

exam

by Leon William Scammell

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1

Star/Delta Connection

3) $n = 15$, $15:1$
primary = 15 , secondary = 1

$$\frac{V_{ph \text{ pri}}}{V_{ph \text{ sec}}} = \frac{N_{pri}}{N_{sec}}$$

$$\frac{V_{L \text{ pri}}}{V_{L \text{ sec}}} = \sqrt{3} \frac{V_{ph \text{ pri}}}{V_{ph \text{ sec}}} = \sqrt{3} \frac{N_{pri}}{N_{sec}}$$

$$V_{L \text{ sec}} = \frac{V_{L \text{ pri}}}{\frac{N_{pri}}{N_{sec}}} = \frac{132000}{15\sqrt{3}} = 5080.6824 \text{ V}$$

$$\frac{I_{ph \text{ pri}}}{I_{ph \text{ sec}}} = \frac{N_s}{N_p}$$

$$\frac{I_{LP}}{I_{LS}} = \frac{I_{pp}}{\sqrt{3}} \times \frac{1}{I_{psec}} = \frac{1}{\sqrt{3}} \times \frac{N_s}{N_p}$$

$$\frac{I_{LS}}{I_{LP}} = \sqrt{3} \times \frac{N_p}{N_s}$$

$$I_{LS} = \sqrt{3} \times \frac{N_p}{N_s} \times I_{LP}$$

$$= \sqrt{3} \times \frac{15}{1} \times 170 = 4416.7296 \text{ A}$$

$$\frac{V_{ph \text{ primary}}}{V_{ph \text{ secondary}}} = \frac{N_p}{N_s} \quad \text{Delta/Star Connection}$$

$$\frac{V_{L \text{ pri}}}{V_{L \text{ sec}}} = \frac{V_{ph \text{ sec}}}{\sqrt{3}} \times \frac{V_{ph \text{ pri}}}{\sqrt{3}} = \frac{1}{3} \times \frac{N_s}{N_p} = \frac{15}{3}$$

$$V_{L \text{ sec}} = \sqrt{3} \times \frac{V_{L \text{ pri}}}{\frac{N_{pri}}{N_{sec}}} = \sqrt{3} \times \frac{132000}{15} = 15242.047 \text{ V}$$

2

$$\frac{I_{ph\ pri}}{I_{ph\ sec}} = \frac{N_s}{N_p}$$

$$\frac{I_{L\ pri}}{I_{L\ sec}} = \frac{I_{ph\ pri}}{I_{ph\ sec}} \times \sqrt{3} = \frac{N_s}{N_p} \times \sqrt{3} = \frac{\sqrt{3}}{15}$$

$$I_{L\ sec} = \frac{15}{\sqrt{3}} \times I_{L\ pri} = \frac{15}{\sqrt{3}} \times 170 = 1472.2432 A$$

$$S = V_{L\ sec} \times I_{L\ sec} = 15242.047 \times 1472.2432 \\ = 22.44 MVA$$



$$\begin{aligned}
 1a) \quad V_{L1} &= 230 \angle 0 & f &= 50 \text{ Hz} \\
 V_{L2} &= 230 \angle 120 \\
 V_{L3} &= 230 \angle 240 \\
 Z_1 &= 20 + j37.699 & Z &= 2\pi f L \\
 Z_2 &= 52 + j100 & &= 2 \times \pi \times 50 \times 120 \times 10^{-3} \\
 Z_3 &= 52 + j0 & &= 37.699 \\
 Z_L &= 0 + j31.42
 \end{aligned}$$

$$\begin{aligned}
 a) \quad Z_{\text{eq}} &= \frac{1}{\frac{1}{Z_R} + \frac{1}{Z_L}} = \frac{1}{\frac{1}{52 + j0} + \frac{1}{0 + j31.42}} = 13.907 + j23.026 \\
 Z_3 &= Z = R + j(X_L - X_C) \\
 X_L &= 2\pi f L = 2 \times \pi \times 50 \times 180 \times 10^{-3} = 56.549 \, \Omega \\
 X_C &= \frac{1}{2\pi f C} = \frac{1}{2 \times \pi \times 50 \times 100 \times 10^{-6}} = 31.831 \\
 Z_3 &= 15 + j24.718 \, \Omega
 \end{aligned}$$

$$\begin{aligned}
 b) \quad I_1 &= \frac{V_{L1}}{Z_1} = \frac{230 \angle 0}{20 + j37.699} = \frac{230 + j0}{20 + j37.699} = 0.312 - j1.865 \text{ A} \\
 |I_1| &= \sqrt{0.312^2 + 1.865^2} = 1.891 \text{ A}
 \end{aligned}$$

