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PTQ

Prelims Through Questions

for

ESE 2021

Electrical Engineering

Day 5 of 11

Q.181 - Q.230

(Out of 500 Questions)

Power Systems + Elec. & Electro. Measurements

Power Systems + Elec. & Electro. Measurements

Q.181 Consider the following statements regarding basics of power generation:

1. Steam power plant has less initial cost as compared to Nuclear power plant.
2. The cost of generation in steam power plant is higher than that of diesel power plant.
3. The running cost of hydroelectric power plant is lesser than steam power plant.

Which of the above statement(s) is/are **not** correct?

(a) 1 and 2 only
(b) 3 only
(c) 2 only
(d) 1 only

181. (c)

The cost of generation in steam power plant is lesser than that of diesel power plant.

Q.182 An ACSR conductor having '*d*' as the diameter of each strand. The total number of strands required to form three layers is

(a) 17
(b) 19
(c) 18
(d) 20

182. (b)

If x is the number of layers, then the total number of strands is obtained by,

$$N = (3x^2 - 3x + 1)$$
$$= 3(3^2) - (3 \times 3) + 1$$
$$= 27 - 9 + 1$$
$$N = 19$$

Q.183 The Thevenin's equivalent impedance of a bus bar in 3-phase, 400 kV, 50 Hz system is 0.4 p.u. at the base of 1000 MVA. The reactive power needed to boost up the voltage by 7 kV at the bus bar is

(a) 39.16 MVAR
(b) 43.75 MVAR
(c) 51.12 MVAR
(d) 46.24 MVAR

183. (b)

$$\text{Reactive power, } Q = \frac{V}{X}\cdot \Delta V = \frac{1}{0.4}\times\frac{7\text{ kV}}{400\text{ kV}}$$
$$Q = 0.04375 \text{ p.u.} = 0.04375 \times 1000 \text{ MVA}$$
$$= 43.75 \text{ MVAR}$$

Q.184 A 400 kV transmission line having,

$A = 0.9\angle 0° = D$, $B = 150\angle 90°\ \Omega/\text{ph}$ and $C = 0.4 \times 10^{-6}\ ℧/\text{ph}$

is working under no-load condition. The shunt reactor required to compensate the Ferranti effect at receiving end is

(a) $1500\angle 90°\ \Omega$
(b) $j1600\ \Omega$
(c) $j500\ \Omega$
(d) $j150\ \Omega$

184. (a)

$X_{L,\,sh}$ under no-load condition

$$= \frac{|B|}{1-|A|} = \frac{|150\angle 90°|}{1-0.9} = j1500\ \Omega$$

$$X_{L,\,sh} = 1500\angle 90°\ \Omega$$

Q.185 A three core cable is delivering power at 100 kV (phase voltage) and 50 Hz. The insulation capacitance is 1 μF/km. If the dielectric loss tangent is 2×10^{-4}, then the dielectric power loss in the cable is

(a) 200 π W/km (b) 300 π W/km
(c) 400 π W/km (d) 600 π W/km

185. (d)

$$\text{Dielectric power loss} = P_L = 3 \times V_{ph}^2 \times \omega C_i \times \tan\delta$$

$$= 3 \times (100 \times 10^3)^2 \times 2\pi \times 50 \times 1 \times 10^{-6} \times 2 \times 10^{-4}$$

$$P_L = 600\,\pi\ \text{W/km}$$

Q.186 Two dc 2-wire systems, one operating with 200 V and other with 400 V. The percentage saving in conductor material with 400 V system if same power is transmitted over the same distance with same power loss

(a) 25% (b) 50%
(c) 85% (d) 75%

186. (d)

$$P_{transmitted} = VI \quad \text{for 2-wire DC system}$$

$$= \text{constant}$$

$$\Rightarrow \quad V_1 I_1 = V_2 I_2$$

$$\text{or} \quad \frac{I_1}{I_2} = \frac{V_2}{V_1} = 2$$

$$P_{loss} = I^2 R_{line} = \text{Constant}$$

$$\Rightarrow \quad I_1^2 R_1 = I_2^2 R_2$$

$$\text{or} \quad \frac{R_2}{R_1} = \left(\frac{I_1}{I_2}\right)^2 = 4$$

$$\therefore \quad R_2 = 4R_1$$

Since conduction length is same (given),

$$\therefore \quad R \propto \frac{1}{A}$$

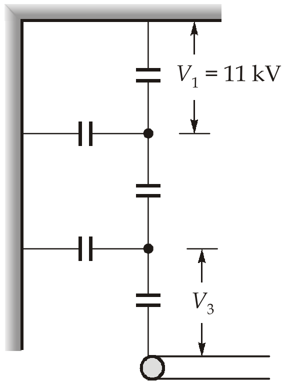
or, $R \propto \dfrac{1}{\text{Conductor material}}$

Thus, $(\text{Conductor material})_2 = \dfrac{1}{4}(\text{Conductor material})_1$

So, $\text{Material saving} = \dfrac{3}{4}(\text{Conductor material})_1$

$\therefore$ $\text{Percentage material saving} = \dfrac{3}{4}\times 100 = 75\%$

Q.187 In the string of suspension insulator shown below, if the capacitance of link pins to earth is 20% of the self capacitance, then voltage V_3 is



(a) 22.00 kV
(b) 15.60 kV
(c) 18.04 kV
(d) 19.26 kV

187. (c)

$$K = \frac{C_m}{C_s} = 0.20$$

$$V_3 = V_1(K^2 + 3K + 1)$$

$$= 11\,(0.2^2 + (3 \times 0.2) + 1)$$

$$V_3 = 18.04\text{ kV}$$

Q.188 Consider the following statements regarding distribution system.

