61714

ROLL No. | | | | | |

TEST BOOKLET No. 56

TEST FOR POST GRADUATE PROGRAMMES

INSTRUMENTATION

Time: 2 Hours | Maximum Marks: 450

INSTRUCTIONS TO CANDIDATES

1. You are provided with a Test Booklet and an Optical Mark Reader (OMR) Answer Sheet to mark your responses. Do not soil the Answer Sheet. Read carefully all the instructions given on the Answer Sheet.
2. Write your Roll Number in the space provided on the top of **this page**.
3. Also write your Roll Number, Test Code, and Test Subject in the columns provided for the same on the **Answer Sheet**. Darken the appropriate bubbles with a **Ball Point Pen.**
4. The paper consists of 150 objective type questions. All questions carry equal marks.
5. Each question has four alternative responses marked **A, B, C** and **D** and you have to **darken** the bubble fully by a **Ball Point Pen** corresponding to the correct response as indicated in the example shown on the Answer Sheet.
6. Each correct answer carries **3** marks and each wrong answer carries **1** minus mark.
7. Space for rough work is provided at the end of this Test Booklet.
8. You should return the Answer Sheet to the Invigilator before you leave the examination hall. However, you can retain the Test Booklet.
9. Every precaution has been taken to avoid errors in the Test Booklet. In the event of any such unforeseen happenings, the same may be brought to the notice of the Observer/Chief Superintendent in writing. Suitable remedial measures will be taken at the time of evaluation, if necessary.

SEAL

INSTRUMENTATION

1. A null type of instrument as compared to a deflection type instrument has

   (A) a higher accuracy
   (B) a higher sensitivity
   (C) a faster response
   (D) All the above

2. In a measurement system, the open loop transfer function is 10 and change by 10 percent. If a closed loop system is adopted, where the feedback system has a transfer function of 100, the change in the output in the case of open loop and closed loop systems are,

   (A) 10 %, $10*10^{-3}$ %
   (B) 10 %, $1*10^{-3}$ %
   (C) 100%, $10*10^{-3}$ %
   (D) 100%, $1*10^{-3}$ %

3. A measurement system with input $x(t)$ and output $y(t)$ is described by the differential equation $3\frac{dy}{dt}+5y=8x$. The static sensitivity of the system is

   (A) 0.60
   (B) 1.60
   (C) 1.67
   (D) 2.67

4. The volume of a cylinder is computed from measurements of its height (h) and diameter (d). A set of several measurements of height has an average value of 0.2m and a standard deviation of 1%. The average value obtained for the diameter is 0.1m and the standard deviation is 1%. Assuming that the errors in the measurement of height and diameter are uncorrelated, the standard deviation of the compound volume is

   (A) 1.00%
   (B) 1.73%
   (C) 2.23%
   (D) 2.41%

5. The response of a first-order measurement system to a unit step input is $1-e^{-0.5t}$, where t is in seconds. A ramp of 0.1 units per second is given as the input to this system. The error in the measured value after transients have died down is

(A) 0.02 units
(B) 0.1 units
(C) 0.2 units
(D) 1 unit

6. Accuracy of an instrument is defined as

(A) closeness of the indicated value to the true value
(B) closeness of the indicated value to the error
(C) closeness among the indicted values
(D) None of the above

7. The best way to specify accuracy of an instrument is

(A) as a percentage of error
(B) as a percentage of the true value
(C) as a percentage of scale range
(D) as point accuracy

8. The threshold and resolution are

(A) smallest measurable input and input change
(B) smallest measurable output and output change
(C) smallest measurable input change and input
(D) None of the above

9. A reading is recorded 23.90°C. The reading has

(A) three significant figures
(B) five significant figures
(C) four significant figures
(D) None of the above

10. A 0-10 A ammeter has a guaranteed accuracy of 1 percent of full scale deflection. The limiting error while reading 2.5 A is

(A) 1%
(B) 2%
(C) 4%
(D) None of the above

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

(A) 1225 - 1275W
(B) 1245 - 1255W
(C) 1200 - 1300W
(D) 1237 - 1262W

12. The voltage of a potentiometer is measured by a voltmeter having an input impedance comparable of the output impedance of the potentiometer, thereby causing an error in the measurement. The error may be called as

(A) gross error
(B) random error
(C) error caused by misuse of instrument
(D) error caused by loading effect

13. For a Gaussian distribution, the probable error is r. This means that

(A) area under the curve between ±r limits is 0.5
(B) half of the observed values lie between ±r limits
(C) the chances that an additional observation will lie between ±r limits are 50%
(D) All of the above

14. If the confidence level is 0.95, then the value lying outside the confidence interval is

(A) 1 in 5
(B) 1 in 20
(C) 1 in 100
(D) 1 in 1000

15. A batch of resistors have a mean value of 100.00Ω and a standard deviation of $\sigma = 0.2\Omega$. The probability corresponding to 2σ is 0.9546. The value of odds that randomly selected resistor will lie within $100.00 \pm 0.40\Omega$ is

(A) 1 to 1
(B) 2.15 to 1
(C) 21 to 1
(D) 256 to 1

16. A thermometer with time constant of 60s is used for measuring temperature cycling with 600s time period. The time lag and ratio of the output to input are

(A) 63.6 s, 0.847
(B) 53.6s, 0.847
(C) 53.6 s, 0.647
(D) None of the above

17. The time constant is defined as

(A) time taken to reach 63.2% of the final value
(B) time taken to fall to 36.8% of its initial value
(C) time taken by the response to reach the final value if initial slope is maintained
(D) All of the above

18. Dynamic error is

(A) difference between the true value of the quantity changing with time and measured value
(B) difference between the true value and measured value
(C) difference between the true values of the quantity changing with time
(D) All of the above

19. The temperature of a furnace is increasing at a rate of 0.1°C/s. The maximum time constant of a first order instrument that can be used, so that the temperature is read with a maximum error of 5°C is

