

electrical engineering exam

by Aaron Stewart Hillam

FILE	1400_AARON_STEWART_HILLAM_ELECTRICAL_ENGINEERING_EXAM_325225_98544897.DOCX (74.89K)		
TIME SUBMITTED	22-JAN-2021 01:28PM (UTC+0000)	WORD COUNT	655
SUBMISSION ID	143079645	CHARACTER COUNT	3495



Exam Submission

BEng Electrical & Electronic Engineering
ACDA5001 – Electrical Engineering

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Submitted to:

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22/01/2021

1.

$$L_1 = 230\angle 0, L_2 = 230\angle 120, L_3 = 230\angle 240, f = 50\text{Hz},$$

Z1 is comprised of a 120mH inductance in series with a 20Ω resistance

Z2 is comprised of a 100mH inductance in parallel with a 52Ω resistance

Z3 is comprised of a 180mH inductance in series with a $100\mu\text{F}$ capacitance and a 15Ω resistor.

A) $I_1 = V_{11} / z_1 = 230\angle 0 / 120 + j20 = (230+j0)/(120+j20) * (120-j20)/(120-j20)$
 $I_1 = ((27600 - j4600)/(14400 + 400))$
 $I_1 = 27600 - j4600 / 14800$
 $I_1 = (27600/14800) - (j4600/14800) = 1.864 - j0.3108 \text{ A}$
 $|I_1| = \sqrt{1.864^2 + 0.3108^2} = 1.89$
 $\Theta = \text{Tan}^{-1}(-0.3108/1.864) = -9.47^\circ$
 $I_1 = 1.89\angle -9.47^\circ \text{ A}$

$$I_2 = V_{12} / z_2 = 230\angle 120 / 100 + j52 = (230+j120)/(100+j52) * (100-j52)/(100-j52)$$

$$I_2 = ((27600 - j4600)/(14400 + 400))$$

$$I_2 = (27600 - j11960 + j12000 - j6240) / 10000 - j^2 2704$$

$$I_2 = (27600 / 12704) - (j6200 / 12704)$$

$$I_2 = (27600/12704) - (j6200/12704) = 2.17 - j0.49 \text{ A}$$

$$|I_2| = \sqrt{2.17^2 + 0.49^2} = 2.22$$

$$\Theta = \text{Tan}^{-1}(-0.49/2.17) = -12.72^\circ$$

$$I_2 = 2.22\angle -12.72^\circ \text{ A}$$

$$I_3 = V_{13} / z_3 = 230\angle 240 / 180 + j15 = (230+j240)/(180+j15) * (180-j15)/(180-j15)$$

$$I_3 = ((41400 + j36150)/(32400 + 225))$$

$$I_3 = (41400 / 32625) - (j36150 / 32625) = 1.27 - j1.11 \text{ A}$$

$$|I_3| = \sqrt{1.27^2 + 1.11^2} = 1.69$$

$$\Theta = \text{Tan}^{-1}(-1.11/1.27) = -41.15^\circ$$

$$I_3 = 1.69\angle -41.15^\circ \text{ A}$$

$$I_n = I_1 + I_2 + I_3 = 1.89\angle -9.47^\circ + 2.22\angle -12.72^\circ + 1.69\angle -41.15^\circ = 5.8\angle -63.34^\circ$$

2.

Central Compensation, has the supply voltage connected to an isolator, Which in turn is connected to a buzz bar, with all of the loads connected to it. The buzz bar is also connected to the power factor correction. There is only one bank of capacitors on the main power distribution switch board or substation. These are best suited where the systems have recurrent fluctuations on a daily basis.

Clear-cut, easy-to-monitor concept; Good utilization of installed capacitance; Installation usually relatively simple; Less total installed capacitance, since the coincidence factor can be taken into account; Less expensive for power distribution systems troubled by harmonics, as controlled devices are simpler to choke. The disadvantage of this Reactive currents within the user's internal power distribution system are not reduced; Additional costs for the automatic control system, replacement/removal of loads require the PFC or capacitors to be adjusted / replaced.

The application of the compensation includes it Can always be used where the user's internal power distribution system is not under-dimensioned.