1. There are very less voltage fluctuations at consumers terminal.
2. Power flow is in one direction.
3. If a fault occurs it will result in supply failure to associated customers as there is no alternative supply.

Which of the above statement(s) is/are correct for ring main distribution system?

(a) 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1 only

188. (d)

Statement 2 and 3 are not correct for ring main distribution system.

Q.189 Consider the following statements regarding load frequency control:

1. In transformers, electrical motors and generators losses will decrease with increase in frequency.
2. When sudden loss of load occurs on a generator running in steady state condition the frequency will reduce.
3. Load frequency control mainly concentrates on transient condition of load changes and their effects on the frequency.

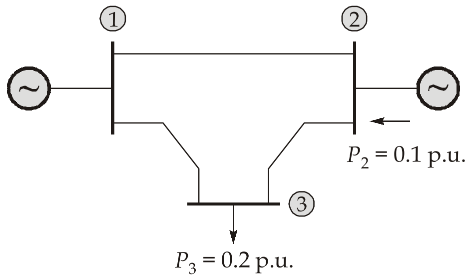
Which of the above statement(s) is/are correct?

(a) 1 only
(b) 2 and 3 only
(c) 3 only
(d) 1, 2 and 3

189. (c)

- In transformers, electrical motors and generators losses will increase with increase in frequency.
- When Sudden loss of load occurs on a generator running in steady state condition the frequency will increase.

Q.190 In the following network, the voltage magnitudes at all buses are equal to 1 p.u., the voltage phase angles are very small, and the line resistances are negligible. All the line reactances are equal to *j*1 p.u.



The voltage phase angle δ_3 in radian at bus 3 is
(Assume one of the generator bus as slack bus and $\sin^{-1}(0.1) = 0.1$ rad)

(a) –0.1
(b) –0.2
(c) 0.1
(d) 0

190. (a)

$$P_1 + P_2 + P_3 = 0$$
$$P_1 + 0.1 - 0.2 = 0$$
$$P_1 = 0.1 \text{ p.u.}$$

Power flow from bus 1 to 2 is zero

$$P_{12} = \frac{EV}{X}\sin(\delta_1 - \delta_2) = 0$$

$\therefore$ $$\delta_1 = \delta_2$$

As bus 1 is slack bus $\delta_1 = \delta_2 = 0$

$$P_{23} = \frac{V_2 V_3}{X}\sin(\delta_2 - \delta_3)$$

$$0.1 = \frac{1 \times 1}{1} \sin(\delta_2 - \delta_3)$$

$$\delta_2 - \delta_3 = \sin^{-1}(0.1) = 0.1 \text{ rad}$$

$$\delta_3 = -0.1 \text{ rad}$$

Q.191 In a load flow problem solved by Newton-Raphson method with polar coordinates, the size of the Jacobian is 100 × 100. If there are 20 *PV* buses in addition to *PQ* buses and a slack bus, the total number of buses in the system is

(a) 58 (b) 61
(c) 74 (d) 63

191. (b)

The order of Jacobian matrix is,

$$[J] = [2n - m - 2]$$

$$100 = [2n - 20 - 2]$$

$$n = \frac{100 + 22}{2} = 61$$

Total number of buses, $n = 61$

Q.192 A transformer circuit breaker is equipped with 500/5 A C.T.s connected to a induction type over current relay. The relays have 125% plug setting and 0.4 time setting. If a 3– ϕ fault current of 7500 A flows from C.T. and relays follow characterstics given by below table at (TMS = 1), then operating time of the relay will be

PSM	4	8	12	16
Operating time(sec.)	5	3	2.8	2.2

(a) 1.12 sec (b) 2.24 sec
(c) 2.81 sec (d) 1.01 sec

192. (a)

The C.T. secondary current, $I_S = \frac{I_P}{n}$

Where, $n = \frac{500}{5}$

$$\therefore \quad I_S = 7500 \times \frac{5}{500} = 75 \text{ A}$$

Relay current setting = 125% of 5A = 1.25 × 5 = 6.25 A

∴ Plug setting multiplier (PSM)

$$= \frac{75}{6.25} = 12$$

Using data in characterstic table

Operating time corresponding to PSM = 12 is 2.8 sec (at TMS = 1)

Operating time of relay = 2.8 sec × 0.4 = 1.12 sec.

Q.193 Switching over voltages may be caused due to
1. Sustained earth fault on phase conductor.
2. Energization or reclosure of long lines.
3. Load rejection at the receiving end.

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

193. (d)

All the three cause switching over voltages.

Q.194 In the following given factors, which of them improve the transient stability of the system:
1. Increase of system voltages, using AVR.
2. Use of high speed excitation systems.
3. Reduction in system transfer reactance.
4. Use of high speed reclosing breakers.

