Time :- 03 Hours   **Max. Marks :- 80 Marks**

(i)   Question No. 1 is compulsory & attempt any four out of the remaining five questions.
(ii) Assume suitable data if required but justify it logically wherever applicable.
(iii) Figures to the right indicate full marks & every sub-question from Q.2 to Q.6 has equal weightage.
(iv) This paper tests your basic level of understanding the fundamentals; so read each question carefully.

Q.1   ATTEMPT ANY FOUR (04) :-   **20**

    (a) Define the following dynamic characteristics of instruments & mention for which types
       of measurements they have to be considered ?

       (i) Speed of Response
       (ii) Lag
       (iii) Fidelity
       (iv) Dynamic Error

    (b) Draw a neat circuit diagram of LCR – Q meter & explain its operating principle.

    (c) Explain the function of delay line in cathode ray oscilloscope (CRO) with neat diagram.

    (d) Describe operating principle of heterodyne wave analyzer with a neat block diagram.

    (e) With a neat diagram, explain the principle of digital time measurement.

    (f) Describe in brief, the classification / types of transducers.

Q.2 (a) The true value of the voltage across a resistor in a circuit is 10 V when it is calculated by   **20**
mathematical analysis. Measuring the same voltage by six different random individuals (but
all with the same digital multimeter) gives the following results as shown :-

Observation No.	Measured Values
1	10.25 V
2	10.05 V
3	9.9 V
4	9.95 V
5	10.15 V
6	9.85 V

    (i) Calculate the arithmetic mean (average) for the above observations.
    (ii) Calculate the percentage error for the fourth observation.
    (iii) Calculate the accuracy for the second observation.
    (iv) Determine the precision of the fifth observation.
    (v) Calculate the standard deviation (σ) for the above observations.
    (vi) Calculate the average deviation (d_{avg}) for the above observations.

       For Q.2 (a) students can attempt any five sub-questions between (i) to (vi)

(b) Wien Bridge is one of the AC bridges as shown in the Fig. 1 below. Derive conditions under which the bridge becomes balanced. Which quantity / parameter is it used to measure?
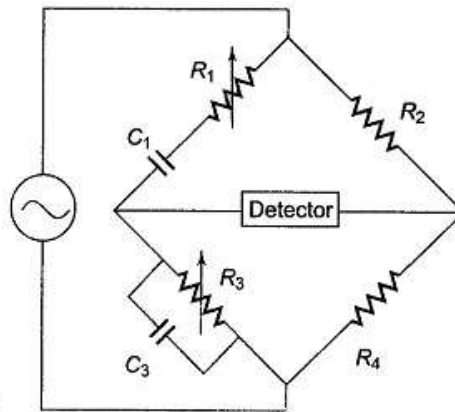

Fig. 1 – The Wien Bridge for Q.2 (b)

Q.3 (a) The block diagram of a general purpose cathode ray oscilloscope (CRO) is as shown in Fig. **20** 2 below. Identify the blocks / elements numbered from 1 to 5 & describe their functionality. What is the use of trigger circuit / trigger generator in CRO ? Explain with neat diagram.
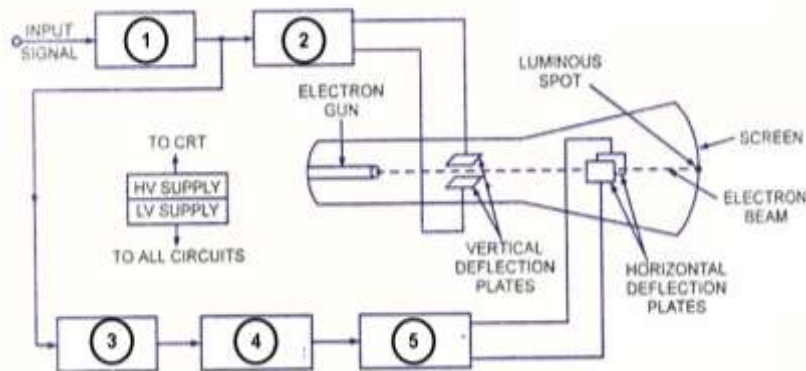

