OFFLINE TEST SERIES

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ESE-2017 : Prelims Exam

UPSC Engineering Services Examination

E & T ENGINEERING

Answer Key & Solutions

Test 13: Part Syllabus Technical

Adv. Communication + Measurements

1.	(a)	16.	(a)	31.	(b)	46.	(c)	61.	(a)
2.	(a)	17.	(a)	32.	(b)	47.	(a)	62.	(b)
3.	(d)	18.	(c)	33.	(a)	48.	(a)	63.	(d)
4.	(b)	19.	(b)	34.	(b)	49	(c)	64.	(a)
5.	(b)	20.	(b)	35.	(b)	50.	(c)	65.	(c)
6.	(b)	21.	(c)	36.	(b)	51.	(a)	66.	(a)
7.	(d)	22.	(d)	37.	(a)	52.	(b)	67.	(d)
8.	(c)	23.	(d)	38.	(a)	53.	(d)	68.	(c)
9.	(a)	24.	(d)	39.	(a)	54.	(c)	69.	(a)
10.	(b)	25.	(a)	40.	(b)	55.	(b)	70.	(a)
11.	(b)	26.	(d)	41.	(d)	56.	(c)	71.	(a)
12.	(d)	27.	(c)	42.	(b)	57.	(b)	72.	(a)
13.	(c)	28.	(b)	43.	(b)	58.	(b)	73.	(b)
14.	(b)	29.	(d)	44.	(c)	59.	(b)	74.	(b)
15.	(a)	30.	(a)	45.	(c)	60.	(d)	75.	(b)

DETAILED EXPLANATIONS

1. (a)

$\because$
$$I_{FSD} = 100\ \mu A$$
$$R_m = 1\ k\Omega$$
$$V_{FSD} = V_m = 100\ \mu A \times 1\ k\Omega = 100\ mV$$
$$R_s = (m-1)\ R_m$$

where
$$m = \frac{V}{V_m} = \frac{50\ V}{100\ mV} = 500$$
$$R_m = 1\ k\Omega$$
$$R_s = (500 - 1)\ k\Omega = 499\ k\Omega$$

2. (a)

$$T_D \propto VI\cos\phi \quad \text{(active power)}$$

Average is taken over a period.

3. (d)

$$\text{error in } R = \pm 10\%$$

$\therefore$
$$\text{limiting error}\left(\frac{\delta R}{R}\%\right) = \pm 10\%$$
$$\text{error in } I = \pm 2\% \text{ of } 25\ mA = \pm 0.5\ mA$$
$$\text{limiting error}\left(\frac{\delta I}{I}\%\right) = \frac{\pm 0.5\ mA}{10\ mA} \times 100 = \pm 5\%$$

$\because$
$$P = I^2 R$$
$$\text{limiting error in power}\left(\frac{\delta P}{P}\%\right) = \pm\left[2\frac{\delta I}{I}\% + \frac{\delta R}{R}\%\right] = \pm[2 \times (5)\% + 10\%] = \pm 20\%$$

5. (b)

Maxwell's bridge is used for medium Q coils (1 to 10)

6. (b)

$$\text{Limiting error in } V_1,\ \left(\frac{\delta V_1}{V_1}\right) = 1\%$$
$$\text{Limiting error in } V_2,\ \left(\frac{\delta V_2}{V_2}\right) = 5\%$$
$$V = V_1 + V_2$$
$$V = 100 + 80 = 180\ V$$
$$\text{Limiting error in } V,\ \frac{\delta V}{V} = \pm\left[\frac{V_1}{V}\frac{\delta V_1}{V_1} + \frac{V_2}{V}\frac{\delta V_2}{V_2}\right]$$
$$\frac{\delta V}{V} = \pm\left[\frac{100}{180}[1\%] + \frac{80}{180}[5\%]\right]$$
$$= \pm 2.7\%$$

7. (d)

Error in reading of first meter $\delta M1 = \text{FSD} \times \text{accuracy} = 100\text{ V}\left[\pm\frac{1}{100}\right] = \pm 1\text{ V}$

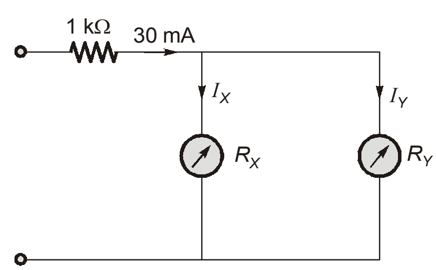
Error in reading of second meter $\delta M2 = 50\text{ V}\left[\pm\frac{2}{100}\right] = \pm 1\text{ V}$

Error in reading of third meter $\delta M3 = 20\text{ V}\left[\pm\frac{2.5}{100}\right] = \pm 0.5\text{ V}$

Error in reading of fourth meter $\delta M4 = 10\text{ V}\left[\pm\frac{2.5}{100}\right] = \pm 0.25\text{ V}$

hence, meter M4 has minimum error in the reading.