(a) 1 and 4 only (b) 1 and 2 only
(c) 3 and 4 only (d) 1, 2, 3 and 4

194. (d)

All the given above factors improve the transient stability limit of a power system.

Q.195 A generator operating at 50 Hz delivers 1 p.u. power to an infinite bus through a transmission circuit in which resistance is ignored. A fault takes place reducing the maximum power transferable to 0.5 p.u. Where as before the fault, this power was 2.5 p.u. and after the clearance of the fault, it is 2 p.u. The value of δ_{max} is

(a) 170° (b) 180°
(c) 120° (d) 150°

195. (d)

The maximum value of δ,

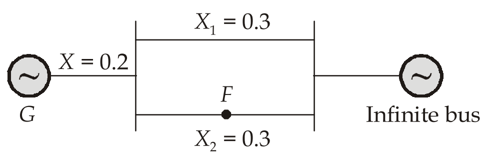
$$\delta_{max} = \pi - \sin^{-1}\left(\frac{P_m}{P_{max\,III}}\right)$$

$$= \pi - \sin^{-1}\left(\frac{1}{2}\right)$$

$$= \pi - \frac{\pi}{6} = \frac{5\pi}{6}$$

$$\delta_{max} = 150°$$

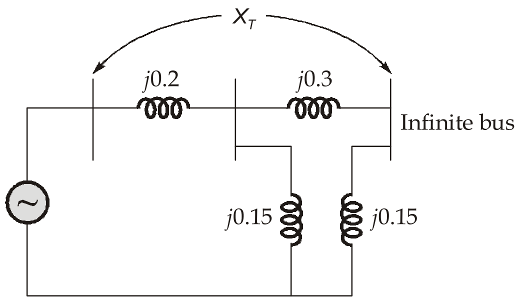
Q.196 A three-phase fault occurs at the middle point *F* on the transmission line as shown in figure given below. The transfer reactance appearing between the generator and the infinite bus is



(a) $j0.9$ p.u. (b) $j0.57$ p.u.
(c) $j0.5$ p.u. (d) $j0.65$ p.u.

196. (a)

The reactance diagram after the fault is



The transfer reactance, $X_T = j\left(0.2 + 0.3 + \frac{0.2 \times 0.3}{0.15}\right) = j0.9$ p.u.

Q.197 Consider the following statements regarding the suitable choice of HVDC converter configuration:

1. Pulse number should be high.
2. Ratio of peak inverse voltage to no load dc output voltage should be as high as possible.
3. Transformer utilization factor should be nearly unity.

Which of the statements given above are correct?

(a) 1 and 2 only (b) 1, 2 and 3
(c) 2 and 3 only (d) 1 and 3 only

197. (d)

Q.198 Figure-2 given below is the "equal-area" criterion diagram for the determination of transient stability limit of the power system shown in Figure-1 for a fault on the transmission line. The type of fault and the time of clearing from Figure-2 are

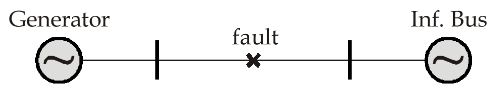


Figure-1

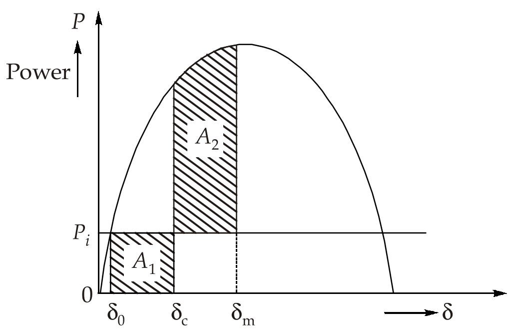


Figure-2

(a) Three-phase fault with instantaneous clearing
(b) Three-phase fault with subsequent clearing
(c) Single-line to ground fault with instantaneous clearing
(d) Single-line to ground fault with subsequent clearing

198. (b)

As shown in curve after fault power transferred is zero and angle δ_0, δ_C are different which implies subsequent clearance.

Q.199 The phasor diagram in figure (b) is of a short transmission line shown in figure (a) as below:

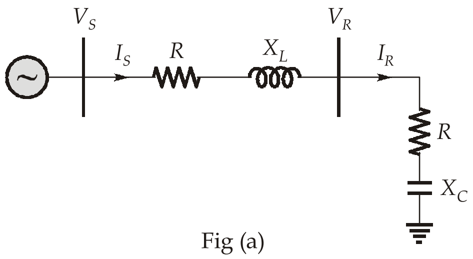


Fig (a)

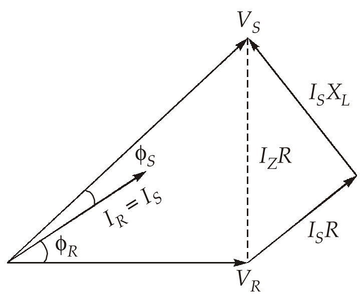


Fig (b)

Which of the condition is satisfied?

