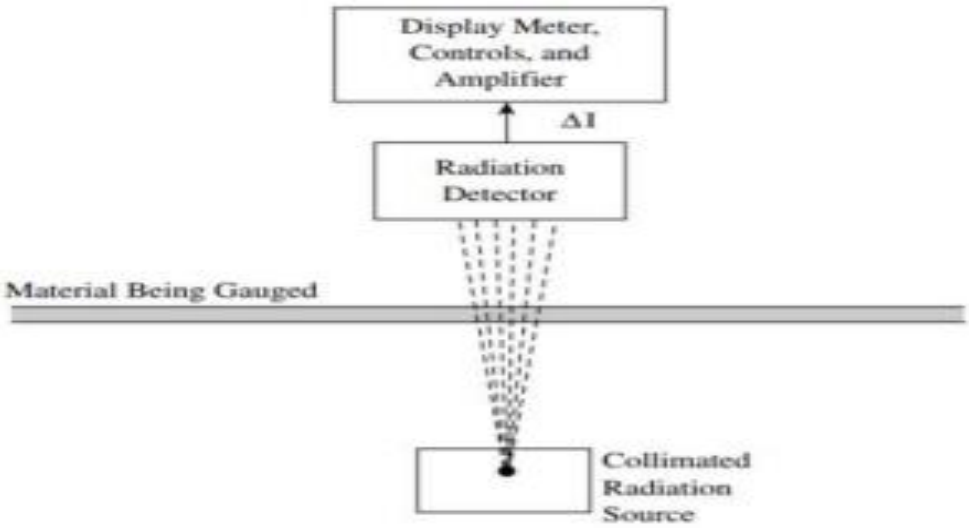
| | **Ans:** | Vibration can indicate a problem and if left unchecked can cause damage or expedited deterioration. Vibration can be caused by one or more factors at any given time, the most common being<br>I. Imbalance<br>II. Bearing failures<br>III. Mechanical looseness<br>IV. Misalignment<br>V. Resonance and natural frequencies<br>VI. Electrical faults in motors<br>VII. Bent shaft<br>VIII. Gearbox failures<br>IX. Cavitation in pumps<br>X. Critical speeds | **1M - each cause**<br>**consider any two** |
| | **g)** | **Sketch the diagram of piezoelectric load cell.** | **2M** |
| | **Ans:** |  <br>**OR**<br>  <br>**Note: Consider relevant diagram** | **Diagram-2M** |

| Q.2 | | Attempt any THREE of the following: | 12-Total Marks |
|---|---|---|---|
| | a) | **Describe calibration procedure of absolute vibration sensor.** | 4M |
| | Ans: |  <br>**Absolute Vibration:** Absolute is a measuring technique that refers to a stationary point in free space. Then absolute vibration is a measurement of vibration (either displacement, speed, or acceleration) measured against a stationary point in free space. Generally absolute vibration measurements only use speed transducers or accelerators. The speed transducer sensor is equipped with a coil as a reference point, while the acceleration transducer uses a mass. Absolute vibration on a machine shaft cannot be measured directly. A real-time measurement method and calculation is needed.<br>  | 1M-Definition<br>3M-Calibration |

| | | | |
|---|---|---|---|
| | | **Calibration of vibration sensors:(NOTE: consider any relevant method or procedure)**<br><br>For Dynamic calibration of displacement, velocity or acceleration measuring devices, an electrodynamics shaker is used. The shaker is driven by a variable frequency oscillator and a power amplifier. The transducer to be calibrated is mounted on the shaker table and moved at circular frequency ω which can be changed by oscillator setting. The amplitude of harmonics can be changed by a power amplifier. Thus amplitude, velocity and acceleration can be read with the help of optical devices. So the vibration transducer is easily calibrated.<br><br>  | |
| | **b)** | **Describe with sketch working principle of radiation type thickness measurement transducer.** | **4M** |
| | **Ans:** |  | **2M-diagram**<br><br>**2M-working** |

It is a Non-contact type of thickness measurement method.

**Radiation Source**

This component generates the radiation that will be applied for measurement. The source may be either natural (radioactive isotope) or artificial (XRay tube), and may project a radiation pattern that is sensitive to alignment with the housing aperture. The beta-radioisotope is used to measure the thickness of sheets or the thickness of coatings on sheets.

• **Material Under Measurement** – Material under measurement may be flat rolled, sheet / strip products, composed of various metals (e.g., steel, aluminum, and copper / brass alloys, etc.) The strip may be stationary or moving.

• **Detection System** – Transmitted / scattered radiation, I (in photons/sec), that results from the incident radiation, $I_0$, penetrating the strip, is collected and measured by this device, which is typically located above the strip and aligned to the optical axis of the radiated beam. • **Detector** – Collected incident radiation is converted to an electrical signal that is functionally related to the radiation intensity .A radiation detector such as Geiger Muller tube , ionization chamber or a scintillation counter is used for measuring the amount of radiation reaching the detector

• **Preamplifier** – The feeble detector signal is amplified to usable amplitudes by a high gain, low noise electrometer / trans-conductance amplifier. To reduce signal noise and interference, it is desirable to place the preamplifier as close as possible to the detector and mounted in a shielded, hermetically sealed enclosure.

• **Signal Processing** – The amplified detector signal requires wide bandwidth signal processing (in both time and amplitude) to render a calibrated measurement of the intensity of the received radiation (i.e., related to material absorption / attenuation). This processing can be provided by real-time digital signal processors or Field Programmable Gate Arrays

