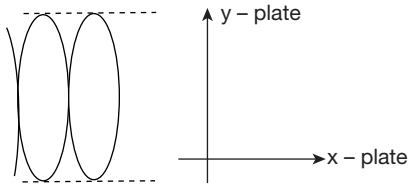
Electrical and Electronic Measurements Test 4

Number of Questions: 25 **Section Marks: 90**

Directions for questions 1 to 25: Select the correct alternative from the given choices.

1. Which one of the following types of instruments can be used to determine the rms value of ac voltage of high magnitude (10 kV) and of any wave shape?
(A) Permanent magnet moving coil instruments
(B) Moving iron instruments
(C) Electrostatic instruments
(D) Induction instruments

2. In a CRO sine waves are applied to *X* and *Y* plates. The lissajous pattern obtained on CRO screen as shown below. The ratio of horizontal signal frequency (f_x) to the vertical signal frequency (f_y) will be



(A) $\frac{1}{2}$ (B) $\frac{2}{3}$
(C) $\frac{2}{5}$ (D) $\frac{2}{7}$

3. Which one of the following decides the precision of integrating digital voltmeter?
(A) Reference voltage of analog comparator
(B) Electronic counter
(C) Width of the generated pulses
(D) Slope of the generated ramp

4. Match List-I (Type of DVM) with List-II (Sub-component in ADC) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Ramp type	1. DAC
B. Dual-slope	2. Potentio meter
C. Servo-type	3. Voltage to time converter
D. Successive approximation	4. Capacitor

Codes:

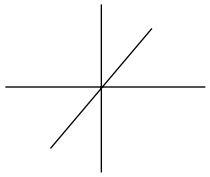
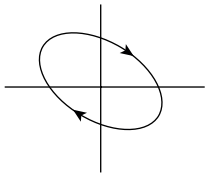
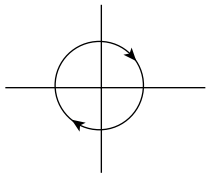
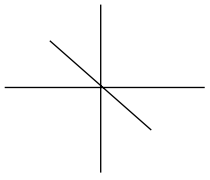
	A	*B*	*C*	*D*
(A)	1	2	3	4
(B)	3	2	1	4
(C)	3	4	2	1
(D)	1	3	2	4

5. Beam of electrons in a cathode ray tube emanates because of
(A) Secondary emission.
(B) Thermionic emission.
(C) Post acceleration.
(D) Diffusion.

6. A sinusoidal voltage of 5V (RMS) at 10 Hz is applied across two terminals of a PMMC type voltmeter. What is the deflection of the pointer?
(A) 2.5V (B) 3.54V
(C) 0V (D) 5V

7. Which one of the following DVM is most suitable to eliminate the effect of period noise?
(A) Successive approximation type digital voltmeter.
(B) Integrating type digital voltmeter.
(C) Ramp type digital voltmeter.
(D) Servo type digital voltmeter.

8. The voltage signals $V_x = V_{xm}$ sin ωt and $V_y = V_{ym}$ sin $\left(\omega t + \frac{\pi}{2}\right)$ are given to CRO *X* and *Y* plates respectively.
The lissajous pattern obtained on the CRO screen will be

(A) 
(B) 
(C) 
(D) 

9. A CRO is operated with *x* and *y* settings of 0.5 ms/cm and 100 mV/cm. The screen of the CRO is 10cm × 10cm (*x* and *y*). A sine wave of frequency 200 Hz and rms amplitude of 300mV is applied to the *Y*-input. The screen will show
(A) One cycle of the undistorted sine wave.
(B) Two cycles of the undistorted sine wave.
(C) One cycle of the sine wave with clipped amplitude.
(D) Two cycles of the sine wave with clipped amplitude.

10. Which of the following are data representation elements in a generalized measurement system?
1. Analog indicator
2. Amplifier
3. *A*/*D* converter
4. Digital display
Select the correct answer using the codes given below:
(A) 1 and 2 (B) 1 and 4
(C) 2 and 3 (D) 3 and 4

11. In a *Q*-meter measurement to determine the self-capacitance of a coil, the first resonance occurred at f_1 with $C_1 = 300$ pF. The second resonance occurred at $f_2 = 2f_1$

with C_2 = 30 pF. The self-capacitance of coil works out to be

(A) 240 pF (B) 120 pF
(C) 180 pF (D) 60 pF

12. Calculate the maximum velocity of the beam of electrons in a CRT having a cathode anode voltage of 1000V. Assume that the electrons to leave the cathode with zero velocity. Charge of electron = -1.6×10^{-19} C and mass of electron = 9.1×10^{-31} kg

(A) 4.75×10^6 m/s (B) 18.75×10^6 m/s
(C) 35.1×10^6 m/s (D) 41.34×10^6 m/s

13. A single channel digital storage oscilloscope uses a 12 bit, 10^9 samples/sec ADC. For a 1 kHz sine wave input, what are the number of samples taken per cycle of input?