(a) $R \le \sqrt{\frac{L}{C}}$
(b) $X_L > X_C$
(c) $X_C > X_L$
(d) $X_L = X_C$

199. (b)

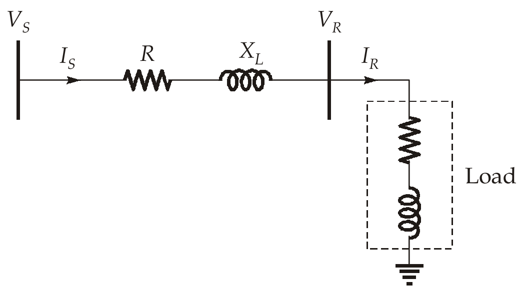
In the phasor diagram we can see that sending end current lags sending end voltage that means $X_L > X_C$ for the complete network.

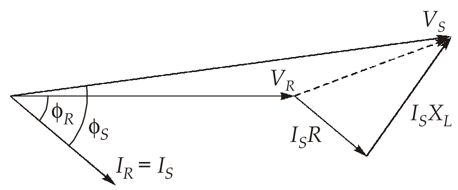
Q.200 In a short transmission line supplying a lagging power factor load

(a) sending end p.f. > receiving end p.f.
(b) receiving end p.f. > sending end p.f.
(c) sending end p.f. = receiving end p.f.
(d) none of the above

200. (b)

A short transmission line is represented as shown below,

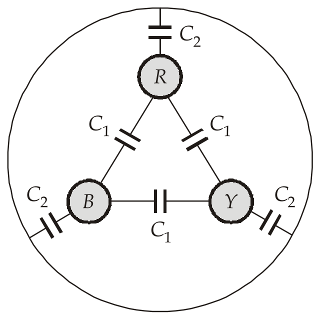




$$\phi_R < \phi_S$$
$$\cos\phi_R > \cos\phi_S$$

$\therefore$ receiving end p.f. > sending end p.f.

Q.201 Consider a three core cable, three phase, 50 Hz, 11 kV as shown below:



Outer sheath

If C_1 = 0.2 μF and C_2 = 0.4 μF, then the per phase charging current is

(a) 1 A
(b) 1.5 A
(c) 2 A
(d) 2.5 A

201. (c)

Per phase capacitance, $C_{ph} = C_2 + 3C_1$

$= (0.4 + 0.6)\ \mu F = 1\ \mu F$

Per phase charging current, $I_{ph} = V_{ph} C_{ph} 2\pi f$

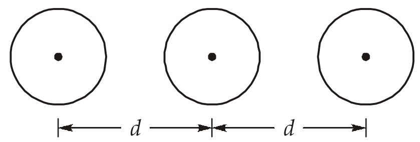
$$= \frac{11\times 10^3}{\sqrt{3}} \times 1 \times 10^{-6} \times 2\pi \times 50$$

$$I_{ph} \approx 2\ A$$

Q.202 A three phase transmission line conductors were arranged in horizontal spacing with 'd' as the distance between the adjacent conductors. If these conductors are rearranged to form an equilateral triangle with sides equal to 'd', then the

(a) C decreases and L increases
(b) C increases and L decreases
(c) C and L increases
(d) C and L decreases

202. (b)



$$\text{GMD} = \sqrt[3]{d \times d \times 2d} = d\sqrt[3]{2}$$

In Equilateral triangular spacing,

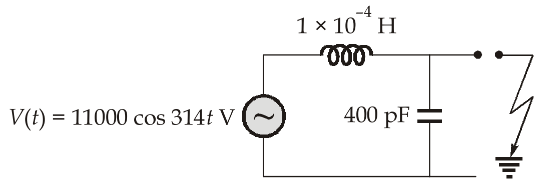
$$\text{GMD} = d$$

$\therefore$ GMD is decreased

$$\downarrow L_{ph} \propto \text{GMD} \downarrow \uparrow C_{ph} \propto \frac{1}{GMD \downarrow}$$

$\therefore$ From above we see, 'L_{ph}' decreases and 'C_{ph}' increases.

Q.203 A single phase equivalent circuit for studying the transient voltage is given as shown below:



The average rate of rise of restriking voltage is

(a) 1.1×10^{10} V
(b) 2.2×10^{10} V
(c) $\frac{11}{\pi} \times 10^{10}$ V
(d) $\frac{22}{\pi} \times 10^{10}$ V

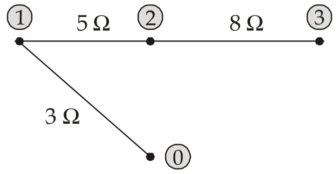
203. (c)

$$\text{Average R.R.R.V.} = \frac{\text{Peak value of restriking voltage}}{\text{Time taken to reach the peak value}}$$

$$= \frac{11000}{\frac{\pi\sqrt{LC}}{2}} = \frac{2 \times 11000}{\pi\sqrt{1 \times 10^{-4} \times 400 \times 10^{-12}}}$$

$$= \frac{2 \times 11000}{\pi \times 2 \times 10^{-7}} = \frac{11}{\pi} \times 10^{10} \text{ V}$$

Q.204 For a graph of power system network shown in figure below, where the bus numbers and impedances are marked, the Z_{bus} matrix will be