- The attenuation of radiation from x-rays or radioactive decay by matter is utilized in the radiation absorption gauge to measure the thickness of the material. The equation is

$$\Delta I = I_o [1 - \exp(-\mu t)]$$

using averaged ionization current for signal,

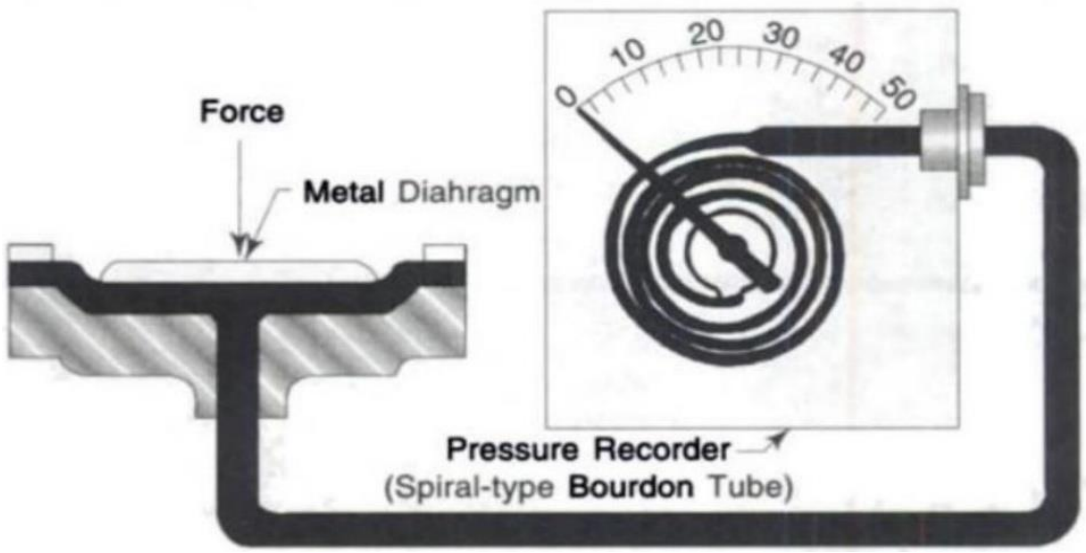
where $\Delta I$ = change in ionization current when absorber is inserted

$I_o$ = ionization current without absorber

$\mu$ = absorption coefficient ($cm^2/\mu g$)

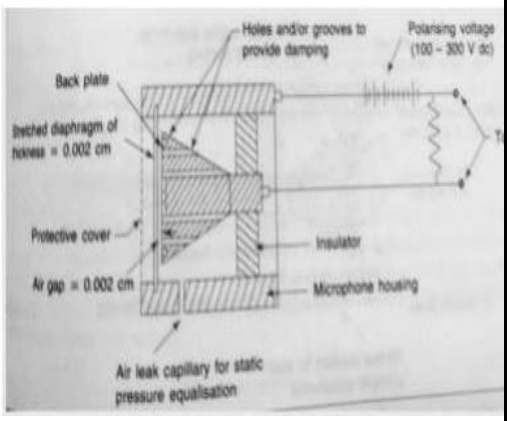
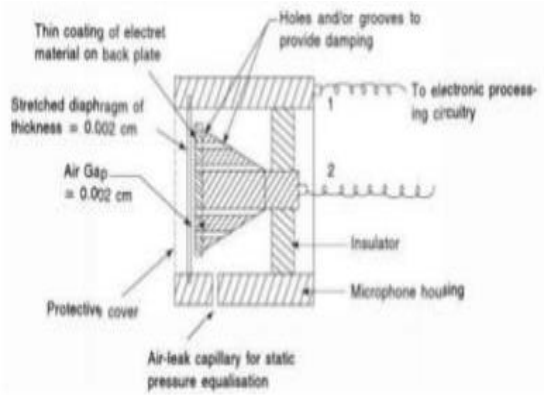
t = thickness ($\mu g/cm^2$)

The display is calibrated to indicate thickness.

| | | | |
|---|---|---|---|
| | **c)** | **State working principle of hydraulic force meter with neat diagram.** | **4M** |
| | **Ans:** |  <br>The hydraulic force meter operates on the principle of a **force counterbalance**. It involves the application of force to a definite area of fluid surface, thus producing hydrostatic pressure in the fluid, which can be measured by a Bourdon tube, manometer or any other type of pressure gauge. The transmitting element between force and pressure may be piston, bellow or diaphragm.<br>**Working**<br>1. The force to be measured is applied to the piston with a loading platform placed on top of the diaphragm.<br>2. The applied force moves the piston downwards and deflects the diaphragm and this deflection of the diaphragm increases the pressure in the liquid medium (oil).<br>3. This increase in pressure of the liquid medium is proportional to the applied force.<br>4. The increase in pressure is measured by the Bourdon tube which is connected to the liquid medium.<br>5. The pressure is indicated by the pointer of the bourdon tube on the calibrated scale and gives the value of the applied force.<br>6. In this an electrical pressure transducer can also be used to obtain an electrical signal. | **2M-diagram 2M-working** |

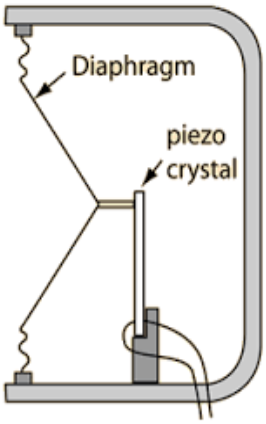
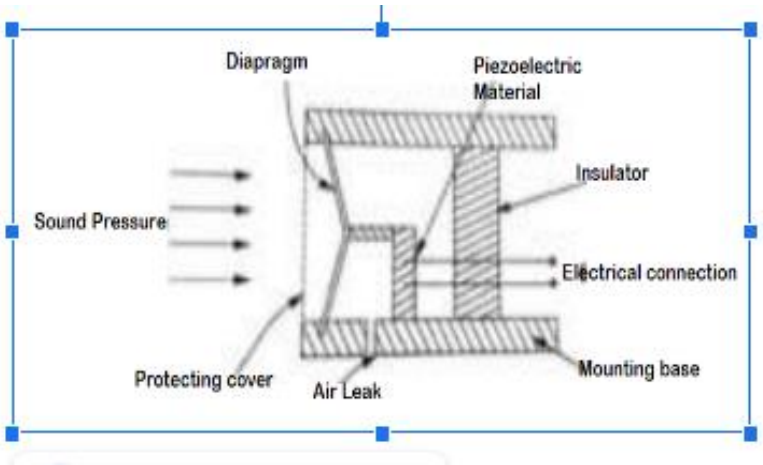
**d) Compare features of condenser type and Electret type of sound measurement transducer.** **4M**