(A) 50s
(B) 25s
(C) 50ms
(D) 500s

20. A first order system with a time constant of 20 is subjected to a step input. The settling time of the system is

(A) 100s
(B) 60s
(C) 20s
(D) infinity

21. A certain system exhibited an overshoot of 16% when subjected to an input of $2u(t)$, where $u(t)$ is a step input. The damping ratio and decay ratio, respectively, are

(A) (0.8, 0.0810) (B) (0.5, 0.0256)
(C) (1.0, 0.1626) (D) (1.1, 0.0089)

22. The following terms used in the context of an instrument are numbered as shown
(1) Accuracy
(2) Sensitivity
(3) Precision
(4) Resolution

Match these with their possible definitions listed below:
P. Repeatability of readings on successive observations
Q. Smallest perceptible change in the output
R. Deviation of the output from the true value
S. Minimum value of the input from the true value
T. Ratio of the change in the instrument reading to the change in the measured variable

(A) 1-P, 2-Q, 3-R, 4-S (B) 1-S, 2-Q, 3-P, 4-T
(C) 1-R, 2-T, 3-P, 4-Q (D) 1-T, 2-Q, 3-P, 4-S

23. The calibration data for a pressure compensator of a pump is given below:

Input x	0	1	2	3	4	5	6	7	8	9	10
Output y	9.5	8.4	7.8	7.4	6.1	5.4	5.2	4.6	3.2	1.9	1.1

For the given data, the slope of the best-fit line applying the least-squares method is

(A) 0.921 (B) -0.803
(C) 0.819 (D) -0.945

24. A wire potentiometer of length 11m and resistance 1Ω/m balances a standard cell voltage of 1.018V at a length of 10.18m. If the voltage of the battery supplying the current through the potentiometer is 2.0V, then the value of the series resistance connected to the potentiometer is

(A) 9Ω
(B) 90Ω
(C) 900Ω
(D) 990Ω

25. The torque in a rotating shaft is measured using strain gauges. The strain gauges must be positioned on the shaft such that the axes of the strain gauges are at

(A) 0 with respect to the axis of the shaft
(B) 30 with respect to the axis of the shaft
(C) 45 with respect to the axis of the shaft
(D) 90 with respect to the axis of the shaft

26. In a second order system, the damping factor is 0.65 and the natural frequency is 4Hz. If the stiffness of springs is halved, the new values of damping factor and natural frequency are

(A) 0.92, 2.83Hz
(B) 0.46, 5.66Hz
(C) 0.92, 5.66Hz
(D) 0.46, 2.83Hz

27. The temperature transducers exhibit nonlinear behavior. The order in which they exhibit nonlinearity (highest to lowest) is

(A) thermocouples, RTDs, thermistors
(B) thermistors, thermocouples, RTDs
(C) RTDs, thermocouples, thermistors
(D) thermistors, RTDs, thermocouples

28. The output of a strain gauge bridge using two active strain gauges used in Poission's configuration is

(A) $\frac{\upsilon G_f \varepsilon e_i}{4}$ (B) $\frac{\upsilon G_f \varepsilon e_i}{2}$

(C) $\frac{(1+\upsilon) G_f \varepsilon e_i}{2}$ (D) $\frac{(1+\upsilon) G_f \varepsilon e_i}{4}$

where, υ = Poisson's ratio, G_f = Gauge factor, ε = strain and e_i = excitation voltage of bridge.

29. For a vertical Venturimeter with acquired water flow, when the measured static pressure difference $p_1 - p_2$, between the inlet and throat is 30kPa, the flow rate is found to be 50 lit/sec; assume that the coefficient of discharge remains the same. When $p_1 - p_2$ =20kPa, the flow rate in lit/sec is

(A) 33.3 (B) 39.3
(C) 40.8 (D) 54.2

30. In an ultrasonic flowmeter with the transducers separated by a distance L=25mm, the line joining the transducers make an angle 60° with the direction of the flow. The transit time difference between upstream and downstream measurements is 10 ns with the sound velocity in the medium being 1000 m/s. Assuming that the size of the transducers is very small as compared to the diameter of the pipe, the flow velocity is

(A) 0.2m/s (B) 2m/s
(C) 0.4m/s (D) 40m/s

31. The seismic mass of an accelerometer oscillates sinusoidally at 100Hz with a maximum displacement of 10mm from its mean position. The peak acceleration of the seismic mass is

(A) 3947.84m/s^2 (B) 3141.50m/s^2
(C) 314.15m/s^2 (D) 100.00m/s^2

32. A different push-pull type capacitive displacement sensor (nominal capacitance $C_0 = 0.01\mu F$) is connected in two adjacent arms of an ac bridge in such a way that the output voltage of the bridge is independent of the frequency of the supply voltage. Supply to the bridge is 1V at 1kHz, and two equal resistance (R = 3.9kΩ) are placed in the other two arms of the bridge. The bridge sensitivity is

(A) 0.001mV/pF
(B) 0.05mV/pF
(C) 0.1mV/pF
(D) 0.5mV/pF

33. In a variable-area flow meter (Rota meter), the inlet tube diameter is the same as that of the effective float diameter and the tube is small. When the volume flow rate of a fluid is Q1, the float stands at a height of 70mm from the inlet and when the volume flow rate of the fluid is Q2, the float moves to a height of 20mm from the inlet. The ratio of the flow rates Q1/Q2 is

(A) 3.5
(B) 0.29
(C) 0.082
(D) 12.3

34. Which type of flow meter measures flow by measuring volume directly?

(A) Coriolis
(B) Magnetic
(C) Positive displacement
(D) Differential pressure

35. The third wire of a RTD (in three lead configuration) for temperature measurement by RTD is used

(A) to complete the bridge
(B) to compensate the errors due to lead resistance
(C) to balance the current flowing in the bridge
(D) to balance the null voltage of the bridge