(a) $\begin{bmatrix} 3 & 8 & 3 \\ 8 & 3 & 3 \\ 3 & 3 & 12 \end{bmatrix}$

(b) $\begin{bmatrix} 8 & 3 & 3 \\ 3 & 8 & 8 \\ 3 & 8 & 16 \end{bmatrix}$

(c) $\begin{bmatrix} 3 & 8 & 8 \\ 8 & 3 & 3 \\ 8 & 3 & 14 \end{bmatrix}$

(d) $\begin{bmatrix} 3 & 3 & 3 \\ 3 & 8 & 8 \\ 3 & 8 & 16 \end{bmatrix}$

204. (d)

Step 1:

When 3 Ω is connected between node (0) and node (1) then

$$[Z_{bus}] = [3]$$

Step 2:

When 5 Ω is connected between (1) and (2)

$$[Z_{bus}] = \begin{bmatrix} 3 & 3 \\ 3 & (5+3) \end{bmatrix} = \begin{bmatrix} 3 & 3 \\ 3 & 8 \end{bmatrix}$$

Step 3:

When 8 Ω is connected between node (2) and (3)

$$Z_{bus} = \begin{bmatrix} 3 & 3 & 3 \\ 3 & 8 & 8 \\ 3 & 8 & (8+8) \end{bmatrix} = \begin{bmatrix} 3 & 3 & 3 \\ 3 & 8 & 8 \\ 3 & 8 & 16 \end{bmatrix}$$

Q.205 Consider the following statements regarding faults:

1. In single line to ground fault all sequence networks are connected in series.
2. In line to line fault all three sequence networks are connected in parallel.
3. In 3-ϕ short circuit fault sequence networks are connected in series.

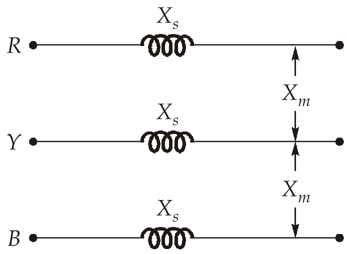
Which of the above statement(s) is/are correct?

(a) 1 and 2 only
(b) 1 only
(c) 3 only
(d) 2 and 3 only

205. (b)

- In line to line fault sequence networks are connected in series opposition.
- A 3-ϕ short circuit fault is a symmetrical fault, where it does not require sequence components.

Q.206 A transposed overhead transmission line is shown in the figure below:



Where, $X_s = 80\ \Omega$

$X_m = 40\ \Omega$

Then the positive and zero sequence reactance of transmission line will be respectively,

(a) 40 Ω, 120 Ω (b) 120 Ω, 40 Ω
(c) 40 Ω, 160 Ω (d) 160 Ω, 40 Ω

206. (c)

For transmission line,

$$X_1 = X_s - X_m = 80 - 40 = 40\ \Omega$$

$$X_0 = X_s + 2X_m = 80 + 80 = 160\ \Omega$$

Q.207 For a machine if the power angle characteristics is given by $P = 5 \sin \delta$, then the synchronizing power coefficient for operating angle $\delta = 30°$ will be

(a) 4.33 (b) 2.5
(c) 1.25 (d) 5

207. (a)

Given, $P_e = 5 \sin \delta$

$$\left.\frac{\partial P_e}{\partial \delta}\right|_{\delta=\delta_0} = 5 \cos \delta_0 = 5 \cos 30° = \frac{5\sqrt{3}}{2}$$

Synchronizing power coefficient = 4.33

Q.208 A $4\frac{1}{2}$ digital voltmeter is working on 1 V scale. A voltage of 0.5231 V will be displayed as

(a) 0.5231 (b) 0.523
(c) 0.5200 (d) 0.52

208. (a)

$$\text{Resolution on 1 V scale} = \frac{1}{10^n};$$

Where n is no. of full bits

$$\text{Resolution} = \frac{1}{10^4} = 0.0001$$

∴ Reading displayed = 0.5231

Q.209 The X-input of a CRO is supplied with a signal 2 sin100t and Y-input is supplied with a signal 5 cos 100t. The gain of X-channel is $\frac{3}{2}$ and Y-channel is $\frac{3}{5}$, then CRO screen will display

(a) a circle
(b) a straight line
(c) an ellipse with axis at 45°
(d) an ellipse with axis at 135°

209. (a)

The signal to X-deflecting plate = $\frac{3}{2} \times 2\sin 100t$ = 3 sin 100t

The signal to Y-deflecting plate = $\frac{3}{5} \times 5\cos 100t$ = 3 cos 100t

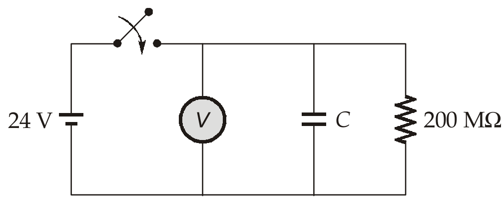
∴ The signal are equal in magnitude but having a phase shift of 90°.

∴ Circle will be displayed on CRO screen.