**Ans:**

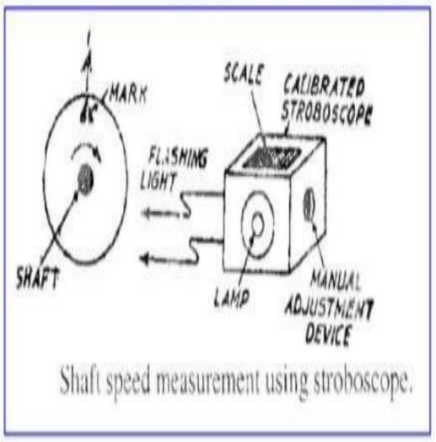
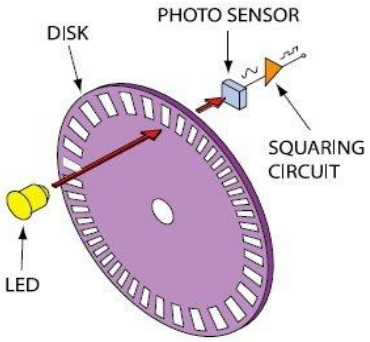
| Sr. No. | Condenser type sound measurement transducer | Electret type of sound measurement transducer |
|---|---|---|
| 1 | The diaphragm and the backplate form the plates of a capacitor. | It consists of two plates, one fixed (called the back plate) and the other moveable (called Diaphragm) with a small gap between them. |
| 2 | The movement of the diaphragm caused by the impingement of sound pressure results in an output voltage | When sound strikes the diaphragm it starts moving, thereby changing the capacitance between the plates which in turn results in a variable electric current to flow. |
| 3 | E α Qd<br>Where, Q = charge provided by the polarizing voltage<br>d = separation between the plates. | Instead of requiring an external voltage source to charge the diaphragm, an electret microphone uses a permanently charged plastic element (electret) placed in parallel with a conductive metal back plate. |
| 4 |  |  |

**1M- each point (any relevant point should be considered)**

| | | | |
|---|---|---|---|
| **Q.3** | | **Attempt any THREE of the following:** | **12- Total Marks** |
| | **a)** | **Describe working principle of piezoelectric type microphone with neat diagram.** | |

| | | | |
|---|---|---|---|
| | **Ans:** | **Diagram**<br>  <br><br>**OR**<br>  <br><br>**working principle** :<br>• Lead zirconatetitanate (PZT) is commonly used in piezoelectric microphones.<br>• The force produced by the acoustic pressure on the diaphragm is used to strain the piezoelectric material which in turn produces voltage output in direct proportion to the applied force<br>• A cantilever type of crystal element is mechanically coupled with the sensing diaphragm.<br>• There is direct contact between the diaphragm and the crystal element either in bending mode or by direct contact.<br>• Piezoelectric microphones are very sensitive and can measure accurately sound pressure level below 24 dB. | **2M**<br>**2M** |
| | **b)** | **Compare working principle of stroboscope and digital encoder with neat diagram.** | |

**Ans:**

| | Stroboscope | Digital Encoder | |
|---|---|---|---|
| Diagram |  Shaft speed measurement using stroboscope. |  | **2M for diagram** |
| Working Principle | 1. A distinctive mark is made on the shaft attached to the rotating object whose speed is to be measured.<br>2. A stroboscope is made to flash light directly on the mark.<br>3. The flashing frequency is adjusted until the mark appears stationary.<br>4. Under these conditions, speed is equal to flashing frequency.<br>5. The scale of the stroboscope is calibrated in terms of speed which can be directly read off. | 1 Any transducer that generates a coded reading of a speed measurement is known as encoder.<br>2. Digital optical Encoders use a glass disc with a pattern of lines deposited on it, a metal or plastic disc with slots or glass or metal strips.<br>3. Light from LED shines through the disc or strip onto one or more photo detectors which produces encoder output.<br>4. An incremental encoder has one or more of these tracks while an absolute encoder has many tracks while an absolute encoder has many tracks as it has output bits<br>5. Output is in digital calibrated in terms of speed | **1 mark each for difference** |

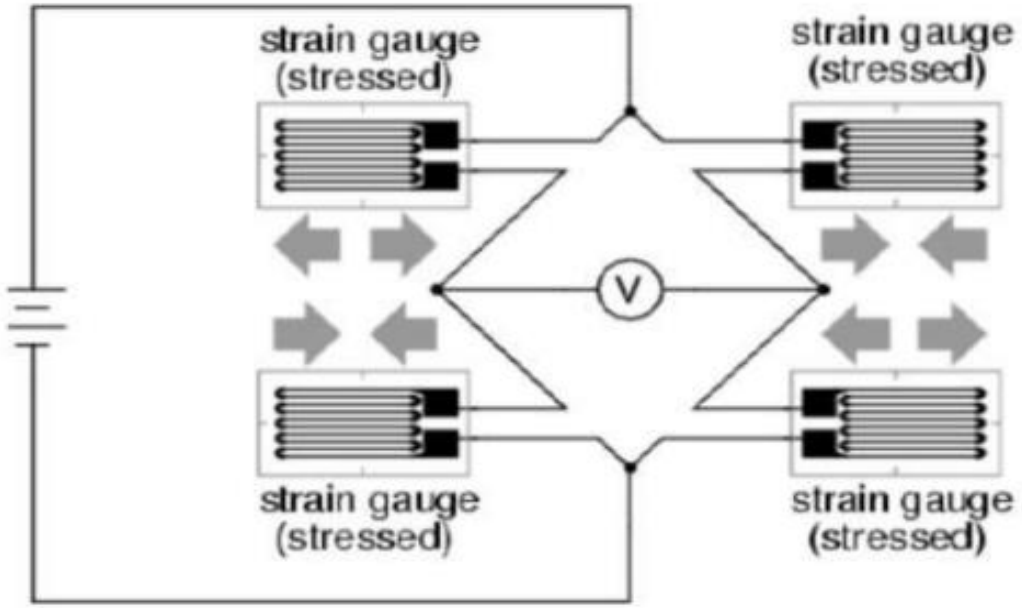
**c)** **Prepare specification of AC tachometer. (Any four)**