(A) 10^4 (B) 10^6
(C) 10^8 (D) 10^{12}

14. A 0 – 500V voltmeter has an error of ±2.5% of FSD. What are the range of readings if true voltage is 50V?

(A) 37.5V to 62.5V (B) 48.75V to 51.25V
(C) 45V to 55V (D) 42.5V to 57.5V

15. One cycle of a square wave signal observed on an oscilloscope and it is found to occupy 8 cm at a scale setting of 50 μs/cm. What is the signal frequency?

(A) 2.5 kHz (B) 5 kHz
(C) 40 kHz (D) 50 kHz

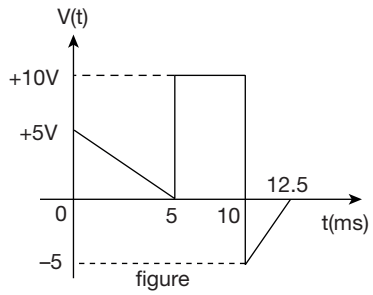
16. The number of bits of Analog to Digital converter required to convert an analog input in the range of 0 – 25 volt to an accuracy of 50 mV is

(A) 8 (B) 9
(C) 11 (D) 15

17. If the bandwidth of an oscilloscope is given as direct current to 35 kHz, what is the fastest rise time a sine wave can have to be produced accurately by the oscilloscope?

(A) 5 μs (B) 10 μs
(C) 35 μs (D) 70 μs

18. A periodic voltage waveform observed on an oscilloscope across a load is shown in figure. A permanent magnet moving coil meter connected across the same load reads



figure

(A) 4V (B) 25V
(C) 50V (D) 12.5V

19. When testing a coil having a resistance of 20Ω, resonance occurred when the oscillator frequency was 100 kHz and the rotating capacitor was set at $\frac{10}{2\pi}$ nF. The effective value of Q of the coil is

(A) 10 (B) 50
(C) 80 (D) 100

20. In a CRT, 5×10^{15} electrons are accelerated through a potential difference of 10000V over a distance of 30mm per minute. Calculate the average power supplied to the beam of electrons

(A) 5 mW (B) 18.99 mW
(C) 76.12 mW (D) 133.33 mW

21. A bridge type rectifier meter and a thermocouple meter employ moving coil movement for indication. Both are calibrated on a 50 Hz sinusoidal wave, if a 50 Hz rectangular wave is applied to each, the ratio of their readings will be

(A) 1 : 2 (B) 0.707 : 1
(C) 1.11 : 1 (D) 1.732 : 1

22. In a dual slope integrating type digital voltmeter the first integration is carried out for 5 periods of the supply frequency of 50 Hz. If the reference voltage used is 5V, the total conversion time for an input of 1V is

(A) 0.01 sec (B) 0.02 sec
(C) 0.1 sec (D) 0.5 sec

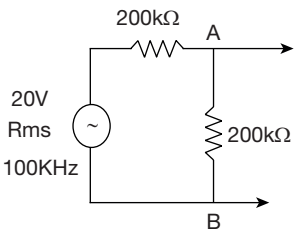
23. A 50 Hz bar primary current transformer has a secondary with 2000 turns. The secondary supplies 1A current into a purely resistive burden of 1 Ω. The magnetizing ampere – turns 500. The phase angle between the primary and secondary current is

(A) 4.6° (B) 175.4°
(C) 14.32° (D) 165.6°

24. A voltage of $100\sqrt{2}\sin(2p \times 50t) + 20\sqrt{2}\sin(2p \times 150t) + 10\sqrt{2}\cos(2p \times 350t + 60°)$V is given to a harmonic distortion meter. The harmonic distortion indicating by the meter will be approximately

(A) 7.07% (B) 30.15%
(C) 42.34% (D) 51.51%

25. A CRO probe has an impedance of 400 kΩ in parallel with a capacitance of 20pF. The probe is used to measure the voltage between A and B as shown in figure. The measured voltage will be



(A) 5.64V (B) 2.31V
(C) 7.43V (D) 9.71V

Answer Keys

1. C	**2.** C	**3.** A	**4.** C	**5.** B	**6.** C	**7.** D	**8.** C	**9.** A	**10.** B
11. D	**12.** B	**13.** B	**14.** A	**15.** A	**16.** B	**17.** B	**18.** C	**19.** B	**20.** D
21. C	**22.** B	**23.** C	**24.** B	**25.** A					

Hints and Explanations

1. The currents drawn from supply is fairly small and therefore the power requirements of electrostatic instruments are quite low. So, they are particularly suited for high voltages. Choice (C)

2. $\frac{f_x}{f_y} = \frac{2}{5} = \frac{\text{Number of vertical tangencies}}{\text{Number of horizontal tangencies}}$

Choice (C)

3. Choice (A)

4. Choice (C)

5. Choice (B)

6. For PMMC, the torque is not unidirectional as it employs permanent magnet. Choice (C)

7. Choice (D)

8. When the two voltages has phase displacement of 90°, the trace is a circle. If the direction of the trace is in the clockwise then the phase difference is + 90° otherwise – 90° Choice (C)