Q.210 By application of loss of charge method, cable insulation resistance was found to be 200 MΩ. The capacitor used for the setup was charged to a value of 24 V before the switch opens. The voltage across capacitor decreases to 12 V in 4 minutes from the instant switch is open circuited. The value of capacitor used is
(Assume ln(2) = 0.693)

(a) 0.521 μF
(b) 0.718 μF
(c) 1.731 μF
(d) 2.174 μF

210. (c)



The discharge of capacitor can be expressed by relation

$$V_c(t) = Ve^{-t/\tau}$$

Where, $\tau = RC$

Taking natural log both sides, we can write,

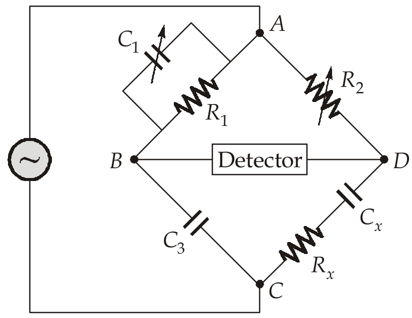
$$C = \frac{t}{R\ln\left(\frac{V}{V_c}\right)} = \frac{4 \times 60}{200 \times 10^6 \times \ln\left(\frac{24}{12}\right)}$$

$$= 1.731 \times 10^{-6} \text{ F}$$

$$= 1.731 \ \mu\text{F}$$

Q.211 An ac bridge has the following constants.
Arm AB - Capacitor of 0.5 μF in parallel with 1 kΩ resistance.
Arm AD - Resistance of 2 kΩ.
Arm BC - Capacitor of 0.5 μF
Arm CD - Unknown capacitor for C_x and R_x in series.
Frequency - 1 kHz

The dissipation factor is



(a) 3.14
(b) 1.05
(c) 6.28
(d) 0.57

211. (a)

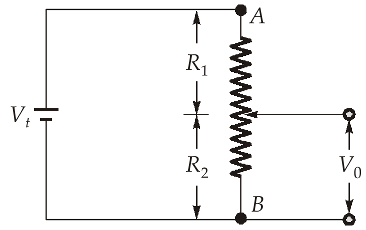
$$R_x = \frac{C_1}{C_3}R_2 = \frac{0.5\mu F}{0.5\mu F}\times 2k = 2\text{ k}\Omega$$

$$C_x = \frac{R_1}{R_2}\times C_3 = \frac{1k}{2k}\times 0.5\mu F = 0.25\ \mu F$$

The dissipation factor is given by,

$$D = \omega R_x C_x$$
$$= 2 \times 3.142 \times 1000 \times 2 \times 1000 \times 0.25 \times 10^{-6}$$
$$= 3.1416$$

Q.212 A displacement transducer with a shaft stroke of 3.0 inches, is applied to the circuit given below. The total resistance of the potentiometer is 5 kΩ. The applied voltage V_t is 5 V. When the wiper is 0.9 inches from B. The value of output voltage is



(a) 1.5 V
(b) 3.0 V
(c) 0.5 V
(d) 2.0 V

212. (a)

$$R_2 = \frac{0.9\text{ in}}{3.0\text{ in}}\times 5k = \frac{9}{30}\times 5k = 1500\ \Omega$$

$\therefore$
$$\frac{V_0}{V_t} = \frac{R_2}{R_1+R_2};$$

$$V_0 = \left(\frac{R_2}{R_1+R_2}\right)\times V_t = \frac{1500}{5k}\times 5V = \frac{1500}{1k} = 1.5\text{ V}$$

Q.213 Which of the following quantities can not be directly measured using CRO?

1. Voltage
2. Current
3. Phase difference
4. Frequency

Select the correct answer using the codes given below.

(a) 1 and 4 only
(b) 2 only
(c) 3 only
(d) 1, 3 and 4 only

213. (b)

The value of current is measured indirectly by measuring voltage drop across known impedance.

Q.214 Consider the following statements regarding Anderson's bridge:

1. It is the modification of the Maxwell's inductance-capacitance bridge.
2. For measuring the low Q of coils, it is superior to the Maxwell's bridge.
3. It is simple in construction compared to Maxwell's bridge.

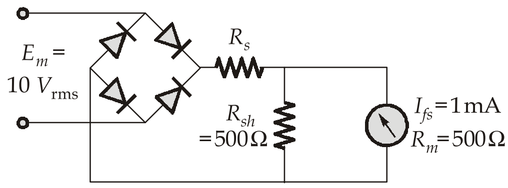
Which of the above statements are correct?

(a) 1, 2 and 3
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1 and 3 only

214. (b)

It is the disadvantage of Anderson's bridge that it is more complex than its prototype Maxwell's bridge.

