CLASS TEST

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POWER SYSTEM-2

ELECTRICAL ENGINEERING

Date of Test : 21/08/2026

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)

Maximum dielectric stress = g_{max}

$$g_{max} = \frac{V}{r \ln\left(\frac{R}{r}\right)}$$

Minimum dielectric stress = g_{min}

$$g_{min} = \frac{V}{R \ln\left(\frac{R}{r}\right)}$$

$\therefore$ the ratio of maximum to minimum dielectric stress

$$= \frac{g_{max}}{g_{min}}$$

(or)
$$\frac{g_{max}}{g_{min}} = \frac{\dfrac{V}{r \ln\left(\frac{R}{r}\right)}}{\dfrac{V}{R \ln\left(\frac{R}{r}\right)}} = \frac{R}{r} = \frac{D}{d}$$

2. (c)

$$n = 183$$

$$\text{No. of equations} = 2n - m - 2$$
$$= 2 \times 183 - 32 - 2$$
$$= 332$$

3. (d)

Given, series impedance: $(0 + j0.5)\ \Omega/\text{km}$

For 500 km : $j250\ \Omega$

Similarly,

shunt admittance = $(0 + j5)\ \mu$ mho/km

for 500 km : $(0 + j5) \times 10^{-6} \times 500 = (0 + j2.5 \times 10^{-3})\ \mho$

Characteristic impedance,

$$Z_C = \sqrt{\frac{Z}{Y}}$$

$$Z_C = \sqrt{\frac{250}{2.50 \times 10^{-3}}} = 316.22\ \Omega$$

4. (b)

$$\text{Insulation resistance, } R = \frac{\rho}{2\pi l} \ln\left(\frac{R}{r}\right) \Omega$$

$$\frac{R_2}{R_1} = \frac{l_1}{l_2}$$

$$R_2 = 1\,\text{M}\Omega\left(\frac{100}{10}\right) = 10\,\text{M}\Omega$$

5. (a)

For given transmission line,

$$\begin{aligned}\text{Positive sequence reactance, } x_1 &= X_s - X_m \\ &= 0.5 - 0.2 \\ &= 0.3\ \Omega/\text{km}\end{aligned}$$

$$\begin{aligned}\text{Zero sequence reactance, } x_0 &= X_s + 2X_m \\ &= 0.5 + 0.2 \times 2 \\ &= 0.9\ \Omega/\text{km}\end{aligned}$$

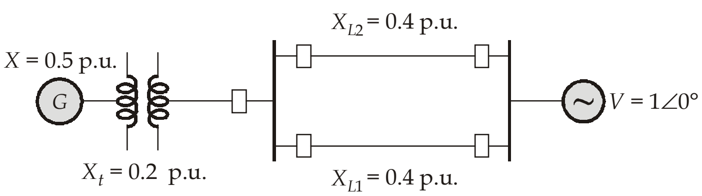
6. (c)

Power transfer capacity $\propto V^2$

$$\frac{P_1}{P_2} = \frac{V_1^2}{V_2^2}$$

$$P_2 = P_1\frac{V_2^2}{V_1^2} = P\left(\frac{100}{400}\right)^2 = \frac{P}{16}$$

7. (b)



$$\begin{aligned}\text{Total reactance, } X &= 0.5 + 0.2 + 0.4 \,||\, 0.4 \\ &= 0.5 + 0.4 = 0.90 \text{ p.u.} \\ P &= V_{\text{p.u.}} \times I_{\text{p.u.}} \cos\phi \\ 0.9 &= 1 \times I_{\text{p.u.}} \times (0.8) \\ I_{\text{p.u.}} &= \frac{0.9}{0.8} = 1.125 \text{ p.u.} \\ E &= V + jI_aX_s \\ &= 1 + 1.125\angle{-36.86^\circ} \times j(0.90) \\ &= 1.607 + j0.810 = 1.79\angle 26.75^\circ \text{ p.u.} \\ \text{Power angle, } \delta &= 26.74^\circ\end{aligned}$$

8. (d)

Rated MVA of circuit breaker = 400 MVA

$\sqrt{3} \times |V_{\text{line}}|_{\text{rated}}$ × symmetrical breaking current = rated MVA of C.B.