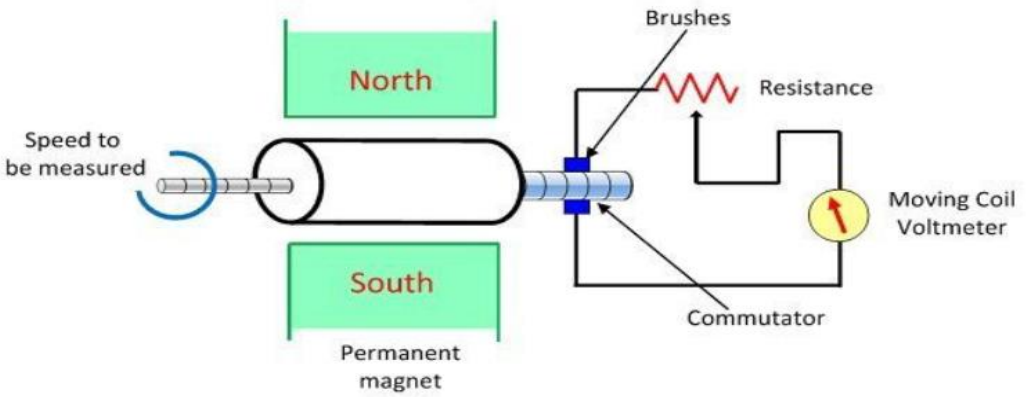
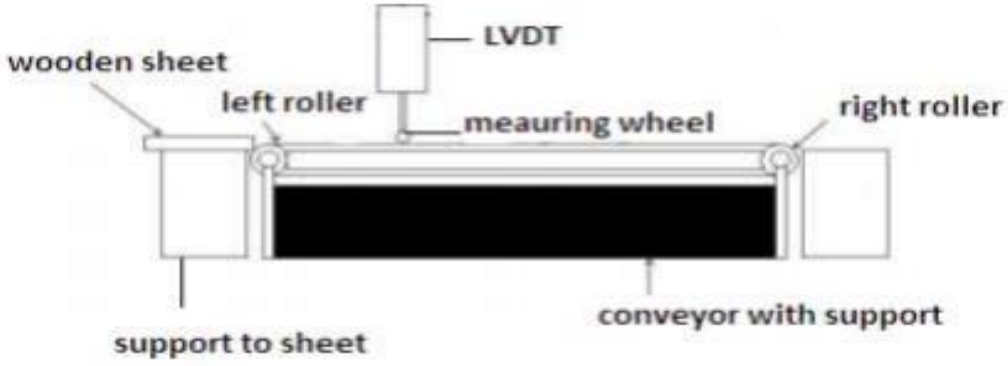
**Ans:**

1. Voltage output.
2. Accuracy.
3. EMF vs Speed Linearity.
4. Shaft Diameter.
5. Temperature Coefficient.
6. Internal Resistance.
7. Maximum Operating Temperature.
8. Frequency at 900 rpm.

**Note: consider any four**

**each specification-1 Mark**

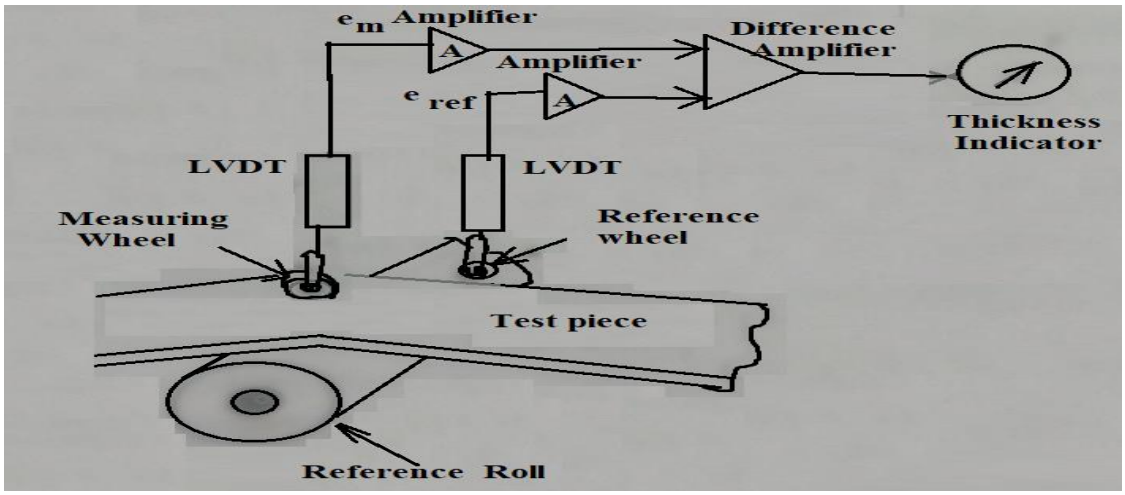
| | | | |
|---|---|---|---|
| | **d)** | **Describe calibration procedure for strain gauge. Load cell weight measurement setup.** | |
| | **Ans:** |  <br>**Steps to Calibrate Load Cells in Weighing Applications:**<br>• Before calibrating load cells, inspect whether the machine is giving correct measurement data. The key indicators are :<br>  ○ When the system is unloaded or empty, the weight indication should return to zero.<br>  ○ The indicated weight must be doubled when the weight is doubled.<br>  ○ Irrespective of where the load is placed, the weight indicator should give equal readings.<br>• Check the electric wires cables attached with it<br>• Check the bridge circuit with<br>  ○ Bridge Resistance with load and without load<br>  ○ voltage value at balance condition<br>  ○ Resistance between cell body and ground<br>• Physical Inspection: check for dents and cracks on all sides of load cell. if the load cell is not in its original shape and is altered- compressed, bent, or stretched, you need to replace the cell.<br>**Note: Consider relevant answer** | **4M** |

| Q.4 | | Attempt any THREE of the following: | 12- Total Marks |
|---|---|---|---|
| | a) | **Describe troubleshooting procedure of DC tachometer.** | 4M |
| | Ans: |  <br>**Troubleshooting Procedure.**<br>i. Identify the fault by usual inspection.<br>ii. Check the supply lines to the DC tachometer.<br>iii. Disconnect the supply lines.<br>iv. Check the continuity using a multimeter (DMM).<br>v. Check the commutator and brush assembly status for measurement.<br>vi. Check the output resistance of DC Tachometer which should be less than input resistance of PMMC. | 2M- diagram 2M- working |
| | b) | **Select relevant thickness measurement transducer for measurement of foil thickness with justification.** | 4M |
| | Ans: |  | 2M- diagram, 2M working |

**Working**

• Above figure shows a basic schematic diagram for the measurement of thickness using LVDT.
• A sheet material whose thickness is to be measured is placed on the conveyor belt.
• At a particular distance from the measuring sensor's LVDT, the object is placed on the belt.
• The conveyor is programmed to move the sheet at a particular speed towards the LVDT.
• The LVDT sensor is installed with a measuring wheel attached to the core which is freely suspended from rigid support to move on the conveyor.
• LVDT converts the thickness of the sheet into voltage which is proportional to thickness of object.
• As the wooden sheet reaches the LVDT, displacement of the measuring wheel takes place due to the thickness of the sheet. This displacement of LVDT core will cause change in mutual inductance of the coil which results in change in the output of LVDT.
• This change in the output is analogous to the thickness of the sheet. The output of LVDT is given to a local controller and for further transmission and Data acquisition. The sheet can be collected at the second roller of the conveyor.