36. The fluid flow through an orifice is

(A) directly proportional to the differential pressure across the orifice
(B) inversely proportional to the differential pressure across the orifice
(C) directly proportional to the square root of the differential pressure across the orifice
(D) None of the above

37. A transmitter installed in a hazardous area with associated safety barrier fails to work near 20mA. The probable cause of failure is

(A) transmitter calibration is out
(B) transmitter is non-linear
(C) transmitter needs zero elevation
(D) internal resistance of the safety barrier is too high

38. The Reynolds number determines

(A) Venturi effect
(B) the Coriolis acceleration
(C) the fluid viscosity
(D) whether the flow is laminar or turbulent

39. The sensitivity of Zirconia probe oxygen analayzer

(A) is increased at low concentration of oxygen
(B) is increased at high concentration of oxygen
(C) is increased at high temperature of probe
(D) remains same irrespective of oxygen concentrations

40. Dead band of an instrument is

(A) the band that prevents the instrument from being tampered with by unauthorized persons
(B) the range of values for which the instrument gives inaccurate readings
(C) the size of the instrument, indicated by the divisions on the scale of the instrument
(D) the range through which an input signal may be changed, on reversal of direction, without observable change in output

41. Dead weight tester represents

(A) Laboratory standard
(B) Ultimate standard
(C) Transfer standard
(D) None of the above

42. To make an accurate measurement with a (an) ..... the circuit connections must be broken.

(A) Oscilloscope
(B) Voltmeter
(C) Logic analyzer
(D) Wattmeter

43. An analog and digital multimeter is basically a(an) ..... and ..... respectively.

(A) Voltmeter and Ammeter
(B) Ammeter and Voltmeter
(C) Ammeter and Wattmeter
(D) Voltmeter and Wattmeter

44. Which of the following cannot be used for AC measurement?

(A) Moving iron instrument
(B) Electrodynamometer type instruments
(C) Permanent magnet moving coil instruments
(D) None of the above

45. A 12V source supplies 25A to the load and ..... would be the load current measured by an ammeter with a resistance of 0.12Ω.

(A) 20 Amps
(B) 12 Amps
(C) 24.9 Amps
(D) 15 Amps

46. Equal resistances of 100 Ω are connected in each arm of a Wheatstone bridge which is supplied by a 2V battery source. A galvanometer of negligible resistance connected to the bridge can sense as low a current as 1μA. The smallest value of the resistance that can be measured is

(A) 20mΩ
(B) 2μΩ
(C) 20μΩ
(D) None of the above

47. What occurs if the temperature of the thermocouple measuring junction is lower than the reference junction?

(A) There is no emf output
(B) The output voltage polarity is reversed
(C) The polarity stays the same, but voltage increases
(D) The emf remains the same when temperature changes

48. In a rotameter, the pressure drop across the float

(A) remains same throughout the flow range
(B) increases with increase in flow
(C) decreases with increase in flow
(D) None of the above

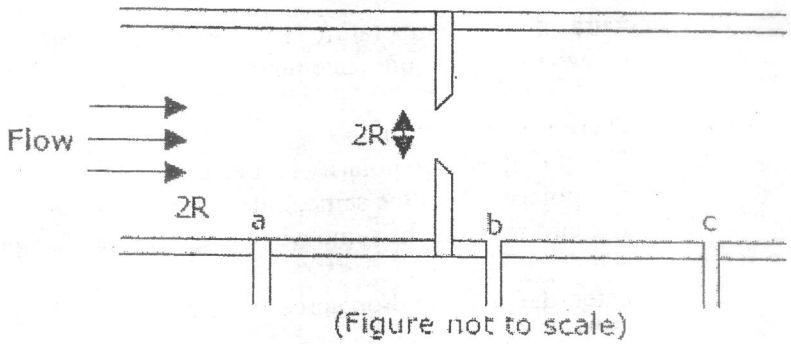
49. A Hall probe of thickness 2×10^{-3} carrying a current of 0.2A is placed in a magnetic field of 0.5T and produces a voltage of 0.4V. The Hall coefficient of the probe in terms of consistent unit is

(A) 1×10^{-3}
(B) 8×10^{-3}
(C) 0.5×10^{-3}
(D) 4×10^{-3}

50. Why is it important to maintain an impedance match from the source to the load when sending signals?

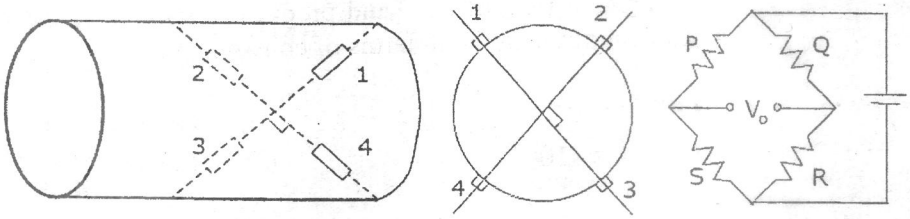
(A) To reduce external noise
(B) To keep the line balanced
(C) To reduce reflected energy
(D) To reduce attenuation

51. The figure shows the cross-sectional diagram of an orifice flow meter with an orifice radius R. Point 'a' is 30R upstream while points 'b' and 'c' are 0.8R and 30R downstream from the orifice respectively. The pressures at points a, b and c are P_a, P_b and P_c respectively. Then



(A) $P_c > P_b > P_a$
(B) $P_b > P_c > P_a$
(C) $P_a > P_b > P_c$
(D) $P_a > P_c > P_b$

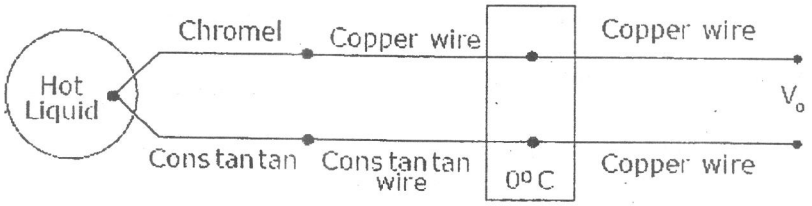
52. Four strain gauges are fixed on a cylindrical shaft to measure torque, as shown in the figure.