Q.215 Each diode in the full-wave rectifier circuit shown in figure below has an average forward resistance of 50 Ω and is assumed to have an infinite resistance in the reverse direction



The value of the multiplier R_s is

(a) 9.0 kΩ
(b) 4.15 kΩ
(c) 6.65 kΩ
(d) 7.15 kΩ

215. (b)

$$I_{sh} = \frac{E_m}{R_{sh}} = \frac{1\text{ mA} \times 500\,\Omega}{500\,\Omega} = 1\text{ mA}$$

and $$I_T = I_{sh} + I_m = 1\text{ mA} + 1\text{ mA} = 2\text{ mA}$$

The equivalent dc voltage is computed as;

$$E_{dc} = 0.9 \times 10\ V_{rms}$$
$$= 0.9 \times 10\ V = 9.0\text{ V}$$

The total resistance of the meter circuit can now be computed as

$$R_T = \frac{E_{dc}}{I_T} = \frac{9.0\text{ V}}{2\text{ mA}} = 4.5\text{ k}\Omega$$

and $$R_S = R_T + 2R_d - \frac{R_m R_{sh}}{R_m + R_{sh}}$$

$$= 4500 + 2 \times 50 - \frac{500 \times 500}{500 + 500} = 4.15 \text{ k}\Omega$$

Q.216 A 0-100 mA moving iron ammeter is converted to a 0 - 500 V, 50 Hz voltmeter by adding a series resistance with the coil. The coil has negligible resistance and an inductance $L = \frac{1}{4\pi}(0.01 + 0.2\theta)\text{H}$, where θ is the deflection in radian. The total angular span of meter is 100°. Calculate the spring constant of the meter.

(a) 45.6×10^{-6} Nm/rad
(b) 21.8×10^{-6} Nm/rad
(c) 14.28×10^{-6} Nm/rad
(d) 0.61×10^{-4} Nm/rad

216. (a)

$$L = \frac{0.01 + 0.2\theta}{4\pi}\text{H}$$

$$\therefore \quad \frac{dL}{d\theta} = \frac{0.1}{2\pi}\text{H/rad}$$

$$K = \frac{1}{2\theta} I^2 \frac{dL}{d\theta} = \frac{(1 \times 100 \times 10^{-3})^2}{2 \times 100 \times (\pi/180)} \times \frac{0.1}{2\pi}$$

$$= 45.6 \times 10^{-6} \text{ Nm/rad}$$

Q.217 In Meggar, the controlling torque is provided by

(a) spring
(b) counter weights to moving system
(c) eddy current
(d) none of the above

217. (d)

The control torque is provided by the voltage coil in case of meggar.

Q.218 The damping method used in horizontally mounted moving iron instrument is

(a) Eddy current
(b) Electro magnetic damping
(c) Fluid friction
(d) Air friction

218. (d)

Air friction damping method is used in horizontally mounted moving iron instruments.

Q.219 The equation governing gauge factor (G_f) for a strain gauge, neglecting the piezoresistive effect is

(a) $G_f = 1 + 2v + \frac{\Delta\rho / \rho}{\in}$
(b) $G_f = 1 + 2v + \frac{\Delta\rho}{\rho}$
(c) $G_f = -v \cdot \frac{\Delta\rho}{\rho}$
(d) $G_f = 1 + 2v$

Where, ρ : resistivity, ∂ρ: change in resistivity

v = Poisson's ratio, ∈ = strain

219. (d)

The gauge factor equation is given by,

$$G_f = 1 + 2v + \frac{\Delta\rho / \rho}{\Delta L / L}$$

Where, $\frac{\Delta L}{L}$ is per unit change in length, and $\frac{\Delta\rho}{\rho}$ is per unit change in resistivity

If piezoresistive effect is neglected

i.e. $$\frac{\Delta\rho}{\rho} = 0$$

Gauge factor, $G_f = 1 + 2v$

Q.220 An energy meter is manufactured such that it makes 200 revolutions for consumption of one unit of energy. When connected to a load of 40 A, 200 V at 0.8 power factor for an hour, it takes 1200 revolutions. The percentage error in reading with respect to true value will be

(a) 4.5% high
(b) 6.25% low
(c) 6.25% high
(d) 4.5% low

220. (b)

The total energy consumed $= VI \cos\phi \times t$

$= 200 \times 40 \times 0.8 \times 1 = 6400$ Whr

$= 6.4$ kWhr

The meter makes 200 revolutions for consumption of 1 kWhr energy

For 6.4 kWhr,

Number of revolutions $= 6.4 \times 200$

$= 1280$ revolutions

But meter makes 1200 revolution,

$$\% \text{ error} = \frac{V_M - V_T}{V_T} \times 100$$

$$= \frac{(1200 - 1280)}{1280} \times 100$$

$$= \frac{-80}{1280} \times 100 = -6.25\%$$

Hence, –ve sign means the energy meter % error is 6.25% low.

Q.221 A wattmeter has current coil resistance, $R_C = 0.01\ \Omega$ and pressure coil resistance, $R_P = 8000\ \Omega$ connected such that current coil is on the load side. If the load takes 10 A at the voltage of 230 V at 0.9 power factor, the percentage error in reading will be

(a) 0.048%
(b) 0.020%
(c) 0.072%
(d) 0.036%

221. (a)

Power consumed by the load $= 230 \times 10 \times 0.9$

$= 2070$ W

The wattmeter also measures loss in current coil

$= I^2R_c = (10)^2 \times 0.01 = 1$ W

$\therefore$ The percentage error $= \frac{1}{2070} \times 100 = 0.048\%$

Q.222 Consider the following statements regarding the correction factor of electrodynamometer wattmeter due to pressure coil inductance.