$\therefore$ symmetrical breaking current $= \dfrac{400}{\sqrt{3} \times 33} = 6.99818$ kA $= 6998.18$ A

9. **(d)**

$$\text{New per unit value} = (\text{old p.u.})\left(\frac{\text{MVA}_{\text{new}}}{\text{MVA}_{\text{old}}}\right)\left(\frac{\text{KV}_{\text{old}}}{\text{KV}_{\text{new}}}\right)^2$$

$$= (0.5)\left(\frac{100}{60}\right)\left(\frac{22}{11}\right)^2 = 3.33 \text{ p.u.}$$

10. **(b)**

$$y_{31} + y_{32} + y_{30} = -j8$$
$$-j4 - j5 + y_{30} = -j8$$
$$y_{30} = j1$$

After compensation of 50%,

$$y_{30}' = j1 \times 0.5$$
$$= j0.5$$
$$\text{New value} = -j8 - j0.5$$
$$= -j\,8.5$$

11. **(d)**

We know that, $$(Z_{\text{p.u.}})_{\text{new}} = (Z_{\text{p.u.}})_{\text{old}} \times \frac{(\text{MVA})_{\text{new}}}{(\text{MVA})_{\text{old}}} \times \frac{(\text{kV})^2_{\text{old}}}{(\text{kV})^2_{\text{new}}}$$

For G_1 and M_1:

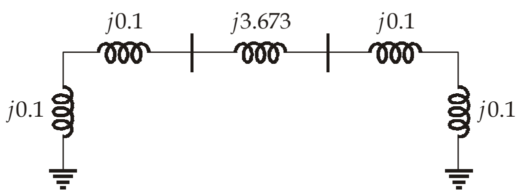
$$(X_{\text{p.u.}})_{\text{new}} = 0.05 \times \frac{80}{40} \times \left(\frac{11}{11}\right)^2 = j\,0.1 \text{ p.u.}$$

For line:

$$(X_{\Omega})_{\text{base}} = \frac{(\text{kV})^2}{\text{MVA}} = \frac{33^2}{80} = 13.6125\ \Omega$$

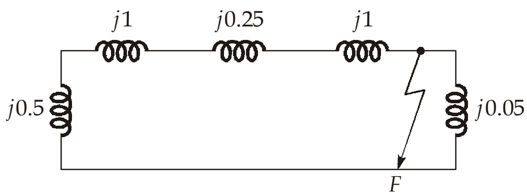
$$(X_{\text{p.u.}})_{\text{line}} = \frac{\text{Actual value}}{\text{Base value}} = \frac{50}{13.6125}$$

$$= j\,3.673 \text{ p.u.}$$



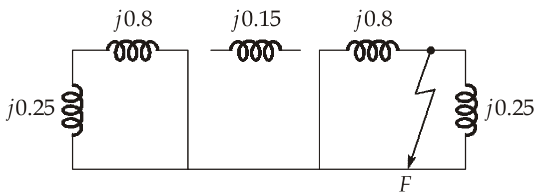
12. **(a)**

Positive and negative sequence reactance diagram:



$$Z_1 = Z_2$$
$$= j\,2.75 \,||\, j\,0.5 = j\,0.423 \text{ p.u.}$$

Zero sequence reactance diagram:



$$Z_0 = j\,0.8 \,||\, j\,0.25 = j\,0.19 \text{ p.u.}$$

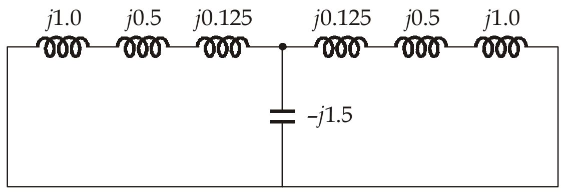
Considering system at no load before fault

i.e. $E = 1.0\angle 0° \text{ p.u.}$

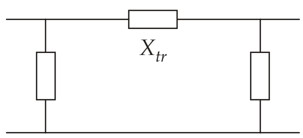
$$(I_F) = 3\left(\frac{E}{Z_1 + Z_2 + Z_0}\right) = 3\left(\frac{1}{j0.423 + j0.423 + j0.19}\right)$$

$$I_f = -j2.896 \text{ p.u.}$$

13. (a)