A correct way to place these gauges in the bridge is

(A) P-1, Q-2, R-3, S-4
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-1, R-2, S-4
(D) P-2, Q-1, R-3, S-4

53. A thermocouple based temperature measurement system is shown in the figure. Relevant thermocouple emf data (in mV) is given below. The cold junction is kept at 0°C. The temperature is 30°C in the other parts of the system. The emf V_0 is measured to be 26.74mV. The temperature of the hot liquid is



Temperature	Emf of Chromel-Constantan	Emf of Copper-Constant
10°C	0.591	0.391
20°C	1.192	0.789
30°C	1.801	1.196
370°C	26.549	19.027
380°C	27.345	19.638

(A) 370.0°C
(B) 372.4°C
(C) 376.6°C
(D) 380.0°C

54. A strain gauge has a nominal resistance of 600Ω and a gauge factor of 2.5. The strain gauge is connected in a dc bridge with three other resistances of 600Ω each. The bridge is excited by a 4V battery. If the strain gauge is subjected to a strain of 100μm/m, the magnitude of the bridge output will be

(A) 0V
(B) 250μV
(C) 500μV
(D) 750μV

55. A temperature sensitive transducer subjected to a sudden temperature change takes 10 seconds to reach the equilibrium condition. What will be the response time of the transducer to reach half of the temperature change?

(A) 3.46 sec
(B) 1.39 sec
(C) 6.93 sec
(D) cannot be determined

56. The speed of a gear having 60 teeth is measured using a proximity sensor. The output of the proximity sensor is fed to a counter with a gating time of 1s. The counter indicates a value of 120. The speed at which the gear is rotating is

(A) 60 rpm
(B) 120 rpm
(C) 600 rpm
(D) 1200 rpm

57. A Transducer is subjected to a sudden change in the measurand. It takes 10seconds to reach the steady state condition. How long will it take to read half the measurand?

(A) 5sec
(B) 2.5sec
(C) 2.39sec
(D) 1.39sec

58. A thermometer with a time constant of 0.5 min is introduced in a bath where the temperature is increasing at a constant rate of 5°C/min. The steady state error in the thermometer reading is

(A) 10°C
(B) 2.5°C
(C) 0.1°C
(D) 0.4°C

59. Match the instruments on the left used for calibration of the instruments on the right,

1.	Inverted Bell	5.	Low Pressure Gauge
2.	Dead Weight Tester	6.	Gas Flow meter
3.	Knudsen Gauge	7.	Very low pressure measurement
4.	Mc Leod Gauge	8.	Pressure Gauges

(A) 1-8, 2-5, 3-6, 4-7
(B) 1-6, 2-8, 3-7, 4-5
(C) 1-6, 2-5, 3-8, 4-7
(D) 1-7, 2-8, 3-5, 4-6

60. A displacement sensor has an input range of 0 to 3 cm and a standard supply voltage V_s = 0.5V. Using the calibration results given in the table estimate maximum non-linearity as a % of fsd

Displacement cm	0	0.5.	1.0	1.5	2.0	2.5	3.0
Output voltage mV	0	16.5	32.5	44.0	51.5	55.5	58.0

(A) 25.95%
(B) 52.95%
(C) 35.25%
(D) 53.25%

61. The following table gives the variations of resistance with temperature for a RTD

Temperature °C	15	18	21	24	26.5	29.5	33
Resistance	106.06	167.14	108.22	109.3	110.38	111.46	112.75

Find the linear approximation equation of the above resistance-temperature curve for a temperature variation between 25°C and 33°C about the mean value of 24°C

(A) $R_\theta = 109.3\left[1+0.0034(\theta-24)\right]$
(B) $R_\theta = 100.3\left[1+0.0034(\theta-24)\right]$
(C) $R_\theta = 109.3\left[1+0.0014(\theta-24)\right]$
(D) $R_\theta = 100.3\left[1+0.0014(\theta-24)\right]$

62. In a Wheatstone bridge, the values of resistances of various arms are P=1000Ω, Q=100Ω, R=2005Ω and S=200Ω. The battery has an emf of 5V and negligible internal resistance. The galvanometer has a current sensitivity of 10mm/μA and internal resistance of 100Ω. Calculate the sensitivity of bridge in terms of deflection per unit change in resistance

(A) 2.34 mm/Ω
(B) 55.4mm/Ω
(C) 5.54 mm/Ω
(D) 23.4mm/Ω

63. A copper-constantan thermocouple was found to have a linear calibration between 0°C and 400°C with emf at maximum temperature (reference junction temperature 0°C) equal to 20.68mV. If the indicated emf is 8.92mV in thermocouple circuit, determine the temperature of hot junction

(A) 197.53°C
(B) 179.53°C
(C) 157.53°C
(D) 193.53°C

64. Two currents from different sources flow in opposite directions through a resistor. I_1 is measured as 79mA on a 100mA analog instrument with an accuracy of ± 3% of fsd. I_2 determined as 31mA, is measured on a digital instrument with an accuracy of ± 100μA. Calculate the maximum and minimum levels of the current in resistor.

(A) 5.37 mA, 4.63mA
(B) 50.37mA, 45.63mA
(C) 50.37mA, 4.63mA
(D) 45.63mA, 5.37mA

65. The dead zone in a certain pyrometer is 0.125% of span. The calibration is 400°C to 1000°C. What temperature difference might occur before it is detected?

(A) 0.25°C
(B) 0.75°C
(C) 7.5°C
(D) 2.5°C

66. The resistance R(θ) of thermistor at temperature 0K is given by $R(\theta) = \alpha e^{\beta/\theta}$. Given that the resistance at the ice point is 9KΩ and the resistance at the steam point is 0.5KΩ. Find the resistance at 25°C.