8. (c)



Let current in ammeter X be I_X

then

$$I_X = 30\text{ mA}\left[\frac{R_Y}{R_X + R_Y}\right]$$

$$= 30\text{ mA}\left[\frac{100}{50+100}\right]$$

$$= 20\text{ mA}$$

9. (a)

$$\text{Voltage sensitivity} = \frac{\text{Charge sensitivity}}{\text{Total capacitance in the measuring circuit}}$$

$$= \frac{4\times10^{-6}}{[1+0.2+0.4]\times10^{-9}} = \frac{4\times10^{-6}}{1.6\times10^{-9}}$$

$$= 2500\text{ V/cm}$$

10. (b)

Total voltage across PMMC

$$V_T = V_1 + V_2(t)$$

$$= 5 - 5\cos(314t)\text{ V}$$

$\because$ PMMC reads the average value of the applied voltage

average value of V_1 = 5 V

average value of $V_2(t)$ = 0 V

$\therefore$ average value of V_T = 5 V

So, PMMC reads 5 V.

11. (b)

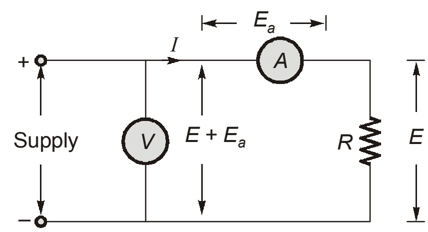
Meter resistance $R_M = 1\text{ k}\Omega/\text{V} \times 10\text{ V} = 10\text{ k}\Omega$

Current through meter when it measure half of full scale (10 V)

$$I = \frac{10/2}{10\text{ k}\Omega} = 0.5\text{ mA}$$

12. (d)

Redraw the circuit



$$E + E_a = 500\text{ V}$$
$$I = 0.5\text{ A}$$
$$R_a = 100\ \Omega$$
$$R_a + R = \frac{E+E_a}{I} = \frac{500\text{ V}}{0.5\text{ A}} = 1000\ \Omega$$
$$R = 1000\ \Omega - 100\ \Omega = 900\ \Omega$$

13. (c)

Iron - constantan $\rightarrow$ –180 to 850°C

Chromel - alumel $\rightarrow$ –200 to 1300°C

Copper - constantan $\rightarrow$ –180 to 400°C

Chromel - constantan $\rightarrow$ –180 to 850°C

16. (a)

$$\text{G.F.} = \frac{\Delta R/R}{\Delta L/L}$$

$\therefore$ $$+200 = \frac{\Delta R}{1000 \times 10^{-4}}$$

$\therefore$ $$\Delta R = 20$$

$\therefore$ Resistance of gauge = 1000 + 20 = 1020 Ω

17. (a)

At balanced condition

$$(R + j\omega L)\left[\frac{R_4}{1 + j\omega C_4 R_4}\right] = R_2 R_3$$
$$(R + j\omega L)R_4 = R_2 R_3 (1 + j\omega C_4 R_4)$$

on comparing real and imaginary parts

$$RR_4 = R_2 R_3$$
$$R = \frac{R_2 R_3}{R_4}$$
$$LR_4 = R_2 R_3 C_4 R_4$$
$$L = R_2 R_3 C_4$$

19. (b)

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$f \propto \frac{1}{\sqrt{C}}$$

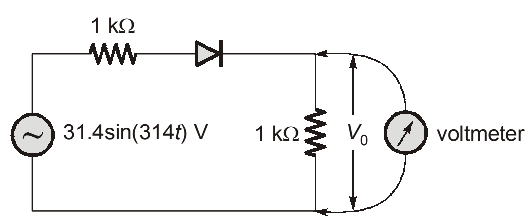
$$\frac{f_1}{f_2} = \sqrt{\frac{C_2}{C_1}}$$

$\because$
$$C_2 = C_1 + \frac{21}{100}C_1 = 1.21C_1$$

$$\frac{110}{f_2} = \sqrt{\frac{1.21C_1}{C_1}}$$

$$f_2 = \frac{110}{\sqrt{1.21}} = 100 \text{ kHz}$$

20. (b)