Converting star into delta:



The transfer reactance, $$X_{tr} = j1.625 + j1.625 + \frac{j1.625 \times j1.625}{-j1.5}$$

$$= 1.48 \text{ p.u.}$$

14. (b)

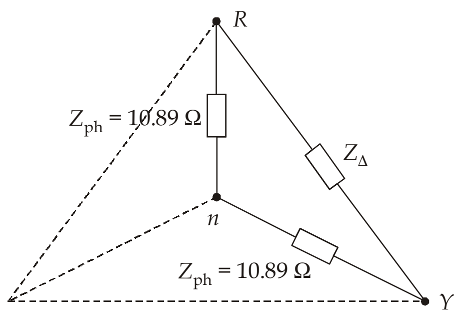
$$\text{The reactance in p.u.} = Z_{\text{p.u.}} = Z_\Omega \times \frac{\text{MVA}_{(b)}}{(\text{kV})_b^2}$$

$$Z_\Omega = Z_{\text{p.u.}} \times \frac{(kV_b)^2}{(\text{MVA})_b}$$

$$= 0.10 \times \frac{(33)^2}{10} = 10.89\ \Omega$$

So reactance per phase $= Z_{ph} = 10.89\ \Omega$

$$Z_\Delta = 3 \times Z_{ph} = 3 \times 10.89$$
$$Z_\Delta = 32.67\ \Omega$$



15. (b)

$$S_{D2} = (0.8 + j0) \text{ p.u.}$$

This 0.8 p.u. active power is supplied by the generator G_1

$$\therefore \qquad 0.8 = \frac{1\times 1}{0.5}\sin\delta$$

$$\delta = \sin^{-1}\left(\frac{0.8}{2}\right) = 23.58°$$

$$Q_R = \frac{|V_1|\times|V_2|}{X}\cos\delta - \frac{|V_1|^2}{X}$$

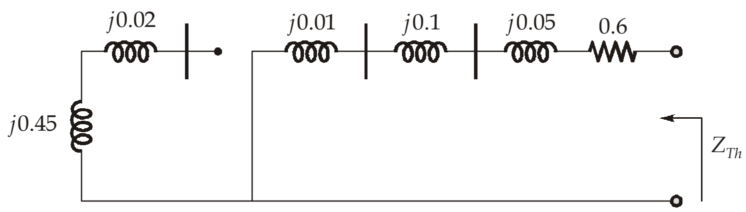
$$= \frac{1}{0.5}\cos(23.58°) - \frac{1}{0.5}$$

$$Q_R = -0.167 \text{ p.u.}$$

The VAR rating of the capacitor = 0.167 p.u.

16. (b)

The zero sequence impedance network from point P and ground



The Thevenin's equivalent zero sequence impedance

$$Z_{\text{Th}} = (0.6 + j\,0.16) \text{ p.u.}$$

17. (a)

$$|I''| = \frac{E}{|X_d''|} = \frac{1}{0.22} = 4.54 \text{ p.u.}$$

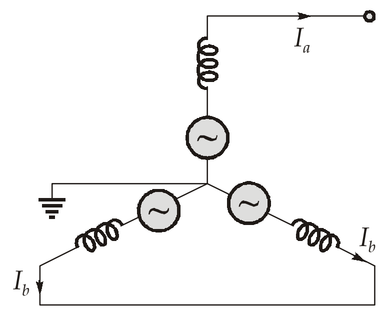
$$I_{\text{base}} = \frac{\text{MVA}_b}{\sqrt{3}(\text{kV}_b)} = \frac{100\times 10^6}{\sqrt{3}\times 11\times 10^3} = 5248.6 \text{ A} = 5.248 \text{ kA}$$

The magnitude of initial symmetrical rms current

$$= 4.54 \times 5.248 = 23.82 \text{ kA}$$

18. (b)