(A) 6.344 KΩ
(B) 4.366 KΩ
(C) 3.644 KΩ
(D) 5.334 KΩ

67. A pressure sensor has the following specifications: Sensitivity at the design temperature=10V/MPa, Zero drift = 0.01V/°C, Sensitivity drift = 0.01(V/MPa)/°C. When the sensor is used in an ambient 20°C above the design temperature, the output from the device is 7.4 V. The true value of the pressure will be

(A) 0.65 MPa
(B) 0.68 MPa
(C) 0.71 MPa
(D) 0.61MPa

68. A thermo couple system has a time constant of 10s. The system is used to measure the temperature of a furnace which fluctuates sinusoidally between 640°C and 600°C, with a periodic time of 80s. What are the maximum and minimum values of the temperature indicated?

(A) 640°C and 600°C
(B) 630°C and 610°C
(C) 635.7°C and 604.3°C
(D) 628.5°C and 608.5°C

69. A micro cantilever type micro accelerometer is designed by scaling down each dimension of the micro accelerometer by a factor of 100. If the natural frequency of the accelerometer is ω, then the natural frequency of the micro accelerometer will be

(A) 100 ω
(B) 10 ω
(C) 0.1ω
(D) 0.01 ω

70. A strain gauge of resistance 120Ω and gauge factor 2.0 is at zero strain condition. A 200kΩ fixed resistance is connected in parallel with it. Then the combination will represent an equivalent strain of

(A) +5290 μm/m (B) zero
(C) –123.8 μm/m (D) –300 μm/m

71. An iron-constantan thermocouple is to be used to measure temperature between 0 and 300°C. With reference junction at 0°C, the emf induced at 100°C and 300°C are E_{100}=5268 μV, E_{300}=16325 μV. Then the nonlinearity at 100°C as a percentage of full scale is

(A) +3.23% (B) –1.06%
(C) –0.96% (D) –3.23%

72. In pressure measurement 1 Pascal is equivalent to ..... bar, ... standard atmosphere (atm) and ..... mm of water.

(A) 0.0689476, 6.80460×10^{-2} and 7.03069×10^{2}
(B) 0.980665, 0.967841 and 10^{4}
(C) 10^{-5}, 9.86923×10^{-6} and 1.01972×10^{-1}
(D) 133.322, 1.31579×10^{-3} and 13.5951

73. In a Venturimeter the flow is 0.15m^3/sec, when the differential pressure is 30kN/m^2. What will be the value of flow when the differential pressure is 60 kN/m^2 ?

(A) 0.212 m^3/sec (B) 0.106 m^3/sec
(C) 0.3 m^3/sec (D) 0.075 m^3/sec

74. A Piezo electric transducer has an output voltage of 3V at no load condition and has a capacitance of 250pF. It is connected to load capacitance of 125pF. The voltage across the load at high frequencies is

(A) 1V (B) 2V
(C) 9V (D) Cannot be determined

75. A differential pressure transmitter is used to measure the flow rate in a pipe. Due to aging, the sensitivity of the pressure transmitter is reduced by 5%. All other aspects of the flow meter remaining constant, change in the sensitivity of the flow measurement is

(A) 10.0% (B) 5.0%
(C) 2.5% (D) 2.2%

76. For a steady flow of liquid, the float of the rotameter will remain in a particular position when

(A) drag force is balanced by the weight of the float and buoyancy force
(B) weight of the float is balanced by the drag force and buoyancy force
(C) buoyancy force is balanced by the drag force and weight of the float
(D) drag force and buoyancy together is slightly greater than the weight of the float

77. A 3½ - digit seven segment LED display uses diodes that requires a 20mA forward current. Calculate the total supply current required

(A) 4.6 mA (B) 46mA
(C) 460mA (D) 0.46 A

78. With the signal generator frequency of a Q meter set to 1.25MHz, the Q of a coil is measured as 98 when C=147pF. Determine the coil inductance and resistance.

(A) L = 110μH, R = 8.8Ω (B) L = 11μH, R = 8.8Ω
(C) L = 110μH, R = 8.8kΩ (D) L = 10mH, R = 8.8kΩ

79. An unknown circuit behaves as a 0.005μF capacitor in series with a 8kΩ resistor when measured at a frequency of 1kHz. The terminal resistance is measured by an ohm meter as 134kΩ. Determine the components.

(A) R = 8kΩ, X = 31.8kΩ (B) R = 134kΩ, X = 33.8kΩ
(C) R = 8Ω, X = 31.8kΩ (D) R = 8kΩ, X = 131.8kΩ

80. Determine the displayed rise time when a pulse waveform with rise time of 21ns is applied to an oscilloscope that has an upper cut-off frequency of 50MHz.

(A) 22 ns
(B) 22 μs
(C) 220 ns
(D) 2.2 ms

81. A highly sensitive galvanometer can detect a current as low as 0.1nA. This galvanometer is used in a Wheatstone bridge as a detector. The resistance of galvanometer is negligible. Each arm of the bridge has a resistance of 1KΩ. The input voltage applied to the bridge is 20V. Calculate the smallest change in resistance which can be detected. The resistance of galvanometer can be neglected as compared to internal resistance of the bridge

(A) 30μΩ
(B) 20μΩ
(C) 10μΩ
(D) 12.5μΩ

82. A certain resistor has a voltage drop of 110.2V and current of 5.3A. The uncertainties in the measurements are ±0.2V and ±0.06A respectively. What is the uncertainty in power?

(A) ±2.32%
(B) ±3.85%
(C) ±1.15%
(D) ±5.84%

83. The bandwidth of a CRO is 20MHz. The fastest rise time a sine wave can be accurately reproduced by the instrument is

(A) 35 ns
(B) 12.8 ns
(C) 0.25 ns
(D) 17.5 ns

84. A velocity control system has a range of 220 to 460 mm/s. If the set point is 327mm/s and measured value is 294 mm/s, calculate the error as % of span.