$$\phi = \tan^{-1} \frac{-1.865}{0.312} = -80.505^\circ$$

$$I_1 = 1.891 \angle -80.505^\circ$$

$$\begin{aligned}
 I_2 &= \frac{V_{L2}}{Z_2} = \frac{230 \angle 120^\circ}{13.907 + j23.026} = \frac{-115 + j194.186}{13.907 + j23.026} \\
 &= 4.128 + j7.4896 \text{ A}
 \end{aligned}$$

$$I_2 = 8.552 \angle 61.14^\circ$$

$$I_3 = \frac{V_C}{Z_3} = \frac{230 \angle 240^\circ}{15 + j24.718} = \frac{230 \angle 240^\circ}{28.83 \angle 59.19^\circ} = \frac{230}{28.83} \angle (240^\circ - 59.19^\circ)$$

$$= -7.953 - j0.174$$

$$= 7.955 \angle 178.75^\circ$$

$$c) I_N = I_1 + I_2 + I_3$$

$$= 0.312 \angle -16.70^\circ + 6.128 + j2.4896 - 7.953 - j0.174$$

$$= -1.513 + j2.3156 - 1.2992 + j2.5546$$

$$= -2.8122 + j4.8702 = 5.485 \angle 122.80^\circ \text{ A}$$

$$d) S_1 = V_1 I_1 = 230 \times 1.891 = 434.93 \text{ VA}$$

$$P_1 = I^2 R = 1.891^2 \times 20 = 71.52 \text{ W}$$

$$Q_1 = \frac{230^2}{X_C} = \frac{230^2}{58.501} = 891.22 \text{ VAR}$$

$$pf = \frac{P}{S} = \frac{71.52}{1239.7} = 0.0577$$

$$\phi = \cos^{-1} pf$$

$$\phi = \cos^{-1} 0.95 = 18.195^\circ$$

$$Q = 5.39 \times 37 = 199.26$$

$$Q = 581.042 \times \tan 18.195 = 190.981 \text{ VAR}$$

$$\Delta Q = 1095.24 - 190.981 = 904.259$$

$$Q = \frac{|V|^2}{X} = X = \frac{|V|^2}{\Delta Q} = \frac{230^2}{904.259} = 58.501 \Omega$$

$$X_C = \frac{1}{2\pi f C}$$

$$C = \frac{1}{2\pi f X_C} = \frac{1}{2\pi \times 50 \times 58.501} = 0.000546 \text{ F}$$

$$= 546 \mu\text{F}$$

$$c.) \quad \Phi = 560 \mu Wb$$

$$B_{core} = \frac{\Phi}{A} = \frac{560 \times 10^{-6}}{(40 \times 10^{-3} \times 100 \times 10^{-3})} = 0.14 T$$

Need H from curve

$$H = 300 At/m$$

$$mmf_{core} = H_{core} \times L$$

$$mmf_{core} = 300 \times 650 \times 10^{-3} = 195 At$$

$$mmf_{gap} = H_{gap} \times L$$

$$H_{gap} = \frac{B}{\mu_0} = \frac{0.14}{4\pi \times 10^{-7}} = 111408.46 \frac{At}{m}$$