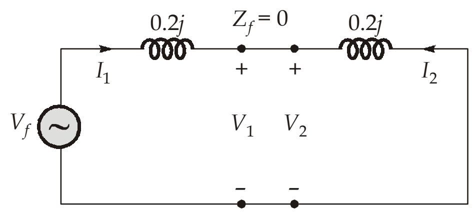
Line-to line fault occurs on b and c phases of generator,



$$I_f = I_b = -I_c$$

and $\qquad I_a = 0$

The sequence network for line to line fault is



$$I_1 = \frac{V_f}{z_1 + z_2}$$

$\Rightarrow$
$$I_f = I_b = (\alpha^2 - \alpha)I_1 = -j\sqrt{3}I_1 = \frac{-j\sqrt{3}V_f}{z_1 + z_2}$$

and
$$I_{f\,\text{p.u.}} = \frac{-j\sqrt{3}\times 1}{j0.2 + j0.2}$$

$$\left|I_{f\,\text{p.u.}}\right| = \frac{\sqrt{3}}{0.4} = 4.33 \text{ p.u.}$$

$$\text{Base current} = \frac{25\times 10^3}{\sqrt{3}\times 11} = 1312.16 \text{ A}$$

$$\text{Fault current, } I_f = 4.33 \times 1312.16 = 5.68\text{kA}$$

19. **(a)**

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

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

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

20. **(c)**

Reactive power supplied by capacitor to bus-1,

$$Q_{21} = \frac{|V_2|^2}{X} - \frac{|V_2||V_1|}{X}\cos\delta$$

Given that, $Q_{21} = 0$

$$\frac{|V_2|^2}{X} = \frac{|V_2||V_1|}{X}\cos\delta$$

$$|V_2| = |V_1|\cos\delta$$

Given that, $|V_1| = 1$ p.u.

$$|V_2| = \cos\delta \qquad \text{...(i)}$$

Since load demand at bus 2 is 1 p.u. (real power). This real power can be supplied by generator S_{G1} only. So this power should flow through transmission line from bus 1 to bus 2

$\therefore$ $P_{12} = 1$ p.u.

$\therefore$ real power flow from bus 1 to bus 2,

$$P_{12} = \frac{|V_1||V_2|}{X}\sin\delta$$

$$1 = \frac{1 \cdot \cos\delta}{0.5} \cdot \sin\delta$$

$$0.5 = \frac{\sin 2\delta}{2}$$

$$\sin 2\delta = 1$$

$$2\delta = 90°$$

$$\delta = 45°$$

$\therefore$ from equation (i),

$$|V_2| = \cos\delta = \cos 45° = \frac{1}{\sqrt{2}}$$

Voltage at bus-2, $$V_2 = \frac{1}{\sqrt{2}}\angle -45°$$

21. (c)

Only Y_{22}, Y_{24}, Y_{42}, Y_{44} will change because transmission line is connected between 2nd and 4th buses.

$$Y_{22} = -j60 + \frac{1}{Z_{se}} + \frac{Y_{sh}}{2}$$

$$= -j60 + \frac{1}{j0.1} + j20 = -j60 - j10 + j20 = -j50$$

$$Y_{24} = Y_{42} = 0 - \frac{Y_{sh}}{2} = -j20$$

$$Y_{44} = -j25 + \frac{1}{Z_{se}} + \frac{Y_{sh}}{2} = -j25 + \frac{1}{j0.1} + j20 = -j25 - j10 + j20$$

$$Y_{44} = -j15$$

22. (b)

Given, before fault,

$$0.6\, P_{m\,1} = P_{m\,1} \sin\delta_0$$

$\therefore$ $$\delta_0 = 36.86° \text{ (or) } 0.643 \text{ radian}$$

During fault,

$$P_{m\,2} = 0.25\, P_{m\,1} \text{ as } X_2 = 4X_1$$

After fualt,

$$P_{m\,3} = 0.75\, P_{m\,1} \text{ (given)}$$

$\therefore$ $$\delta_{max} = 180 - \sin^{-1}\left(\frac{0.6P_{m1}}{0.75P_{m1}}\right)$$

$$= 126.86° \text{ (or) } 2.214 \text{ radian}$$

Since, $$\cos\delta_{cr} = \frac{P_s(\delta_{max} - \delta_0) + P_{m3}\cos\delta_m - P_{m2}\cos\delta_0}{P_{m3} - P_{m2}}$$

$$\cos\delta_{cr} = \frac{0.6P_{m1}[2.214 - 0.643] + 0.75P_{m1}\cos(126.86) - 0.25P_{m1}\cos(36.86)}{0.75P_{m1} - 0.25P_{m1}}$$

