CLASS TEST

S.No. : 01 PT_EC_A+C_290719

Measurement

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CLASS TEST 2019-2020

ELECTRONICS ENGINEERING

Date of Test : 29/07/2019

ANSWER KEY ➤ Measurement

1.	(d)	7.	(b)	13.	(b)	19.	(a)	25.	(c)
2.	(a)	8.	(d)	14.	(c)	20.	(b)	26.	(b)
3.	(b)	9.	(a)	15.	(d)	21.	(b)	27.	(b)
4.	(b)	10.	(b)	16.	(d)	22.	(a)	28.	(a)
5.	(c)	11.	(a)	17.	(d)	23.	(c)	29.	(c)
6.	(d)	12.	(a)	18.	(d)	24.	(b)	30.	(b)

Detailed Explanations

1. (d)

Moving-iron voltmeter reads RMS value,

$$V = \sqrt{V_{1rms}^2 + V_{2rms}^2}$$

$$V_{1\,rms} = 5\text{ V}$$

and $$V_{2\,rms} = \frac{10}{\sqrt{2}}\text{ V}$$

$\therefore$ $$V = \sqrt{5^2 + \left(\frac{10}{\sqrt{2}}\right)^2} = \sqrt{75}\text{ V}$$

2. (a)

At balanced condition,

$$\frac{1000}{R_x + j\omega L_x} = \frac{R_S}{(j\omega R_S C_S + 1)\,1000}$$

or

$$10^6\,(j\omega R_S C_S + 1) = R_S\,(R_x + j\omega L_x)$$

Equating real and imaginary terms,

$$10^6 = R_S R_x$$

$\Rightarrow$ $$R_x = \frac{10^6}{R_S} = 1000\ \Omega$$

and $$10^6\,C_S = L_x$$

$\Rightarrow$ $$L_x = 10^6 \times 0.5 \times 10^{-6} = 0.5\text{ H}$$

3. (b)

Because of over voltage there are chances of insulation breakdown.

4. (b)

$$S_E = \frac{l \cdot L}{2dV_a} = \frac{2\times 20}{2\times 0.2\times 2000} = 0.05\text{ cm/V}$$

5. (c)

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

$\Rightarrow$ $$\frac{f_1}{f_2} = \sqrt{\frac{C_2 + C_d}{C_1 + C_d}}$$

Where, C_d = self capacitance of the coil

$$\frac{1\times 10^6}{500\times 10^3} = \sqrt{\frac{250 + C_d}{40 + C_d}} = 2$$

$\Rightarrow$ $$\frac{250 + C_d}{40 + C_d} = 4$$

$\Rightarrow$ $$250 + C_d = 160 + 4\,C_d$$

$\Rightarrow$ $$3\,C_d = 90$$

$\Rightarrow$ $$C_d = 30\text{ pF}$$

6. (d)

Probable error,

$$\sigma = \sqrt{\left(\frac{\partial I}{\partial I_1}\right)^2 \sigma_1^2 + \left(\frac{\partial I}{\partial I_2}\right)^2 \sigma_2^2}$$

Here, $I = I_1 + I_2$

So, $\dfrac{\partial I}{\partial I_1} = \dfrac{\partial I}{\partial I_2} = 1$

and $\sigma = \sqrt{(1)^2(1)^2 + (1)^2(2)^2} = 2.24$ A

Therefore, $I = 300 \pm 2.24$ A

7. (b)

Deflecting torque in PMMC ;

$$T_d \propto BI$$

Given, $B_2 = 2B_1$

and $I_2 = \dfrac{I_1}{2}$

$\therefore$ $T_{d_2} \propto B_2 I_2 \propto (2B_1)\left(\dfrac{I_1}{2}\right) \propto B_1 I_1$

Thus, $T_{d_2} = T_{d_1}$

So, same deflection (90°) is produced.

8. (d)

Wien bridge is balanced only for pure sinusoidal input supply and no harmonics in supply. So, no null indication is possible.

9. (a)

Heaviside Campbell bridge method is commonly used for finding mutual inductance.

10. (b)

For the d.c. potentiometer, we have:

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

or, emf of the test cell,

$$E_2 = E_1 \cdot \frac{l_2}{l_1} = (1.18) \times \frac{680}{600} \approx 1.34 \text{ V}$$

11. (a)

Method-1

Given that,

$V = 230$ Volt,

$I = 5$ A, $\cos\phi = 0.1$

$R_P = 10$ kΩ, $L_P = 100$ mH $= 0.1$ H

$\therefore$ $\beta = \tan^{-1}\left(\dfrac{\omega L_P}{R_P}\right) \approx 0.18°$

And, $\phi = \cos^{-1}[0.1] = 84.26°$

Now, True power $= P_T = VI\cos\phi = 115$ watt

Reading of wattmeter for lagging p.f.,

$$P_{Read} = VI\cos(\phi - \beta)\cos\beta = 118.6 \text{ watt}$$

$$\therefore \quad \%\text{ error} = \frac{118.6 - 115.0}{115.0} \times 100 = 3.13\%$$