Fig. 2 – Block diagram of general purpose CRO for Q.3 (a)

(b) Explain how Lissajous patterns / figures are used for measurement of an unknown frequency & phase shift using a cathode ray oscilloscope (CRO). Determine the approximate phase shift of the Lissajous figure / pattern as shown in Fig. 3 below observed on CRO screen :-
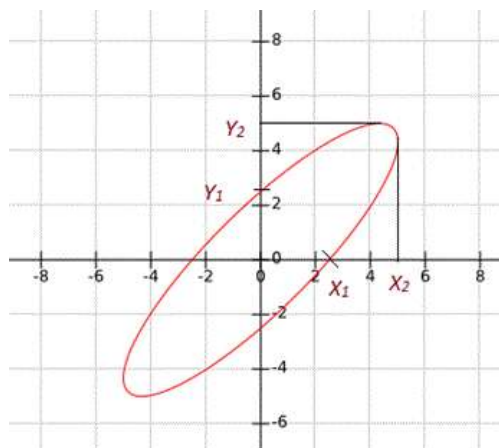

Fig. 3 – Lissajous pattern on CRO for phase measurement for Q.3 (b)

Q.4 (a) From the diagram shown in Fig. 4 below, identify which type of instrument is being used & **20** to measure which kind of electrical signal / input quantity. Describe the operation of that instrument with a neat block diagram.
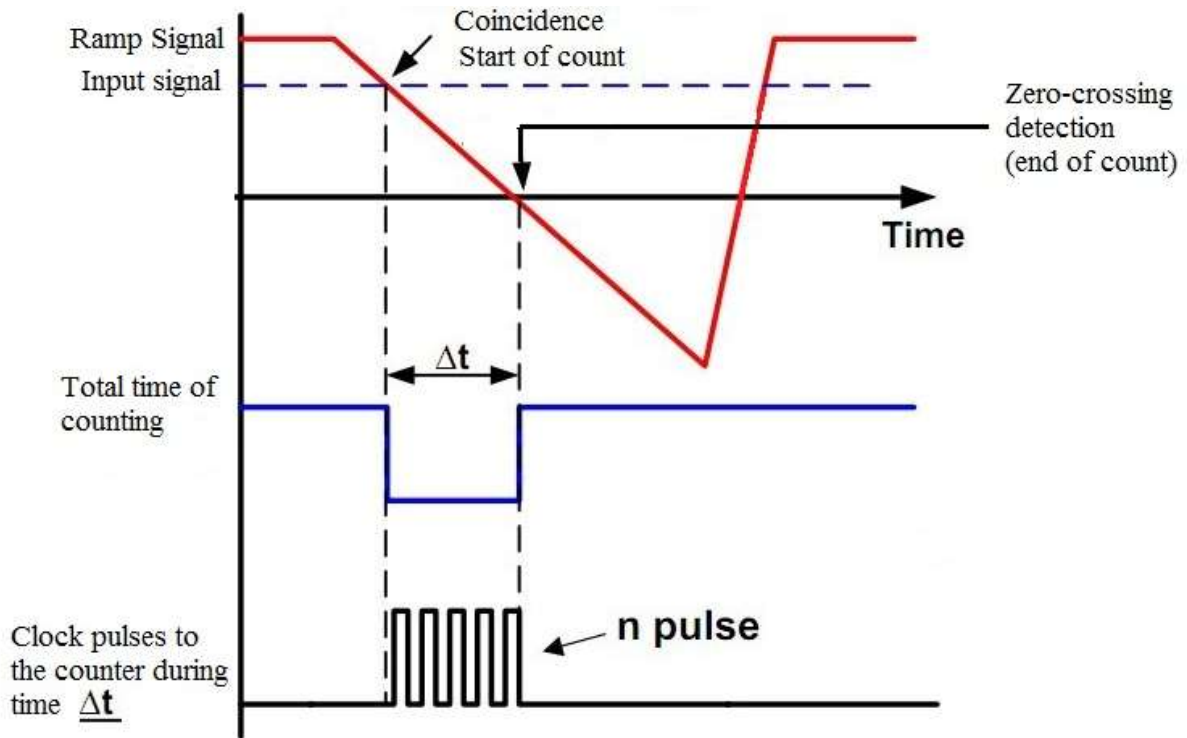