9. Time period of sine wave = $\frac{1}{200} = 5\text{ms}$

The peak to peak voltage shown by the CRO

$= (200\sqrt{2})2\text{mV} < 900\text{ mV}$ Choice (A)

10. Both amplifier and *A/D* converter are signal conditioners. Choice (B)

11. Self-capacitance, $C_d = \frac{C_1 - n^2 C_2}{n^2 - 1}$; $n = \frac{f_2}{f_1} = 2$

$C_d = \frac{300 - 4\times 30}{4-1} = 60\text{pF}$ Choice (D)

12. Velocity of electron = $\sqrt{\frac{2eE}{m}}$

$= \sqrt{\frac{2\times 1.6\times 10^{-19}\times 1000}{9.1\times 10^{-31}}}$

$= 18.75 \times 10^6$ m/s Choice (B)

13. No. of samples = $10^9 \times \frac{1}{1\times 10^3} = 10^6$ per cycle of input

Choice (B)

14. Error in volts = (% error) (FSD value)

$= \frac{2.5}{100}\times 500 = 12.5\text{V}$

$\therefore$ Range for 50V = 50 ± 12.5

= 37.5V to 62.5V Choice (A)

15. Total time period = 50 × 8 = 400 μs

Frequency, $f = \frac{1}{T} = \frac{1}{400\times 100^{-6}} = 2.5$ kHz Choice (A)

16. Resolution = $\frac{FSD}{2^n - 1}$

$50 \times 10^{-3} = \frac{25}{2^n - 1}$

$2^n - 1 = 500$

$2^n = 501$

$\Rightarrow \quad n \simeq 9$ Choice (B)

17. Rise time, $t_r = \frac{0.35}{BW}$

$t_r = \frac{0.35}{35\times 10^3} = 10\mu\text{s}$ Choice (B)

18. PMMC meter reads average value

$V_{O\,\text{avg}} = [\frac{1}{2} \times 5 \times 5] + [5 \times 10] - [5 \times 2.5]$

$= 12.5 + 50 - 12.5 = 50\text{V}$ Choice (A)

19. $Q = \frac{\omega_o L}{R} = \frac{1}{\omega_o RC}$

$= \frac{1}{\left(2\pi\times 100\times 10^3\right)\times 20\times\left(\frac{10}{2\pi}\times 10^{-9}\right)} = \frac{0.5}{10^{-2}} = 50$

Choice (B)

20. The energy supplied by the source

$E = 5 \times 10^{15} \times 1.6 \times 10^{-19} \times 10000 = 8\text{J}$

Average power = $\frac{E}{t} = \frac{8}{60} = 133.33\text{mW}$.

Choice (D)

21. Bridge type rectifier reading, $V_{rms} = 1.11\ V_{avg}$

Thermocouple meter reading, $V_{rms} = V_{avg}$

$\therefore$ Ratio = 1.11:1

Choice (C)

22. For dual slope integration meter,

$V_{in} = V_{ref}(t_2/t_1)$

t_1 = first integration time

$= 5 \times \frac{1}{50} = 0.1$ sec

Input and reference voltages are 1V and 5V respectively

$$t_2 = V_{in} \times \frac{t_1}{V_{ref}} = 1 \times \frac{0.1}{5}$$

$t_2 = 0.02$ sec

Choice (B)

23. Turns ratio $n = \frac{N_S}{N_P}$

$$= \frac{2000}{1} = 2000$$

$$I_m = \frac{\text{Magnetizing ampere turn}}{N_P}$$

$$= \frac{500}{1} = 500\text{A}$$

Phase angle between primary and secondary

Currents $\theta = \left(\frac{180}{\pi}\right)\left(\frac{I_m}{n I_S}\right)$ degrees

$$\theta = \frac{180}{\pi} \times \frac{500}{2000 \times 1}$$

$\theta = 14.32^o$

Choice (C)

24. $\%\text{THD} = \frac{\text{Unless harmonic content RMS}}{\text{Total RMS}} \times 100$

$$= \frac{\sqrt{30^2 + 10^2}}{\sqrt{100^2 + 30^2 + 10^2}} \times 100$$

$= 30.15\%$.

Choice (B)

25. The probe impedance

$R = 400$ k Ω

$$Xc = \frac{1}{2\pi fc} = \frac{1}{2\pi \times 100 \times 10^3 \times 20 \times 10^{-12}} = 79.6 \text{ k}\Omega$$

Applying Nodal equation :

$$\frac{V_{AB} - 20}{200k} + \frac{V_{AB}}{200k} + \frac{V_{AB}}{400k} + \frac{V_{AB}}{-j79.6k} = 0$$

$$V_{AB}\left[\frac{2+2+1}{400k}\right] + \frac{V_{AB}}{-j79.6k} = \frac{20}{200k}$$

$12.5 \times 10^{-3} V_{AB} + j12.56 \times 10^{-3} V_{AB} = 0.1$

$$V_{AB} = \frac{0.1}{[12.5 + j12.56] \times 10^{-3}} = 5.64\angle -45.13.$$

Choice (A)