Individual compensation has the supply voltage connected to an isolator, which in turn is connected to a buzz bar, with all of the loads connected to it. However, each load has a power factor correction (PFC), connected to it. The individual compensation is more effective if the majority of the reactive power is concentrated on a few larger loads that work over long durations. This has the advantage of Reactive power is completely eliminated from the internal power distribution system; Low costs per kvar; customising / ensuring that each load has the correct PFC; If the load is then removed, the PFC is also disconnected. Ultimately, this is a simpler technique. The disadvantages are The PFC system is distributed throughout the entire facility; High installation costs; A larger overall capacitor power rating is required as the coincidence factor cannot be taken into account.

The applications for individual include: to compensate the no-load reactive power of transformers; For drives in continuous operation; For drives with long power supply cables or cables whose cross section allows no margin for error.

The choice of the correct power factor correction equipment depends on the type of loads present and on their way of working.

3.a 132kV 170A n 15:1 turns

$$VL_{sec} = VL_{Pri}/n\sqrt{3} = 132,000/15\sqrt{3} = 5080.68V$$

$$IL_{sec} = \frac{1}{\sqrt{3}} * \frac{N_s}{N_p} = 15\sqrt{3} * 170 = 4416.73A$$

 7

$$S = V_{ls} * I_{ls} = 5080.68 * 4416.73 = 22.44 \text{ mVA}$$

 8

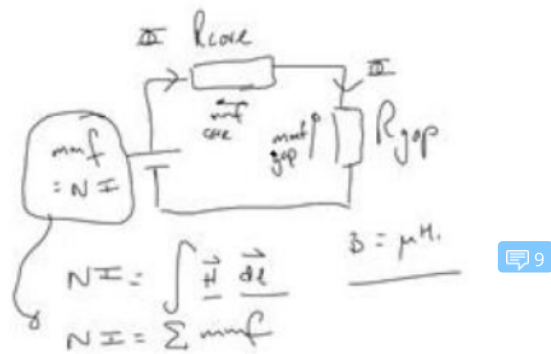
3.b

$$VL_{sec} = (VL_{Pri}/n) * \sqrt{3} = 132,000/15 * \sqrt{3} = 15242.05V$$

$$IL_{sec} = \frac{15}{\sqrt{3}} * \frac{I_{pl pri}}{I_{pl Sec}} = 15/\sqrt{3} * 170 = 1472.24A$$

$$S = V_{ls} * I_{ls} = 15242.05 * 1472.24 = 22.44 \text{ mVA}$$

4.



Definitely too much to do within the time limit. Spent an entire hour just getting through what I have submitted in Q1.

electrical engineering exam

GRADEMARK REPORT

FINAL GRADE

52/100

GENERAL COMMENTS

Instructor

Q1a) 0 Marks

Q1b) 3+1+3=7 Marks

Q1c) 1 Mark

Q2) 18 Marks

Q3a)10 Marks

Q3b) 10 Marks

Q4) 1 Mark

Total 47/90=52.2%

PAGE 1



Comment 1

Q1a) 0 Marks

Q1b) 3+1+3=7 Marks

Q1c) 1 Mark

Q2) 18 Marks

Q3a)10 Marks

Q3b) 10 Marks

Q4) 1 Mark

Total 47/90=52.2%

PAGE 2



Comment 2

You have made a mistake with the impedance of your circuits.

The real part of the complex impedance is the resistance and the imaginary part of the impedance is from the combined reactance, not the inductance. - without using reactance we cannot take account of frequency.

$$Z1=R + j(2*\pi*f*L)$$



Comment 3

Q1b)

phase 1 - correct (error carried forward) - 3 Marks

phase 2 - errors in polar to rectangular conversion of voltage. Various algebraic errors in multiplication & division. - 1 Mark

phase 3 - correct (errors carried forward) some rounding errors

3 Marks



Comment 4

230 angle 120 is not the same as $230+j120$



Comment 5

Q1c) 1 Mark

You cannot add complex numbers like this. You should convert to rectangular format first.

PAGE 3



Comment 6

Q2) Good discussion.

18 Marks

PAGE 4



Comment 7

Q3a) correct (ignoring the m in place of M) - 10 Marks

Q3b) correct (ignoring the m in place of M) - 10 Marks



Comment 8

Should be MVA not mVA. there is a factor of a billion between these two.

PAGE 5



Comment 9

Q4)1 Mark for magnetic circuit