1. Correction factor is value which is multiplied with true value to find the error in reading.
2. Correction factor for leading load is $\frac{\cos\phi}{\cos\beta\cos(\phi-\beta)}$ and for lagging load is $\frac{\cos\phi}{\cos\beta\cos(\phi+\beta)}$.

   Where ϕ is power factor angle and β is angle by which current in pressure coil lags behind true value of voltage due to inductive effect.

Which of the above statement(s) is/are correct?

(a) 1 only (b) 2 only
(c) both 1 and 2 (d) neither 1 nor 2

222. (d)

Correction factor is a factor which we multiply with wattmeter reading to get the true power.

Correction factor is $\frac{\cos\phi}{\cos\beta\cos(\phi+\beta)}$ for leading load and $\frac{\cos\phi}{\cos\beta\cos(\phi-\beta)}$ for lagging load, where ϕ is power factor angle and β is pressure coil angle.

Q.223 Resistance of the circuit was calculated using current flowing through circuit and power consumed in the circuit. If the limiting error in current and power are ±2% and ±4% respectively. The value of limiting error in the resistance will be

(a) 2% (b) 4%
(c) 8% (d) 10%

223. (c)

Given,

Limiting error in current = ±2%

limiting error in power = ±4%

$$P = I^2R$$

$$\ln P = 2\ln I + \ln R$$

$$\ln R = \ln P - 2\ln I$$

Differentiating both sides, we get

$$\frac{\delta R}{R} = \frac{\delta P}{P} - 2\frac{\delta I}{I}$$

$$\frac{\delta I}{I} = \pm 2\% = 0.02$$

$$\frac{dP}{P} = \pm 4\% = 0.04$$

Limiting error, $$\frac{dR}{R} = \frac{\delta P}{P} \pm \frac{2\delta I}{I}$$

$$= 0.04 \pm 0.04 = 0.08 = 8\%$$

Q.224 A coil has a resistance of 100 Ω and inductance of 2 H when measured for very low frequency. The distributed capacitance is 200 pF. The percentage change in the value of effective inductance when same coil was used for 2 kHz, will be

(a) 4.24% (b) 2.64%
(c) 6.32% (d) 3.72%

224. (c)

Given,

$$L = 2\text{ H},$$
$$C = 200 \times 10^{-12}\text{ F}$$
$$\omega = 2\pi f$$
$$= 2\pi \times 2000 = 4000\pi\text{ rad/sec}$$

Effective (equivalent) inductance,

$$L_{eff} = L(1 + \omega^2 LC)$$

Percentage change $$= \frac{L_{eff} - L}{L} \times 100 = \omega^2 LC \times 100$$

$$= (4000\pi)^2 \times 2 \times 200 \times 10^{-12} \times 100 = 6.32\%$$

Q.225 Three milliammeters with full scale currents 1 mA, 10 mA and 100 mA are connected in parallel and they read 0.2 mA, 0.5 mA and 2.5 mA respectively. Their internal resistances will be in ratio

(a) 2 : 5 : 25 (b) 1 : 10 : 100
(c) 100 : 10 : 1 (d) 25 : 5 : 2

225. (c)

Voltage across ammeter remains same as they are connected in parallel combination

Hence,

Internal resistance of ammeter-1 $$= \frac{V}{I_{fsd1}} = \frac{V}{1\text{ mA}}$$

Internal resistance of ammeter-2 $$= \frac{V}{I_{fsd2}} = \frac{V}{10\text{ mA}}$$

Internal resistance of ammeter-3 $$= \frac{V}{I_{fsd3}} = \frac{V}{100\text{ mA}}$$

Ratio of internal resistance = 100 : 10 : 1

Direction (Q.226 to Q.230): The following items consists of two statements, one labelled as **Statement (I)** and the other labelled as **Statement (II)**. You have to examine these two statements carefully and select your answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are true but Statement (II) is **not** a correct explanation of Statement (I).
(c) Statement (I) is true but Statement (II) is false.
(d) Statement (I) is false but Statement (II) is true.

Q.226 Statement (I): In Y_{bus} matrix the sum of row entries corresponding to a bus having shunt branch connected to it is zero.

Statement (II): The non zero value corresponding to sum of the row entries is the admittance of the shunt branch connected to the bus.

226. (d)

Statement I is wrong because, the sum of row entries corresponding to a bus having shunt branch connected to it is non zero and the non zero value is the admittance of the shunt branch connected to the bus.

Q.227 Statement (I): The frequency of a power system should be constant.

Statement (II): The frequency keeps the balance between generation and absorption of real power and thus makes the operation of power station in parallel satisfactory.

227. (a)

Q.228 Statement (I): Diode is a passive device.

Statement (II): Diode is linear for small signal A.C. analysis when both A.C. and D.C. source are present.

228. (b)

Q.229 Statement (I): Wein's bridge can not function satisfactorily, if there are harmonics present in the applied voltage.

Statement (II): Wein's bridge has high frequency sensitivity.

229. (a)

Q.230 Statement (I): Creeping error occurs in the energy meters when there is redundant rotation of disc, even if no power is drawn by load.

Statement (II): Creeping error can be eliminated by drilling diametrically opposite holes on the disc.

230. (b)

Both statements are individually correct.

■■■■