For half cycle diode is ON.
For half cycle voltage across 1 kΩ resistor is,

$$V_0 = 31.4\sin(314t)\left[\frac{1}{1+1}\right]$$

$$= 15.7\sin(314t) \text{ V}$$

$\because$ PMMC voltmeter measures average value of V_0
In case of half wave rectification

$$V_{0\,avg} = \frac{V_m}{\pi} = \frac{15.7}{3.14} = 5 \text{ V}$$

21. (c)
Voltage applied to deflecting plates

$$E_d = \frac{2dE_aD}{LI_d}$$

$$= \frac{2\times0.5\times10^{-2}\times2500\times4\times10^{-2}}{20\times10^{-2}\times2.5\times10^{-2}}$$

$$= 200 \text{ V}$$

22. (d)

$$\pm 1\% \text{ on full scale reading} = \pm\frac{1}{100}\times 200 = \pm 2 \text{ mA}$$

$\because$ The meter can read from 0 to 1999 = 2000 counts

$$\text{Error due to 5 counts} = \pm\frac{200}{2000}\times 5 = \pm 0.5 \text{ mA}$$

$$\text{Worst case error} = \pm(2 \text{ mA} + 0.5 \text{ mA}) = \pm 2.5 \text{ mA}$$

26. (d)

$$\text{Sensitivity of LVDT} = \frac{\text{Output}}{\text{Input}} = \frac{8 \text{ V}}{4 \text{ mm}} = 2 \text{ V/mm}$$

Minimum voltage that can be read by voltmeter

$$= 10\times\frac{1}{100}\times\frac{2}{10} = 20 \text{ mV}$$

Minimum displacement that can be read by this voltmeter

$$= \frac{20 \text{ mV}}{2 \text{ V/mm}} = 10 \text{ μm}$$

$$= 10 \text{ μm}$$

27. (c)

$\because$

$$\Delta R = R\times GF\times E = 100\times 4\times 20\times 10^{-6} = 8\times 10^{-3}\ \Omega$$

28. (b)

For platinum resistance thermometer

$$R_T = R_0[1+\alpha(\Delta T)]$$

$$R_{200} = 100[1+0.004(200-0)] = 180\ \Omega$$

30. (a)

For triangular wave

$$\text{Avg value} = \frac{V_m}{2}$$

$$\text{RMS value} = \frac{V_m}{\sqrt{3}}$$

$\therefore$

$$\frac{V_m}{2} = 10 \text{ V} \Rightarrow V_m = 20$$

$$\text{RMS value} = \frac{V_m}{\sqrt{3}} = \frac{20}{\sqrt{3}} \text{ V}$$

31. (b)

For closed Lissajous pattern

$$\frac{f_y}{f_x} = \frac{\text{Number of Tangencies in Horizontal plane}}{\text{Number of Tangencies in Vertical plane}}$$

$$\frac{f_y}{f_x} = \frac{3f}{f} = \frac{3}{1}$$

Hence, option (b) is correct.

33. (a)

$$D_{\text{skip}} \propto \sqrt{f_{\text{used}}}$$

34. (b)

In datagram switching all packets are treated independent of each other.

37. (a)

In a circuit switch network a physical link must be present between the end users to connect.

38. (a)

Time division multiplexing is also called as time-slot interchange (TSI) switch.

40. (b)

In electronics, a banyan switch is a complex crossover switch used in electrical or optical switches. A banyan switch is a multistage switch with micro-switches at each stage that route the packets based on the output port represented as a binary string

45. (c)

The computer on which the information is loaded and can be extracted is called as a host.

50. (c)

In an IPv4 datagram is fragmented into three smaller datagrams the identification field is the same for all three datagrams.

51. (a)

Base header is a necessary part of the IPv6 datagram.

56. (c)

$$\begin{aligned} T_s &= T_0(N.F - 1) \\ 600 &= 300(N.F - 1) \\ 2 &= N.F - 1 \\ N.F &= 3 \end{aligned}$$

58. (b)

A geostationary has a circular orbit and it revolves around the earth in 24 hrs.

61. (a)

A skew ray does not have to cross the fiber axis.

64. (a)

A very small aperture terminal (VSAT) is a two way satellite ground station with a dish antenna that is a small than 5 meters. The majority of VSAT antennas range for 0.75 m to 1.2 m.

65. (c)

Reflective index of core = n_1

refractive index of cladding = n_2

Numerical apperture $NA = \sqrt{n_1^2 - n_2^2}$

Acceptance angle $\phi_a = \sin^{-1}$ (NA)

$$= \sin^{-1}\left(\sqrt{n_1^2 - n_2^2}\right)$$

67. (d)

Thermocouple works on the following effects.

1. Seebeck effect.
2. Peltier effect.
3. Thomson effect.

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