Thickness α Voltage **OR**

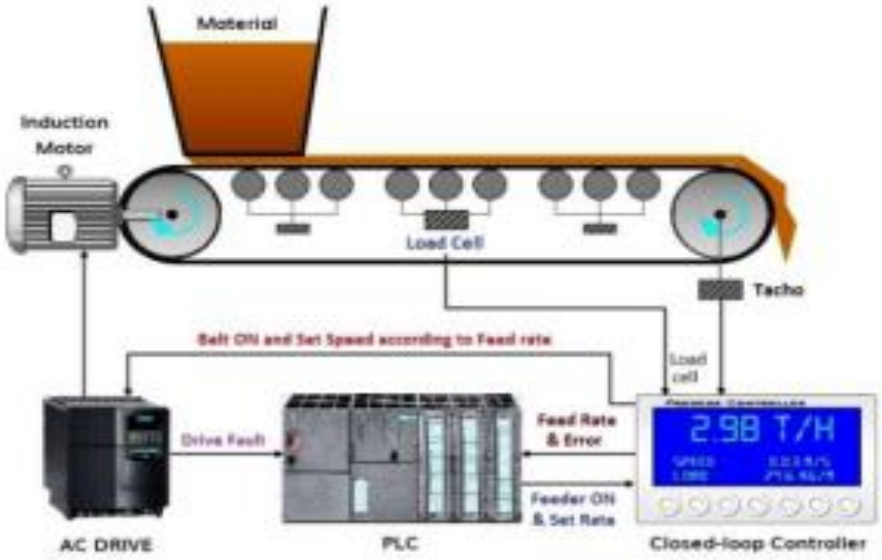
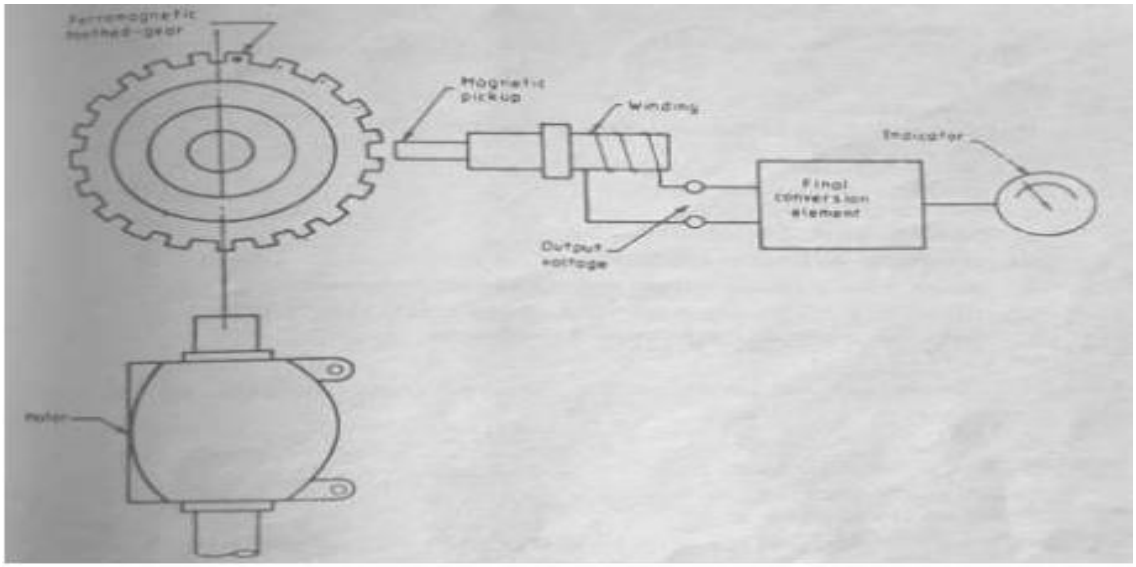



1. The differential dial gauge adapts the calipers to continuous measurement by using rolling contact points and indicating the difference between a reference wheel usually on a calendar roll, and the measuring wheel on the sheet stock.
2. Thickness signal is derived from the output of a linear variable differential transformer (LVDT)
3. The thickness t can be calculated as
   I. $t=k(e_m - e_{ref})$

| | | | |
|---|---|---|---|
| | | where, t = thickness of test piece (mm)<br>k = calibration constant (mm/volt)<br>$e_m$ = output of measuring LVDT (volt)<br>$e_{ref}$ = output of reference LVDT (volt)<br><br>The output voltage of the LVDT can be calculated as<br>$e_{out} = (e_{s2} - e_{s1})$<br>where, $e_{out}$ = output signal of LVDT (volt)<br>$e_{s1}$ = output signal of 1st secondary winding of LVDT (volt)<br>$e_{s2}$ = output signal of 2nd secondary winding of LVDT (volt)<br><br>The difference between the secondary voltages caused by displacement of the movable iron core (armature) is linearly proportional to the displacement. With the proper power source and input mechanism, dimensional gauging from point 0.0254 mm to several cm(0.001 in. to several inches) is possible. The accuracy is independent on the finish of the calendar roll. A single roller dial gauge contacting the stock would rely on the accuracy of the backing roll for overall accuracy. | |
| | **c)** | **Prepare specification of Electromechanical relative vibration pick-up transducer. (Any four)** | **4M** |
| | **Ans:** | • Resonant Frequency measurement and detection<br>• Temperature of operation<br>• Sensitivity<br>• Type of output: analog or digital.<br>• Frequency response<br>• Size of sensor based on object under test<br>• Range of vibration<br>• Type of application | **1 M each** |
| | **d)** | **Describe calibration procedure of sound measurement measuring system.** | **4M** |