Method-2

Solution can be given directly from the equation given below after finding "β" as,

$$\%\text{ error} = \tan\phi \cdot \tan\beta \times 100 = \tan(84.26°) \cdot \tan(0.18°) \times 100 = 3.13\%$$

12. (a)

$$S_{dc} = \frac{1}{I_{fs}} = \frac{1}{1 \times 10^{-3}} = 1000\ \Omega/\text{v}$$

$$R_m = S_{dc}V = 1000 \times 1 = 1000\ \Omega$$

$$\because \quad R_s = 0.45 \times 1000 \times 10 - 1000$$

$$R_s = 3.5\ \text{k}\Omega$$

13. (b)

$$\text{The limiting error to 80 V} = \frac{0.02 \times 100}{80} \times 100 = 2.5\%$$

$$\text{The limiting error at 80 mA} = \frac{0.02 \times 150}{80} \times 100 = 3.75\%$$

The limiting error for power calculation

$$= 2.5\% + 3.75\% = 6.25\%$$

14. (c)

Effective value of input wave (thermocouple based instrument reads rms value)

$$= \sqrt{I_1^2 + I_H^2} = \sqrt{I_1^2 + \left(\frac{I_1}{5}\right)^2} = \sqrt{\frac{26}{25} I_1^2} = \sqrt{1.04 I_1^2} = 1.0198\, I_1$$

$$\approx 1.02\, I_1 = I_1 + 0.02\, I_1$$

Hence, error = 2%

15. (d)

At balance condition,

$$Z_1 Z_x = Z_2 Z_3$$

i.e.,
$$R_1\left(R_x - \frac{j}{\omega C_x}\right) = R_2\left(R_3 - \frac{j}{\omega C_3}\right)$$

$$\therefore \quad R_1 R_x - \frac{jR_1}{\omega C_x} = R_2 R_3 - \frac{jR_2}{\omega C_3}$$

Equating the real and the imaginary parts,

$$R_1 R_x = R_2 R_3$$

$$\Rightarrow \quad R_x = \frac{R_2 R_3}{R_1} = \frac{30 \times 25}{20} = 37.5\ \Omega$$

and
$$\frac{R_1}{\omega C_x} = \frac{R_2}{\omega C_3}$$

$$\Rightarrow \quad C_x = \frac{C_3 R_1}{R_2} = \frac{10 \times 20}{30} = 20/3 \text{ pF}$$

16. (d)

Total power in the circuit

$$P = W_1 + W_2 = 500\ W + (-100)\ W = 400\ W$$

Power factor of the circuit,

$$\cos\phi = \cos\left[\tan^{-1}\left\{\left(\frac{W_1 - W_2}{W_1 + W_2}\right).\sqrt{3}\right\}\right] = \cos\left(\tan^{-1}\left\{\left[\frac{0.5-(-0.1)}{0.5+(-0.1)}\right].\sqrt{3}\right\}\right)$$

$$= \cos\left(\tan^{-1}(1.5\times\sqrt{3})\right) = 0.359$$

17. (d)

Rate of change of inductance with deflection is,

$$\frac{dL}{d\theta} = \frac{d}{d\theta}(10 + 5\theta - \theta^2) = (5 - 2\theta)\ \mu\text{H/rad}$$

The deflection is, $\theta = \frac{1}{2}\frac{I^2}{K}\frac{dL}{d\theta}$

or, $\theta = \frac{1}{2}\times\frac{(5)^2}{12\times10^{-6}}\times(5-2\theta)\times10^{-6}$

On solving, we get:

$$\theta = 1.69\ \text{rad} = 1.69\times180/\pi\ \text{degree} = 96.8°$$

18. (d)

$$v = V_1\sin\omega t + V_2\sin(2\omega t + \theta_1) + V_3\sin(3\omega t + \theta_2) + \cdots$$

$$i = I_1\sin\omega t + I_2\sin2\omega t + I_3\sin3\omega t + \cdots$$

So, $P = v\cdot i = \frac{1}{2}V_1I_1 + \frac{1}{2}V_2I_2\cos\theta_1 + \frac{1}{2}V_3I_3\cos\theta_2 + \cdots$

Here, $v = 100\sin\omega t + 60\cos(3\omega t - 30°) + 40\sin(5\omega t + 45°)\text{V}$

$$i = 8\sin\omega t + 6\sin(5\omega t + 120°)\text{A}$$

So, power $P_T = \frac{1}{2}\times100\times8 + \frac{1}{2}\times60\times0 + \frac{1}{2}\times40\times6\cos(120° - 45°)\text{W} = 431\ \text{Watt}$

19. (a)

$$V_{\text{true}} = 400\times\frac{200}{400} = 200\ \text{V} = V_t$$

Resistance of voltmeter $= 20\frac{\text{k}\Omega}{V}\times10\text{V} = 200\ \text{k}\Omega$

$\therefore$ $V_{\text{measured}} = 400\times\frac{100}{300} = 133.33\ \text{V} = V_m$

Thus, $\%\ \text{error} = \frac{V_m - V_t}{V_t}\times100 = -33.335\% \approx -33.33\%$