(A) 17.35%
(B) 15.75%
(C) 11.35%
(D) 13.35%

85. The effective resistance of a coil at high frequencies is more than its d.c. resistance on account of

(A) skin effect
(B) proximity effect
(C) eddy current losses
(D) All of the above

86. The inductance of a MI instrument is given by $L= (10+5\theta+\theta^2)\mu H$, where θ is the deflection in radian from zero position. The spring constant is $12*10^{-6}$Nm/rad. Estimate the deflection for a current of 5A.

(A) 96.8°
(B) 86.9°
(C) 69.8°
(D) 89.6°

87. A Hay bridge operating at a supply frequency of 100Hz is balanced when components are $C_3=0.1\mu F$, $R_1=1.26K\Omega$, $R_3=75\Omega$ and $R_4=500\Omega$. Calculate the Q factor of the coil.

(A) 112
(B) 212
(C) 108
(D) 231

88. Power flowing in a three-phase, three-wire balanced load system is measured by two wattmeter method. The reading of wattmeter A is 7500W and of wattmeter B is –1500W. If the voltage of the circuit is 400V, what is the value of capacitance which must be introduced in each of the phase to cause the whole of power measured to appear on wattmeter A? The frequency is 50Hz.

(A) 1060μF
(B) 1060 pF
(C) 2106μF
(D) 2160PF

89. A PMMC instrument with FSD of 100μA and $R_m=1K\Omega$ is to be employed as a voltmeter with FSD of 100V(rms). Silicon diodes are used in the rectifier circuit. Calculate the multiplier resistor value required.

(A) 980.7KΩ
(B) 780.9KΩ
(C) 890.7KΩ
(D) 790.7KΩ

90. What value of shunt resistance is required for using a 50μA meter movement with an internal resistance of 250Ω, for measuring (0 – 500mA)?

(A) 0.135Ω
(B) 0.053Ω
(C) 0.085Ω
(D) 0.025Ω

91. Calculate the tilt angle if in-phase 60Hz ac signals are applied to the deflection plates of a CRO, so that E_V=38V, E_h=14V peak.

(A) 69.8°
(B) 96.8°
(C) 89.6°
(D) 60.8°

92. A 0.5 Volt RMS voltage is across a 50Ω resistor. Express this value in dBV and dBm.

(A) –6.02dBV, –6.97dBm
(B) –6.02dBV, 6.97dBm
(C) 6.02dBV, –6.97dBm
(D) 6.02dBV, 6.97dBm

93. What is the voltage resolution of a digital oscilloscope with an 8-bit ADC when the sensitivity is 200mV/div? (Assume the ADC range spread over 8 vertical divisions).

(A) 6.3V
(B) 6.3μV
(C) 6.3mV
(D) 0.063 mV

94. A reciprocal counter that has a time base clock frequency of 100MHz counts 5 time base periods during 20 cycles of the input signal. What is the frequency of the signal?

(A) 4MHz
(B) 40MHz
(C) 60kHz
(D) 40kHz

95. With the signal generator frequency of a Q meter set to 1.25MHz, the Q of the coil is measured as 98 when C=147pF. Determine the coil inductance and resistance.

(A) 110μF and 8.8Ω
(B) 110pF and 8.8kΩ
(C) 110F and 8.8MΩ
(D) 10μF and 8Ω

96. A pulse waveform with a 3.3kΩ source resistance is to be displayed on an oscilloscope with an input capacitance of 15pF. The shortest pulse width that can be displayed without noticeable distortion being introduced by the combination of R and C will be

(A) 109 μS
(B) 1.09 μS
(C) 10.9 mS
(D) 1.09 nS

97. Find the value of C required to compensate a 10:1 probe when the oscilloscope input capacitance is 30pF and the coaxial cable capacitance is 100pF.

(A) 1.30pF
(B) 0.3pF
(C) 130pF
(D) 1300pF

98. A digital frequency meter has a time base derived from a 1MHz clock frequency divided by decade counters. Find the measured frequency when 1.512kHz sine wave is applied and the time base uses four decade counters.

(A) 15kHz
(B) 1.5 kHz
(C) 150 kHz
(D) 0.15 kHz

99. A PMMC instrument has FSD of 100μA and coil resistance of 1kΩ. Calculate the required shunt resistance value to convert the instrument into an ammeter with FSD=1A.

(A) 10001 kΩ
(B) 0.10001Ω
(C) 0.0001 kΩ
(D) 100 kΩ

100. A simple emitter follower voltmeter circuit has V_{CC}=20V, R_s+R_m=9.3kΩ, I_m=1mA at full scale and transistor h_{FE}=100. Calculate the voltmeter input resistance.

(A) 1 MΩ
(B) 1kΩ
(C) 0.1Ω
(D) 10.9kΩ

101. Find the signal frequency at which a probe with Z_i=10M Ω. ‖3.5pF reduces the signal from 600Ω source by 3dB.

(A) 7.58kHz
(B) 7.58Hz
(C) 75.8MHz
(D) 75.8kHz

102. Find the displayed rise time when a pulse waveform with rise time of 21ns is applied to an oscilloscope that has an upper cut off frequency of 20MHz.