| | | | |
|---|---|---|---|
| | **Ans:** | • Microphones are individually calibrated at the factory, and the calibration chart must be delivered with the instrument.<br><br>• In the field, calibration is performed by applying a known sound pressure level at a fixed frequency to the microphone. Calibrators are small, battery driven and operate on different principles. One operates at 250 Hz and produces a sound level of 124 dB, accurate to + 0.2 dB.<br><br>• To obtain the best results, the microphone should be well sealed in the coupler opening. A change in atmospheric pressure alters the calibration level slightly, but a correction can be made using the barometer which is provided as a part of the instrument set.<br><br>• Another example is a pocket unit, which operates at 1000 Hz. The calibration level is 94 dB with an accuracy of + 0.5 dB. The use of a calibrator as defined by IEC 60942 is recommended for checking the accuracy of hand-held<br><br>indicating instruments, and must be used when tape recording data, as explained previously.<br><br>• Accurate calibration of equipment used in the field is essential as it provides for consistency in measurements, allows accurate comparison of measurements made over long time intervals, brings to light any slight changes in the accuracy of instrumentation, and allows a reanalysis of data, if this is required at a later date.<br><br>• This care in the use of calibration for field measurements should be backed up by regular laboratory calibration using more accurate techniques, in order to check the frequency response as well as the amplitude response of the equipment. | **4 marks** |
| | **e)** | **Describe troubleshooting procedure for pressductor load cell.** | **4M** |
| | **Ans:** | ● Visual inspection for noticeable damage.<br>● Power the system up and make sure all connections are made and verify that batteries have enough voltage and are installed.<br>● If everything appears to be working, but the output does not make sense, check for mechanical issues. Some load cells have internal stops that may cause the output to plateau. Make sure any adapters threaded into the transducer are not bottoming out.<br>● Check and make sure the leads (all wires) are properly connected to the load cell and meter.<br>● Inspect the cable for breaks - With everything hooked up proceed to test the cable making a physical bend every foot .<br>● Check for continuity of the cable (pin each individual connection) – If the cable is common to the system, check another load cell and verify the other cell is working properly.<br>● Use a load cell tester or another meter to check the zero resistance of the load cell – If you do not have a load cell tester you can check the bridge resistance with a common multimeter<br>● Check voltage and current on the power supply. | **4 Marks** |

| Q.5 | | Attempt any TWO of the following: | 12- Total Marks |
|---|---|---|---|
| | a) | **Explain in detail calibration procedure for conveyor belt weight feeding system with neat diagram.** | 6M |
| | Ans: | **Instruments used in weigh feeder system**<br>• Closed-loop controller<br>• Load cell<br>• Tacho<br>• AC Drive<br>**Steps to Calibrate Load Cells in Weighing Applications:**<br>Before calibrating load cells, inspect whether the machine is giving correct measurement data.<br>We have mentioned three key indicators to evaluate whether the load cells and transducers are functioning correctly, these are:<br>1. When the system is unloaded or empty, the weight indication should return to zero.<br>2. The indicated weight must be double when the weight is doubled.<br>3. Irrespective of where the load is placed, the weight indicator should give equal readings.<br>**• Provided that all the conditions are met, it is safe to conclude that the load cells and transducers are working.**<br>follow the next steps.<br>1. Load cells can give inaccurate readings due to faulty cables and incorrect installation. Therefore, check the following before calibrating load cells:<br>2. Inspect the electrical cables and wires<br>3. Remember to place dummy cells in place of operational load cells until construction and welding work is finished.<br>**▪ After performing the preliminary tests, if you find that load cells are causing problems, conduct the following tests:**<br>**Physical Inspection:** This involves inspection for any physical damage in the load cell. Also, check for dents and cracks on all sides, if the load cell is not in its original shape and is altered- compressed, bent, or stretched, you need to replace the cell.<br>Bridge Resistance: This test should be done when there is no load and the system is disconnected from the weight controller. Now measure the excitation leads for input resistance, and signal leads for output resistance. Compare the readings with the load cell specifications. out-of-tolerance readings are often caused by power fluctuation.<br>**Zero Balance:** Residual stress in the sensing area can often cause a shift in zero balance. If a load cell is overloaded repeatedly over multiple operational cycles, residual stress builds up. Check the output of a load cell with a voltmeter when the system is empty. It must be within 0.1% of the mentioned zero output signal. If it exceeds the zero balance tolerance band, the cell might be damaged. | **3M- Calibration Procedure**<br>**1M- Diagram** |

| | | | |
|---|---|---|---|
| | | **Resistance to Ground:** Connect the input, output, and ground leads. With the help of an ohmmeter, check the resistance between the load cell body and the leads. If the reading does not reach 5,000 mega ohms, separate the ground wire, and repeat the test. If it fails again, the cell could be damaged. By following these steps, you would not only ensure load cells are functioning correctly but would also be able to prevent and take precautions against any potential damages.<br>  <br><br>**Note: Consider relevant diagram** | |
| **b)** | **With neat diagram describe working of magnetic. Pick-up contact less tachometer.** | **6M** |
| **Ans:** | **Diagram:**<br>  <br> | **3M-Diagram**<br>**3M-Explanation** |

Explanation

- It consists of cylindrical permanent magnet placed behind a soft iron pole piece around which coil is wound.
- The magnetic pickup sensor is placed in front of shaft gear made up of ferromagnetic material whose speed is to be measured. As the gear rotates, magnetic flux in the soft iron pole piece becomes high when tooth of ferromagnetic gear comes in front of the magnetic pickup.
- The flux drops off as the tooth of the gear is passed.
- The voltage is generated in coil which is proportional to the speed at which the gear makes the flux to build up or collapse.
- The output voltage waveform depends upon tooth shape of gear, spacing and thickness of the tooth.
- The output voltage amplitude is proportional to the space between magnetic pickup sensor and surface of gear.
- The frequency of voltage is given by:

$$\text{Frequency} = \frac{\text{Rpm} * \text{No. of teeth}}{60}$$

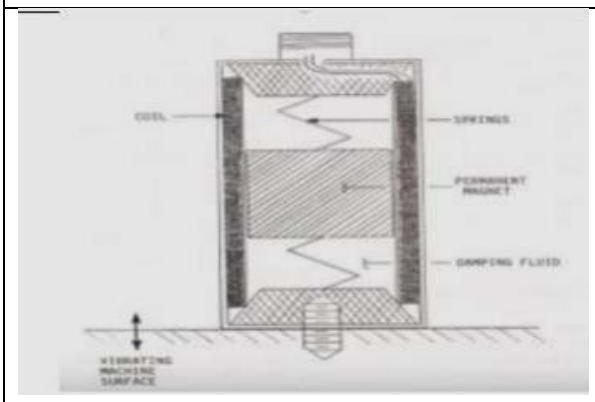
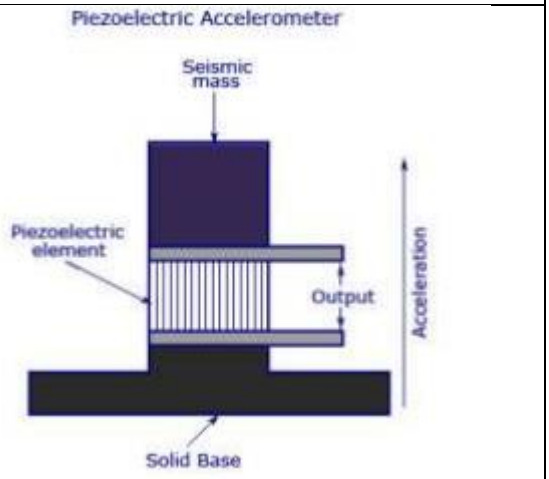
**c)** **Differentiate between relative displacement vibration pick-up and electromechanical vibration pick-up vibration measurement transducer.** **6M**

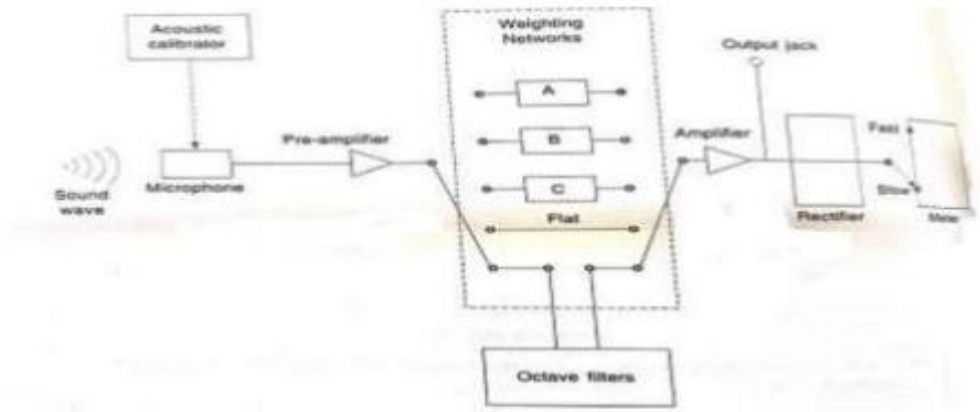
**Ans:**

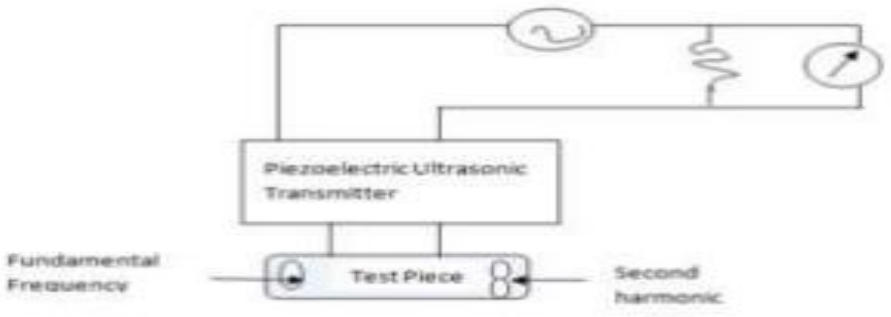
| Electromagnetic Relative Vibration Pickup. | Electromechanical Pickup |
|---|---|
| It is basically Velocity type vibration pickup It is Basically Accelerometer used piezoelectric pickup. | It is basically Velocity type vibration pickup It is Basically Accelerometer used piezoelectric pickup. |
| The electromagnetic seismic harvester is formed by a cylindrical magnetic element with an inner gap where a coil is housed. | The piezoelectric seismic harvester is formed by a cantilever beam with a small block mass at its tip. |
| The two components are connected via soft springs and the coil is fixed to the case of the harvester | The beam is fixed to the harvester case and is equipped with piezoelectric patches, which are bonded on its top and bottom surfaces |
| It is electromagnetic pick –up as the relative motion between the permanent magnet and the coil generates a voltage that is proportional to the velocity of the motion. | Due to the special self-generating property, the crystal produces a voltage that is proportional to the accelerative force. |