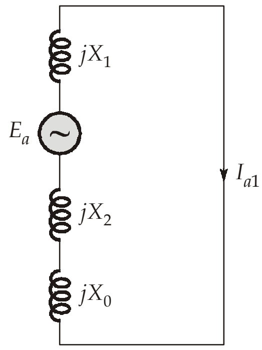
$$= \frac{0.6(2.214 - 0.643) + 0.75\cos(126.86) - 0.25\cos(36.86)}{0.75 - 0.25}$$

$$\cos\delta_{cr} = 0.585$$

$$\delta_{cr} = 54.2°$$

23. **(c)**

For a line to ground fault,
Positive sequence current,



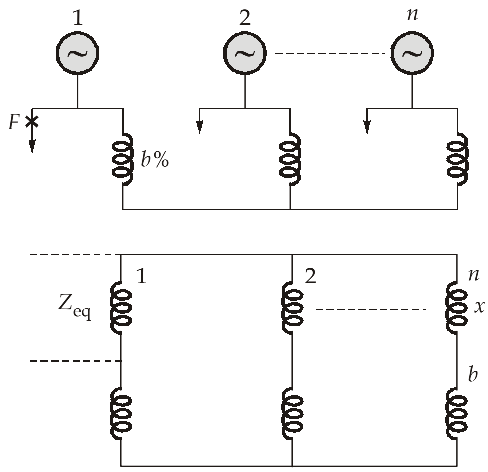
$$I_{a1} = \frac{E_a}{Z_1 + Z_2 + Z_0}$$

$$I_{a1} = \frac{1}{j0.25 + j0.35 + j0.1} = -j1.428$$

Base current, $$I_B = \frac{25 \times 1000 \times 10^3}{\sqrt{3} \times 13.2 \times 10^3} = 1093.46 \text{ A}$$

Fault current, $$I_f = 3I_{a1} \times I_b$$
$$= 3 \times 1.428 \times 1093.46$$
$$= 4684.38 \text{ A}$$

24. **(d)**



Equivalent impedance Z_{eq} between the zero potential bus and the fault point is

$$\left(\frac{b+x}{n-1} + b\right) \| \, x = \left(\frac{bn+x}{n-1}\right) \| \, x$$

$$\frac{1}{Z_{eq}} = \frac{1}{x} + \frac{n-1}{bn+x}$$

$$\text{SC kVA} = \frac{8}{Z_{eq}} \times 100$$

$$= 8\left[\frac{1}{x} + \frac{n-1}{bn+x}\right] \times 100$$

If n is very large.

$$\text{Short circuit kVA} = 8\left[\frac{1}{x} + \frac{1}{b}\right]$$

25. (a)

Total Kinetic energy of the two machines,

$$= G_1H_1 + G_2H_2$$
$$= 400 \times 4 + 1600 \times 2$$
$$= 4800 \text{ MJ}$$

The equivalent H on the base of 200 MVA,

$$= \frac{4800 \text{ MJ}}{200 \text{ MVA}}$$
$$= 24 \text{ MJ/MVA}$$

26. (b)

$$\delta_0 = \sin^{-1}\left(\frac{P_e}{P_m}\right) = \sin^{-1}(0.5) = 30°$$

$$P_e = \frac{EV}{X}\sin\delta_0$$

$$\frac{dP_e}{d\delta} = \frac{EV}{X}\cos\delta_0 = \frac{1.2\times 1}{1.8}\cos 30°$$

$$= 0.577 \text{ MW (p.u.)/elec. rad}$$

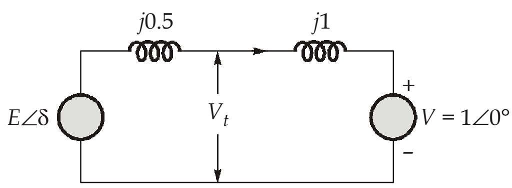
$$M = \frac{GH}{\pi f} = \frac{1\times 4}{\pi\times 50} = 0.025 \text{ s}^2\text{/elec. rad}$$

$$\omega = \left(\frac{\left(\frac{dP_e}{d\delta_0}\right)}{M}\right)^{1/2} = \left(\frac{0.577}{0.025}\right)^{1/2} = 4.8 \text{ rad/sec}$$

