Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (ME/PE)/SEM-4/ME-403/2010

2010

MEASUREMENT AND INSTRUMENTATION

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 × 1 = 10

   i) A wattmeter has a full scale range of 2500 W. It has an error ± 1% of true value. What would be the range of reading if true power is 1250 W ?

   a) 1225 W – 1275 W b) 1245 W – 1255 W

   c) 1200 W – 1300 W d) 1237·5 W – 1262·5 W.

   ii) Radiation pyrometers are used in the temperature range of

   a) 0° C to 500° C b) 500° C to 1000° C

   c) 250° C to 500° C d) 1200° C to 2500° C.

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iii) Pressure can be measured by the use of

a) the Bourdon tube

b) accelerometer

c) tachometer

d) encoder.

iv) Liquid level in a container can be determined by the weight of the liquid acting on

a) load cell b) capacitive sensor

c) inductive sensor d) potentiometer.

v) The ratio of the output to the input change for a given measuring system is referred to as

a) sensitivity b) linearity

c) stability d) none of these.

vi) In measurements which of the following static characteristics are desirable ?

a) Accuracy b) Sensitivity

c) Reproductivity d) All of these.

vii) The proximity type of instrument is a

a) dial gauge b) load cell

c) pyrometer d) speedometer.

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viii) Zero error of a micrometer is

a) random error

b) interference error

c) systematic error

d) loading error

ix) Gear tooth vernier is use to measure

a) gear tooth profile

b) gear tooth thickness

c) pitch line thickness of gear tooth

d) module.

x) LVDT is

a) a passive transducer

b) an inductive transducer

c) a digital transducer

d) a capacitive transducer.

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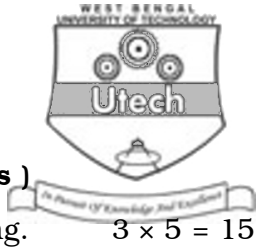

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. A slip gauge set with 87 pieces, as under is available. A 100 mm sine bar is to be set up to an angle of 33°. Determine the number of slip gauges needed from the 87 pieces set.

Range (mm)	Steps (mm)	Number of blocks
1·001 to 1·009	0·001	9
1·01 to 1·49	0·01	49
0·5 to 9·5	0·5	19
10 to 90	10	9
1·0005	—	1

3. What is a 'Load Cell' ? Explain its working principle.

4. a) What is Hall effect ? Write the expression of Hall coefficient with the magnetic field. 1 + 1

   b) Write the uses of Hall effect. 3

5. Show that standard deviation is the best estimate of uncertainty.

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6. Define transfer function and prove that transfer function of a closed loop in given as

$$T.F. = \frac{G(s)}{1 + G(s)H(s)}$$

where $G(s)$ = *T.F.* of instrument

$H(s)$ = *T.F.* of feedback.

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) In a test, temperature is measured 100 times with variations in apparatus and procedures. After applying the corrections, the results are as follows :

Temperature °C	297	298	299	300	301	302	303	304	305
Frequency of occurrence	1	3	12	23	37	16	4	2	2

Calculate,

i) arithmetic mean

ii) mean deviation

iii) standard deviation

iv) the probable error of one reading

v) the standard deviation and the probable error of the mean

vi) the standard deviation of the standard deviation.

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b) Differentiate between the terms 'Scale range' and "Scale span giving suitable examples.

c) Discuss the desirable and undesirable dynamic characteristics of an instrument. 9 + 2 + 4

8. a) Draw the block diagram for 2nd order system and explain each term of the transfer function.

b) A 2nd order system follows the differential equation given below :

$$\frac{d^2 I_0}{dt^2} + 3\frac{dI_0}{dt} + 30 I_0 = 30 I$$

Find :

i) Damping ratio

ii) Damped natural frequency

iii) Static sensitivity

iv) Time constant. (3 + 4) + 8

9. a) What is the difference between primary texture and secondary texture ? Describe the various methods of measuring surface roughness.

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b) In the measurement of surface roughness, heights of 20 successive peaks and troughs were measured from a datum and were 35, 25, 40, 22, 35, 18, 42, 25, 35, 22, 36, 18, 42, 22, 32, 21, 37, 18, 35, 20 microns. If these measurements were obtained over a length of 20 mm, determine the C.L.A. and R.M.S. values of the roughness. 8 + 7

10. a) A seismic instrument, used for motion measurement, of an object, has m of 100 gm, spring stiffness 1 N/mm and damping constant 8 N-s/m. If the recorded motion has amplitude of 3·5 mm, find the amplitude of motion of the object if the frequency of the motion is 30 Hz.

b) Along with the necessary circuit, explain how 4 numbers of bonded strain gauges can be used for measuring force giving the highest sensitivity.

c) A platinum resistance thermometer has a resistance of 140·5 Ω and 100·0 Ω at 100° C and 0° C, respectively. If its resistance becomes 305·3 Ω when it is in contact with the hot gas, determine the temperature of the gas. The temperature coefficient of platinum is $0{\cdot}0039^{\circ}\ C^{-1}$. 6 + 6 + 3

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11. a) What are the necessary conditions for interference of light waves ?

b) Describe the Base Tangent method used for measuring gear tooth thickness.

c) Explain 'three wire method' for measuring effective diameter of a screw thread. 3 + 6 + 6

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