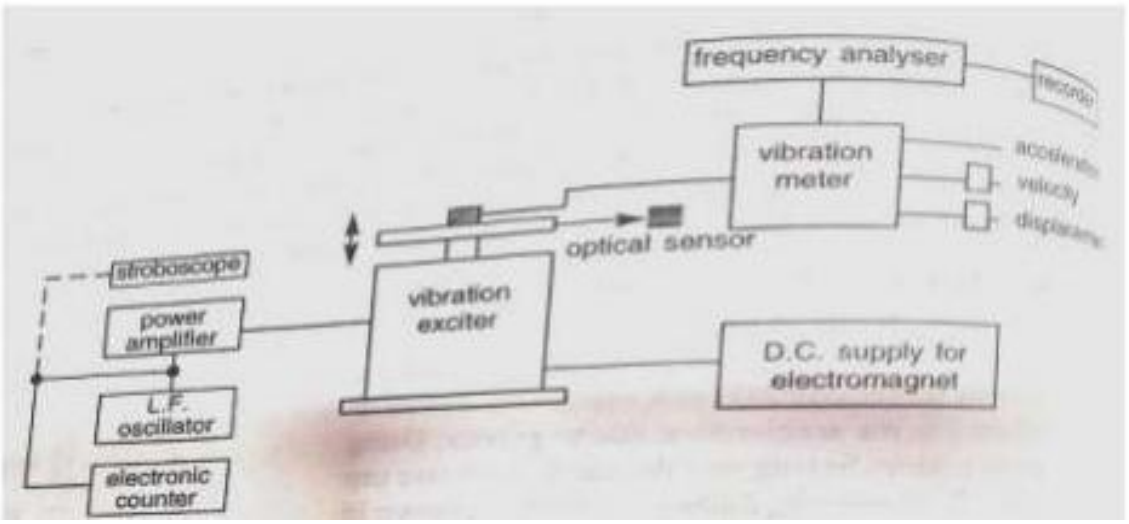
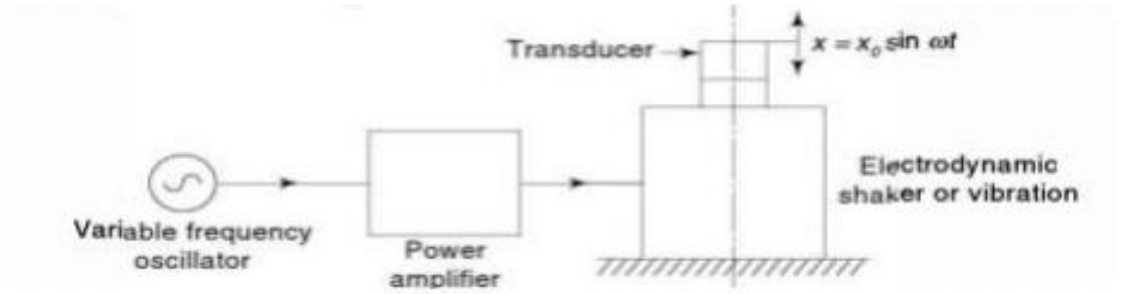
**1M-For each difference**

**Continued….**

| | | | |
|---|---|---|---|
| | | **Electromagnetic Relative Vibration Pickup.** | **Electromechanical Pickup** |
| | |  |   |
| | | On small devices this added mass can significantly affect the vibration output. | its application as a highly accurate vibration measuring device, it is also called a vibrating sensor. |
| **Q.6** | | **Attempt any TWO of the following:** | **12- Total Marks** |
| | **a)** | **Define sound. Give its unit of measurements. Describe working of sound level meter with diagram.** | **6M** |
| | **Ans:** | Sound is a vibration that propagates as an acoustic wave, through a transmission medium such as a gas, liquid or solid. In human physiology and psychology, sound is the reception of such waves and their perception by the brain,<br><br>A sound unit is any acoustic unit of sound measurement.<br><br>• dB, decibel - noise of sound measurement is called decibels (dB). Ratio of the sound pressure to reference pressure to something.<br>• sone - a unit of perceived loudness equal to the loudness of a 1000-hertz tone at 40 dB above threshold, starting with 1 sone.<br>• phon - a unit of subjective loudness.<br>• Hz, hertz = unit of sound frequency is called hertz (Hz) | **1M- Definition**<br><br>**1M- Units**<br><br>**2M- Diagram**<br><br>**2M- Explanation** |

| | | | |
|---|---|---|---|
| | | **Diagram:**<br>  <br><br>**Working:**<br>• Sound level meters convert acoustic pressure into a voltage. Figure shows the block diagram of a typical sound level meter.<br>• The system contains a microphone, an electric amplifier with frequency weighting network and a recorder/meter calibrated in decibels.<br>• Microphone converts sound pressure variations into analogous electrical signals. It uses a thin diaphragm to convert pressure into motion. Motion is then converted into a suitable electrical output using a secondary transducer like, capacitor type, piezo - electric type, electro dynamic type and carbon granules type.<br>• Signal is amplified and applied to a frequency weighing network. The frequency weighting network provides a response similar to that of a human ear.<br>• Three standard weighing networks, A, B and C are used to approximate the equal loudness curve. These give different amount of amplification for each frequency.ie, it provides greater amplification for frequencies between 500 and 5000Hz.<br>• A rectifier circuit included produces a signal proportional to the root mean square value. Finally the electrical signal is given to a recorder or meter. | |
| | **b)** | **Describe the construction and working of ultrasonic vibration type thickness measurement transducer with diagram. List it's applications.** | **6M** |

| | | | |
|---|---|---|---|
| | **Ans:** | **Diagram:**<br>  <br> | |
| | | **Explanation:**<br>• The transducer is placed on the top of test piece and ultrasonic vibrations are passed through it.<br>• The frequency of the oscillator is varied and standing waves are setup at certain frequencies. • The values of these frequencies are based on the thickness of test piece. A standard frequency used by an ultrasonic thickness gauge is 5 MHz.<br>• Thickness is calculated as<br>$t = 0.5 \frac{v}{f}$<br>• where t= thickness (m, cm, ft) , v= velocity of sound, f=frequency of response.<br>• When used as a high ultrasonic transmitter (generally >500KHz), piezo film is normally operated in the thickness mode. Maximum transmission occurs at thickness resonance. The basic half wavelength resonance of 28μm piezo film is about 40 MHz.<br>**Applications:**<br>• Ultrasonic transducers are even better than infrared sensors. These are not hampered by dust, black particles, water, smoke, and even temperature variations. Thus, ultrasonic transducers suppress background interference better than other infrared devices.<br>• Ultrasonic transducers are used for accurate measuring of different elements like minute defects, low depths, and high distances.<br>• Ultrasonic transducers can work in several types of mediums, materials, and environments. These are easy to carry and can be taken to difficult-to-reach sites without any hassles or difficulties. | **2M-Diagram**<br>**2M-Explanation**<br>**2M-Applications** |
| | **c)** | **Describe in detail the calibration procedure of relative displacement vibration pick-up transducer.** | **6M** |

| | | | |
|---|---|---|---|
| | **Ans:** | **Diagram:**<br>  <br> | **2M-Diagram** |
| | | Calibration of vibration sensors: (NOTE: consider any relevant method or procedure)<br><br>For Dynamic calibration of displacement, velocity or acceleration measuring devices, an electrodynamic shaker is used. The shaker is driven by variable frequency oscillator and a power amplifier. The transducer to be calibrated is mounted on the shaker table and moved at circular frequency ω which can be changed by oscillator setting. The amplitude of harmonics can be changed by power amplifier. Thus amplitude, velocity and acceleration can be read with help of optical device. So as vibration transducer easily calibrated.<br>  <br><br><br>**Note: Consider relevant diagram** | **4M-Calibration procedure** |