Frequency of natural oscillation,

$$f = \frac{\omega}{2\pi} = 0.764 \text{ Hz}$$

27. (c)



$$I = \left(\frac{V_t - V}{j1}\right) = \left(\frac{1.2\angle\theta - 1}{1\angle 90°}\right) = (1.2\angle(\theta - 90°) - 1\angle -90°)$$

$$E\angle\delta = V_t + j0.5I$$
$$E\angle\delta = 1.2\angle\theta + (1.2\angle(-90 + \theta) + j)0.5\, j$$
$$= 1.2\angle\theta + 1.2 \times 0.5\angle\theta - 0.5$$
$$= 1.2\angle\theta + 0.6\angle\theta - 0.5$$

At steady state power, $\delta = 90°$

$$1.2\cos\theta + 0.6\cos\theta - 0.5 = 0$$
$$1.8\cos\theta = 0.5$$

$$\theta = 73.87°$$

$$I = \frac{1.2\angle 73.87° - 1}{j1} = 1.3316\angle 30.1° \text{ A}$$

$$E = V + j1.5I$$
$$= 1 + j1.5 \times 1.3316\angle 30.1°$$
$$= 1.727\angle 90° \text{ p.u.}$$

$$P_{max} = \frac{1.727 \times 1}{1.5} = 1.151 \text{ p.u.}$$

28. (d)

$$M = \frac{GH}{\pi f} = \frac{100 \times 8}{50 \times 180} = \frac{4}{45} \text{ MJ-s/elec. degree}$$

$$\frac{Md^2\delta}{dt^2} = (P_m - P_e)$$

$$\frac{d^2\delta}{dt^2} = 30 \times \frac{45}{4}$$

$$\frac{d^2\delta}{dt^2} = 337.5 \text{ elec deg/s}^2$$

$$\frac{d\delta}{dt} = 337.5t$$

$$\frac{d\delta}{dt} = 337.5 \times \frac{10}{50} \times \frac{60}{360} \times \left(\frac{2}{4}\right) = 5.625 \text{ rpm}$$

$$\omega_m = \omega_{m0} + \frac{d\delta}{dt}$$

$$N_m = \frac{120 \times 50}{4} + 5.625 = 1505.625 \text{ rpm}$$

29. (b)

Transient recovery voltage,

$$\text{TRV} = e = E_m(1 - \cos \omega t)$$

$$RRRV = \frac{de}{dt} = E_m \omega \sin \omega t$$

$$RRRV_{max} = E_m \omega = \frac{E_m}{\sqrt{LC}}$$

$$E = I\omega L$$
$$= 7500 \times 314 \times 1.75 \times 10^{-3}$$
$$= 4.121 \text{ kV}$$

$$RRRV_{max} = \frac{4121\sqrt{2}}{\sqrt{1.75 \times 10^{-3} \times 25 \times 10^{-10}}} = 2786 \text{ V/}\mu\text{S}$$

30. (b)

$$X_{1\,eq} = \frac{j0.18}{2} = j0.09 \text{ p.u.}$$

$$X_{2\,eq} = \frac{j0.15}{2} = j0.075 \text{ p.u.}$$

$$Z_{0\,eq} = j0.1 + \frac{3 \times 2}{11^2} \times 20 = (0.9917 + j0.1) \text{ p.u.}$$

$$\text{Fault current, } I_f = \frac{3E_f}{j(X_1) + jX_2 + Z_{0eq}}$$

$$= \frac{3 \times 1\angle 0°}{1.0265\angle 14.96°} = 2.922\angle -14.96° \text{ A}$$

Current in grounding resistor,

$$I_f = 2.922 \times \frac{20}{11\sqrt{3}} = 3.07 \text{ kA}$$

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