Fig. 4 – Waveform analysis for Q.4 (a)

(b) The diagram below in Fig. 5 shows a graph (spectrum) where a complex waveform having multiple signal components is displayed on a screen, with each individual signals having its own frequency (Hz) & its own amplitude (magnitude is as shown in mV). Which instrument is used to display it ? Describe its operation with a neat block diagram.
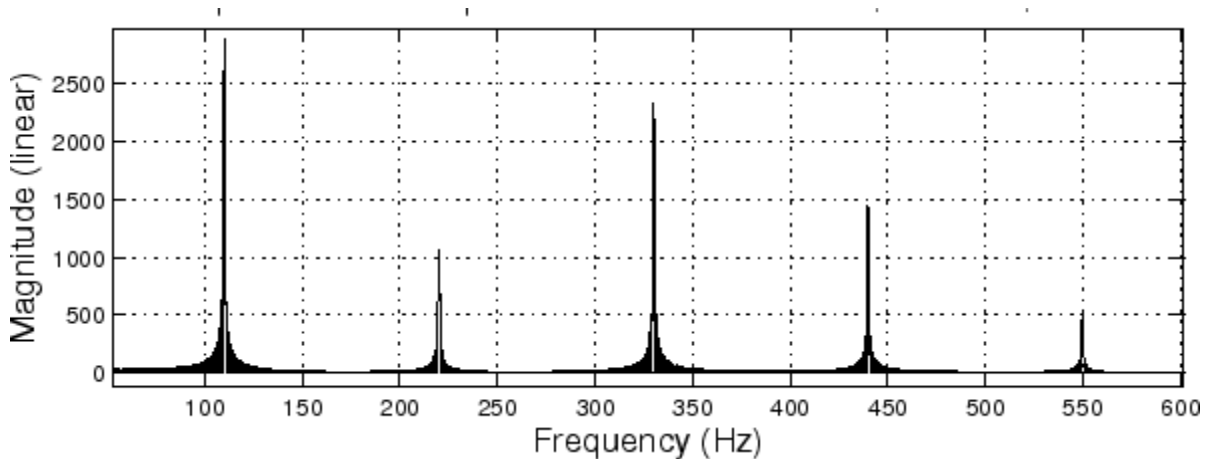

Fig. 5 – Amplitude spectrum of a complex signal waveform for Q.4 (b)

Q.5 (a) You have been asked to measure the displacement of a shaft, which is linearly attached to a **20** piston in a machine wherein the shaft has a rectilinear motion (straight line) going back & forth. Which transducer will you use for above application ? Describe its operation with a neat diagram.

(b) In a food processing unit, a highly acidic solution is stored in a storage tank where its level has to be continuously monitored round the clock. Your supervisor suggests that due to highly acidic nature of the solution, a non-contact transducer should be used for the level measurement. Which transducer will you use for above application ? Describe its operation with a neat diagram.

Q.6 (a) You are asked to measure the flow rate in a network of pipes that carry brine (a salt water **20** solution). At first, it seems an easy task to use electromagnetic flow meters since brine solution being highly conductive, the output signal obtained is proportional to the flow rate. However on close inspection, you find that due to several issues; including the shortage of space & the myriad arrangement of piping the flow transducer can be only installed in a vertical position. The plant supervisor also tells you 'it should be such that' simply by looking at flow rate directly on its scale, he can adjust the valve manually & quickly so as to control it. Which flow transducer will you select for such an application ? Explain with a neat diagram.

(b) A thermostat in a home heating system needs a temperature transducer to work between the temperature ranges of + 15 °C to + 45 °C. Being fully electronic in nature, the thermostat requirements are that the sensor should be as small as possible, be extremely light in weight & portable. Apart from being easily interfaced with electronic devices / circuits in the thermostat, it should have a quick response to the variations in the ambient temperature & should be of cheaper cost. Out of the various temperature transducers, describe which is the best suited for above requirements. Explain its construction, operation & characteristics with a neat diagram.