20. (b)

The magnitude of limiting error for the voltmeter

$$\varepsilon_V = 0.01\times150 = 1.5\ \text{V}$$

the limiting error at 100 V $= \frac{1.5}{100}\times100 = 1.5\%$

The magnitude of the limiting error for the ammeter

$$\varepsilon_A = 0.01 \times 100 = 1 \text{ mA}$$

The limiting error at 55 mA $= \dfrac{1}{55} \times 100 = 1.8\%$

The limiting error for the power, $P = VI$

$= $ sum of the individual limiting error $= (1.5 + 1.8)\% = 3.3\%$

21. (b)

When op-amps are used as comparators in ADC, this means ADC is flash type ADC.
So, number of comparators required for n-bit ADC is $2^n - 1$.

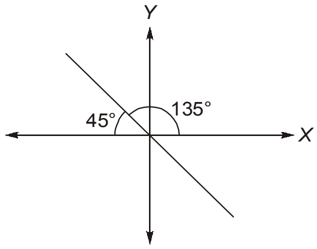
$$= 2^5 - 1 = 31 \text{ comparators}$$

22. (a)

The overall uncertainty

$$\omega_x = \sqrt{\omega_{x1}^2 + \omega_{x2}^2 + \omega_{x3}^2} = \sqrt{1^2 + 1^2 + 3^2} = \sqrt{11}\,\%$$

23. (c)



It means voltages are 180° in phase.

$$\therefore \quad V_y = 2\sin(\omega t + 180°)$$

$$V_y = -2\sin\omega t$$

24. (b)

$$P = \frac{1}{2}(V_1 I_1 \cos\phi_1 + V_3 I_3 \cos\phi_3) = \frac{1}{2}(40 \times 5 \cos 75° + 60 \times 3 \cos 15°)$$

$$= 112..8 \text{ W}$$

25. (c)

$$\text{Resolution} = 0.01\% = \frac{0.01}{100} = \frac{1}{10000}$$

$$\frac{1}{2^n} = \frac{1}{10000}$$

$\therefore$ Minimum number of bits, $n = 14$ as $2^{14} = 16384$

(we cannot choose $n = 13$ as $2^{13} = 8192$. Which is less than 10000)

$$\text{Analog value of LSB} = \frac{1}{2^n} \times 10 = \frac{1}{2^{14}} \times 10 = \frac{1}{16384} \times 10 \text{ V} = 610.4\ \mu\text{V}$$

26. (b)

$$\sin\theta = \frac{K}{K_g} \cdot V$$

$$\theta_1 = 90°, V = 200 \text{ V}$$

$$\Rightarrow \quad \frac{K}{K_g} = \frac{1}{200}$$

$$\sin\theta_2 = \frac{1}{200} \times 100 = \frac{1}{2}$$

$$\Rightarrow \quad \theta_2 = 30°$$

27. (b)

instantaneous value of voltage across 1 mH inductor is

$$V_L = L\frac{dI}{dt} = 1\times 10^{-3}\frac{d}{dt}(0.5 + 0.3\sin\omega t - 0.2\sin 2\omega t)$$

$$= 1\times 10^{-3} \times \omega(0.3\cos\omega t - 0.4\cos 2\omega t)$$

Put, $\omega = 10^6$ rad/sec then,

$$V_L = 300\cos\omega t - 400\cos 2\omega t$$

Hence, reading of electrostatic voltmeter across 1 mH inductor is

$$V_L = \sqrt{\left(\frac{300}{\sqrt{2}}\right)^2 + \left(\frac{400}{\sqrt{2}}\right)^2}$$

$$V_L = 354 \text{ V}$$

28. (a)

$$\sin\phi = \frac{Y_1}{Y_2} = \frac{2}{4} = \frac{1}{2}$$

$$\phi = 30°$$

29. (c)

from the modified De-Sauty bridge

$$\frac{R_2}{R_3} = \frac{r_1}{R_4 + r_4} = \frac{C_4}{C_1}$$

$$r_1 = \frac{R_2(R_4 + r_4)}{R_3} = \frac{2000 \times (4.8 + 0.4)}{2850} = 3.65\ \Omega$$

and, $$C_1 = \frac{R_3 C_4}{R_2} = \frac{2850 \times 0.5 \times 10^{-6}}{2000} = 0.7125\ \mu\text{F}$$

and $$\tan\delta_1 = \omega C_1 r_1 = 2\pi \times 450 \times 0.7125 \times 10^{-6} \times 3.65 = 7353.1 \times 10^{-6} = 0.007351$$

$$\delta_1 = \tan^{-1}(0.007351) = 0.42°$$

30. (b)

In parallel voltage is same.

If R_1 is resistance of 1st ammeter and R_2 is resistance of 2nd ammeter.

Hence, $$R_1 = \frac{V}{I_{fsd_1}} = \frac{V}{1\text{ mA}}$$

$$R_2 = \frac{V}{I_{fsd_2}} = \frac{V}{10\text{ mA}}$$

$$\therefore \quad \frac{R_1}{R_2} = \frac{10}{1}$$

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