(A) 27ns
(B) 37ms
(C) 27μs
(D) 37s

103. A differential amplifier has a difference mode gain of 1000 and common mode gain of 0.05. The common mode rejection ratio of the amplifier is

(A) 5000
(B) 20000
(C) 15000
(D) 10000

104. Two resistances 100Ω±5Ω and 150Ω±15Ω are connected in series. If the deviations are standard deviations the resultant resistance can be expressed as

(A) 250Ω±20Ω
(B) 250Ω±10Ω
(C) 250Ω±15.8Ω
(D) 250Ω±10.6Ω

105. For signal conditioning of a Piezo electric-type transducer, we require

(A) a charge amplifier
(B) a differential amplifier
(C) an instrumentation amplifier
(D) a transconductance amplifier

106. A Piezo electric-type accelerometer has a sensitivity of 100mV/g. The transducer is subjected to a constant acceleration of 5g. The steady state output of the transducer will be

(A) 0V
(B) 100mV
(C) 0.5V
(D) 5V

107. An accelerometer has a seismic mass of 100μg and natural frequency of 1KHz. With 'g' the acceleration due to gravity, the static sensitivity of the accelerometer in nm/g is

(A) 2.58nm/g
(B) 9.81nm/g
(C) 7.28×10^2nm/g
(D) $6.28 \times$ nm/g

108. A Pirani gauge measures vacuum pressure and works on the principle of

(A) change in ionizing potential
(B) change in thermal conductivity
(C) deformation of elastic body
(D) change in self-inductance

109. Match the following:

P.	Radiation pyrometer	W.	Angular velocity measurement
Q.	Dall tube	X.	Vacuum pressure measurement
R.	Pirani gauge	Y.	Flow measurement
S.	Gyroscope	Z.	Temperature measurement

(A) P-Z, Q-W, R-X, S-Y
(B) P-Z, Q-Y, R-X, S-W
(C) P-W, Q-X, R-Y, S-Z
(D) P-Z, Q-X, R-W, S-Y

110. The output voltage of a transducer with an output resistance of 10KΩ is connected to an amplifier. The minimum input resistance of the amplifier so that the error in recording the transducer output does not exceed 2% is

(A) 10KΩ
(B) 49KΩ
(C) 490KΩ
(D) 1.2MΩ

111. Match the essential amplifier characteristics with the sensing applications given below:

Amplifier Characteristics		Sensing Applications	
P.	Charge amplifier with very low bias current and high input impedance	L.	Strain gauge in unipolar DC Wheatstone bridge
Q.	Voltage amplifier with low bias current and very high input impedance	M.	Glass electrode pH sensor
R.	Voltage amplifier with very high CMRR	N.	Piezo electric sensor for measurement of static force

(A) P-L, Q-M, R-N
(B) P-M, Q-N, R-L
(C) P-N, Q-L, R-M
(D) P-N, Q-M, R-L

112. Vena contracta is the cross-section where the flow area is a minimum for a restriction-type flow meter. For an orifice meter, if d is the diameter of the orifice opening, then the area of the vena contracta is approximately

(A) $\pi d^2/4$
(B) $0.99\ \pi d^2/4$
(C) $0.8\ \pi d^2/4$
(D) $0.6\ \pi d^2/4$

113. Different types of transducers and signal conditioning circuits are given below.
Match the transducer with the appropriate signal conditioning circuit commonly used with it.

P.	Thermocouple	1.	DC bridge
Q.	Strain gauge	2.	Phase sensitive detector
R.	Piezo electric sensor	3.	Charge amplifier
S.	LVDT	4.	Cold junction compensation
		5.	Instrumentation amplifier

(A) P-2, Q-3, R-5, S-1
(B) P-1, Q-5, R-2, S-3
(C) P-4, Q-1, R-2, S-5
(D) P-4, Q-1, R-3, S-2

114. Which of the following flow meter has the lowest pressure drop for a given range of flow?

(A) Orifice meter
(B) Venturi meter
(C) Flow nozzle
(D) Rotameter

115. Two copper-constantan thermocouples are connected such that the two constantan wires are joined together. The two copper wires are connected to the input of a low noise chopper stabilized differential amplifier having a gain of 1000. One of the thermocouple junctions is immersed in a flask containing ice and water in equal proportion. The other thermocouple is at a temperature T. If the output of the amplifier is 2.050V, the temperature T is

(A) 205°C
(B) 102.5°C
(C) 51.25°C
(D) 50°C

116. Poisson's ratio for a metal is 0.35. Neglecting Piezo resistive effect, the gauge factor of a strain gauge of this metal is

(A) 0.65
(B) 1
(C) 1.35
(D) 1.70

117. The values of the material constant β for thermistors P and Q are 4000K and 3000K, respectively. The resistance of each thermistor at 298K is 2KΩ. At 373K, the ratio of the resistance of thermistor P to that of thermistor Q will be closest to

(A) 1.33
(B) 1.00
(C) 0.75
(D) 0.50

118. The temperature being sensed by a negative temperature coefficient (NTC) type thermistors is linearly increasing. Its resistance will

(A) linearly increase with temperature
(B) exponentially increase with temperature
(C) linearly decrease with temperature
(D) exponentially decrease with temperature

119. A thermocouple is made using a copper and an iron wire. Its measuring junction is kept at a temperature of 100°C and the reference junction is kept at the ambient temperature of 30°C. The emf developed would be

(A) 700μV (B) 1000μV
(C) 3010μV (D) 5300μV

120. The time constant of a temperature measuring device is 0.5s. The device is used to measure temperature of the air in a room that is changing at about 5°C/h, it is ..... measurement.

(A) static (B) dynamic
(C) uncertain (D) None of the above

121. You have purchased an old sports car. When the engine is idling at 1000rpm, you press on the throttle and change the rpm to 3000rpm. You notice that the tachometer overshoots 3000rpm and oscillate for a couple of seconds about 3000rpm until it becomes steady. Is this a ..... order measuring system?

(A) first order (B) zero order
(C) second order (D) cannot be determined

122. A Hall element made of n-Ge with coefficient of $8\times10^{-3}Vm^3/WbA$ is subjected to a magnetic flux density of $0.75Wb/m^2$. The thickness of this element is 2mm. When a current of 1.5A is flowing through element, what is the voltage output?

(A) 45V (B) 4.5V
(C) 4.5mV (D) 0.45V

123. What is the light velocity within the glass? Glass refractive index =1.5.

(A) 2×10^8 m/s (B) 0.2×10^8 m/s
(C) 20×10^8 m/s (D) 2×10^8 km/s

124. What is acceptance angle of a fiber when
n_1 (core refractive index) = 1.48 and
n_2 (cladding refractive index) = 1.46?