$$mmf_{gap} = 111408.46 \times 90 \times 10^{-3} = 10026.76 At$$

$$mmf_{coil} = mmf_{core} + mmf_{gap}$$

$$= 195 + 10026.76 = 10221.7614 At$$

$$I = \frac{10221.7614}{1200} = 8.518 A$$

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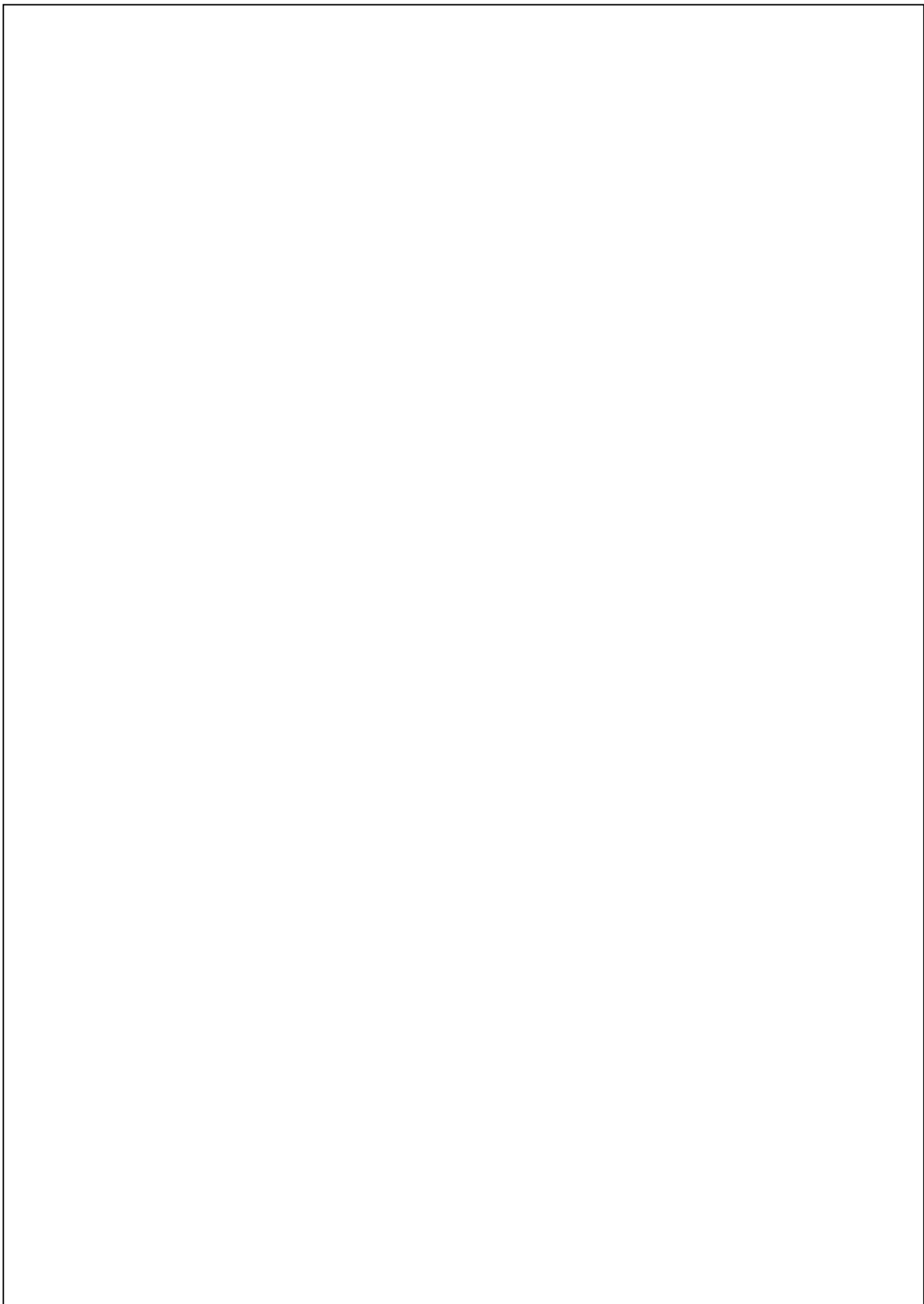
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FINAL GRADE

53/100

GENERAL COMMENTS

Instructor

Q1a) 6

Q1b) 2+3+2 = 7 Marks

Q1c) 4 Marks

Q1d) 1 Mark

Q1e) 0 Mark

Q1f) 1 Mark

Q1g) 1 Mark

Q1h) 3 Marks

Q3a) 8 Marks

Q3b) 10 Marks

Q4) 10 Marks

Total = 48/90 = 53.3%



Comment 1

Q1a) 6

Q1b) 2+3+2 = 7 Marks

Q1c) 4 Marks

Q1d) 1 Mark

Q1e) 0 Mark

Q1f) 1 Mark

Q1g) 1 Mark

Q1h) 3 Marks

Q3a) 8 Marks

Q3b) 10 Marks

Q4) 10 Marks

Total = $48/90 = 53.3\%$



Comment 2

Q3a) 8 Marks

No Power calculation

PAGE 2



Comment 3

Q3b) 10 Marks

PAGE 3



Comment 4

Q1a) Correct

6 Marks



Comment 5

Q1b)

Phase 1

Magnitude correct, angle incorrect.

should be $\tan^{-1}(-4.761/2.5258)$

2 Marks (3 available)

Phase 2

Correct - 3 Marks (3 available)

Phase 3

Magnitude correct - problem with angle. Watch which quadrant the answer should be in when converting.

2 Marks (3 available)



Comment 6

Q1c) correct 4 Marks

Errors carried forwards



Comment 7

Wrong equation used for Q.

Should use $Q = I^2 R$



Comment 8

Only one phase calculated.

Q1d) 1 Mark

Q1e) 0 Mark - Wrong equation used

Q1f) 1 Mark

Q1g) 1 Mark

Q1h) 3 Marks



Comment 9

Q4 Correct - 10 Marks