(A) 38.07° (B) 28.07°
(C) 14.07° (D) 18.07°

125. Calculate the maximum transmission distance for a fiber link with attenuation of 0.5dB/km, if the power launched is 1mW and receiver sensitivity is 50μW.

(A) 24 km (B) 14km
(C) 26 km (D) 34km

126. Calculate the number of modes for a graded index optical fiber if its core diameter is 62.5μm, numerical aperture is 0.275 and its operating wavelength is 300nm.

(A) 431 (B) 341
(C) 143 (D) 134

127. What power is radiated by an LED if its quantum efficiency is 1% and the peak wavelength is 850nm with a forward current of 50mA?

(A) 0.345mW (B) 0.735mW
(C) 537mW (D) 7.35mW

128. The responsivity of a photodiode is 0.85A/W and the input-power saturation is 1.5mW. What is the photocurrent if the incident light power is 1mW?

(A) 0.85mA (B) 85mA
(C) 8.5mA (D) 75mA

129. For a PN photodiode, τ_{TR} and τ_{RC} are 100ps each. What is its bandwidth?

(A) 156GBit/s (B) 0.796GBit/s
(C) 789GBit/s (D) 234GBit/s

130. How much will a light pulse spread after traveling along 5km of step index fiber whose NA is 0.275 and $n_1 = 1.487$?

(A) 84.76 ns/km
(B) 74.76 ns/km
(C) 84.76 ms/km
(D) 74.76 ms/km

131. A Piezo electric transducer has a capacitance of 100pF and a charge sensitivity of 4×10^{-6} Coulomb/cm. The connecting cable has capacitance of 400pF. The display device has an input impedance of 1MΩ resistance and 50pF capacitance connected in parallel. What is the voltage sensitivity of Piezo electric transducer alone?

(A) 4000Volts/cm
(B) 40Volts/cm
(C) 40mVolts/cm
(D) 400Volts/cm

132. A longitudinal Piezo resistor is embedded on the top of a silicon cantilever near the anchored base. The cantilever points in the ‹ 110 › direction. The Piezo resistor is p-type doped with resistivity of 7.8Ω-cm. Find the longitudinal gauge factor of the Piezo resistor. Young's Modulus of silicon crystal is 168GPa

(A) 320
(B) 120.6
(C) 220.6
(D) 215.6

133. A fixed-free cantilever is made of single crystal silicon. The longitudinal axis of the cantilever points in the [100] crystal orientation. The resistor is made by diffusion doping with longitudinal gauge factor of 50. The length, width, and thickness of the cantilever are 200μm, 20μm and 5μm respectively. If a force 100μN is applied at the end of the cantilever in the longitudinal direction, what is the magnitude of stress?

(A) 1MPa
(B) 2MPa
(C) 1.7MPa
(D) 2.9 MPa

134. A body is dropped from a height of 10m and suffers a shock when it hits the ground. If the duration of the shock is 5ms, calculate the magnitude of the shock in terms of "g"?

(A) 312g (B) 286g
(C) 686g (D) 231g

135. Dummy strain gauges are used for

(A) calibration of strain gauges
(B) increasing the sensitivity of the bridge
(C) compensating for differential expansion
(D) compensating for temperature changes

136. Strain gauge rosettes are used

(A) when the direction of principal stress is known
(B) when the direction of principal stress is not known
(C) when the direction of hoop stress is not known
(D) when the direction of hoop stress is known

137. Two strain gauges are used to measure strain in a cantilever, one above and one below. The two strain gauges are connected in the adjacent arms of a Wheatstone bridge, the bridge configuration is called

(A) quarter bridge (B) half bridge
(C) full bridge (D) null bridge

138. The loading effect of a potentiometer is due to

(A) the output meter resistance
(B) potentiometer resistance
(C) both (A) and (B)
(D) the construction

139. The resolution of a potentiometer transducer can be increased by

(A) using bifilar winding
(B) using thin film potentiometer
(C) using helipots
(D) All the above

140. The change in resistivity due to strain in strain gauges is known as

(A) Piezo-electric effect
(B) Piezo-resistive effect
(C) Magnetostrictive effect
(D) Hall effect

141. The gauge factor of a metallic strain gauge is given as

(A) $1 + 2\upsilon$
(B) $\Delta R/R \,/\, \Delta L/L$
(C) $\Delta R/L$
(D) Both (A) and (A)

142. The material with highest gauge factor is

(A) Nickel
(B) Manganin
(C) Platinum
(D) Doped silicon

143. The material with almost zero temperature co-efficient of resistance is

(A) Nichrome
(B) Isoelastic
(C) Constantan
(D) Manganin

144. A resistance wire strain gauge with a gauge factor of 2 is bonded to a steel structure subjected to a stress of $100MN/m^2$. The modulus of elasticity of steel is $200GN/m^2$. The percentage change in the value of the gauge resistance due to the applied stress is

(A) 0.01%
(B) 0.1%
(C) 10%
(D) None of the above

145. A thermistor is used for measuring

(A) temperature
(B) flow
(C) pressure
(D) All of the above

146. The LVDT is used to measure the direction and magnitude of displacement

(A) by using a phase sensitive modulator
(B) by using an AC Voltmeter
(C) by using a DC Voltmeter
(D) None of the above

147. The capacitive transducer cannot be used for

(A) static input
(B) dynamic input
(C) Both (A) and (B)
(D) quasi state

148. Absolute encoders are generally limited to measurement of

(A) quarter revolution
(B) single revolution
(C) lay revolution
(D) multiple revolution

149. While selecting a transducer for a particular application

(A) only the input characteristics should be considered
(B) only the output characteristics should be considered
(C) only the transfer characteristics should be considered
(D) input, output and transfer characteristics should be considered

150. A Hall Effect transducer can be used for the measurement of

(A) power
(B) current
(C) displacement
(D) All of the above

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