ABET Outcomes Assessment: *c* and *f*

27/30 Excellent

University of Jordan | School of Engineering | Electrical Engineering Department

EE482: Power System Analysis (2) | First Exam | 1st Semester 2017-2018 | 26/10/2017 | Time: 2:30-4:00

Q # 1 (28)	Q # 2 (12)	Q # 3 (8)	Q # 4 (10)	Q # 5 (12)	Q # 6 (10)	Q # 7 (10)	GRADE
24	12	8	8	9	9	10	80/90

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Question # 1 (10 points)

Select the correct answer for the following and fill the correct answer in the table provided.

Q #	1.1	1.2	1.3	1.4	1.5	1.6	1.7
Answer	a	c	a	b	a	a d	c
Q #	**1.8**	**1.9**	**1.10**	**1.11**	**1.12**	**1.13**	**1.14**
Answer	d	b	a	a	b	b	d
Q #	**1.15**	**1.16**	**1.17**	**1.18**	**1.19**	**1.20**	**1.21**
Answer	c	c	c	d	a	c	b
Q #	**1.22**	**1.23**	**1.24**	**1.25**	**1.26**	**1.27**	**1.28**
Answer	d	b	a	c	b	c	d

→ b

1.1 Maximum short circuit current occurs due to .... fault.

[a.] bolted 3-phase b. L-G fault c. L-L d. L-L-G

1.2 In case of L-G fault, the fault current is equal to

a. $\frac{E_a}{3(Z_1+Z_2+Z_0)}$ b. $\frac{3E_a}{Z_0}$ [c.] $\frac{3E_a}{Z_1+Z_2+Z_0}$ d. $\frac{3E_a}{(Z_1+Z_2)}$

1.3 The various power system faults can be arranged in the order of increasing severity is

[a.] L-G, L-L, L-L-G, L-L-L-G b. L-L-G, L-L-L-G, L-G, L-L

c. L-L-L-G, L-L-G, L-L, L -G d. L-L-L-G, L-L-G, L-G, L-L

1.4 The zero sequence current in Δ winding of a Y/Δ transformer is found

a. if neutral point of Y winding is not earthed [b] if neutral point of Y winding is earthed

c. whether the neutral point of the star winding is earthed or not earthed d. none of these.

1.5 For a Y-Δ transformer Y-side grounded, the zero sequence current

[a.] exists in the lines on the Y-side b. exists in the lines on both Y and Δ sides.

c. exists in the lines on the Δ-side d. has no path to ground

1.6 Advantages of grounding are: (a)

[a.] E/F current can be utilized to operate relays b. "arcing ground" phenomena is eliminated

c. provide symmetry of the line impedances [d.] both (a) and (b)

1.7 The circuit breaker trip coil is energized always from

a. the bus of the power plant

b. a low voltage AC supply

c. the DC battery of the power plant

d. a medium voltage AC supply

1.8 The instrument transformers are used largely in the power system to:

a. transform the currents of the voltage from high to low values.

b. insulate the relays and metering equipment from the primary high voltage system.

c. give feedback signals to the relays to detect abnormal conditions.

d. all the above.

1.9 The CT error increases when

a. the input current increases

b. the burden impedance increases

c. the burden impedance decreases

d. both (a) and (c)

1.10 The standard rating for CT secondary is

a. 1 A for American standard and 5 A for European standard

b. 5 A for all standards

c. 1A for European standard and 5 A for American standard

d. 1 A for all standards

1.11 Directional overcurrent protection is always used in

a. multi-source distribution system

b. multi-feeder distribution system

c. radial distribution system

d. extra-high voltage lines

1.12 The coordination process of overcurrent relays in a radial system must start with

a. the relay in up-stream

b. the relay in down-stream

c. the relay connected to the highest load

d. the relay connected to the lowest load

1.13 For protection of parallel feeders fed from one end, the relays required are -----------.

a. non directional relays at both ends

b. non directional relays at the source end and directional relays at the load end

c. directional relays at the source end and non-directional relays at the load end

d. directional relays at both ends

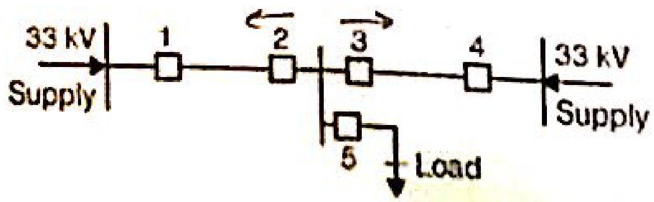
1.14 The distribution system shown below is to be protected by overcurrent system of protection. For proper fault discrimination, directional overcurrent relays will be required at locations

a. 1 and 4

b. 2 & 3

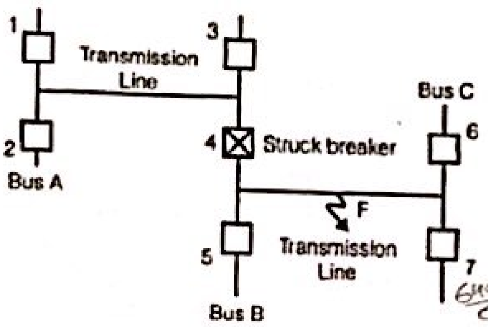
c. 1, 4 & 5

d. 2, 3 & 5



1.15 Consider the protection system shown below. The circuit breakers numbered from1 to 7 are of identical type. A SLG fault with zero fault impedance occurs at the midpoint of the line (at point F), but circuit breaker 4 fails to operate ("stuck breaker"). If the relays are coordinated correctly, a valid sequence of circuit breaker operation is

a. 1,2, 6, 7, 3, 5 b. 1,2, 5, 6, 7, 3 c. 5, 6, 7, 3, 1, 2 d. 5, 1, 2, 3, 6, 7



1.16 Consider a CT having a ratio of 400:5. The primary current is 6400A, while the secondary current is 64 A. Thus, the percentage CT error is

a. 5% b. 10% c. 20% d. 25%

1.17 Consider a CT having a ratio of 300:5. The primary current is 6000A. If we consider the saturation in the CT, the current passing into the relay coil (I_r) will be

a. $I_r = 5$ A b. $I_r < 100$ A c. $I_r > 100$ A d. $I_r < 5$A

1.18 If a fault current is 2000 A, the relay setting is 50% and CT ratio is 400:5, the plug setting multiplier (PSM) will be .... .

a. 25 b. 50 c. 15 d. 10

1.19 An IDMT OC relay having a TMS=0.1, a CTS=5 and an operating time characteristic $t_{op} = \frac{0.14}{PSM^{0.02} - 1} \times TMS$ is fed from a CT with CTR=200/5. If the fault current seen by the relay is 2000 A (primary), the operating time of the relay is .... Second.

a. 0.297 b. 2.97 c. 0.134 d. 1.34

1.20 The pickup value of relay is 6.5 Amp and fault current in relay coil is 39 Amp. Its plug setting multiplier (PSM) is ....

a. 10 A b. 8 A c. 6 A d. 7 A

1.21 If the operating time of a relay is 10 sec for unity TMS, the operating time of 0.5 TMS will be ...... sec.

a. 3 b. 5 c. 7 d. 20

1.22 What is the line current of a circuit when the CT of 1000:5 CTR measures 4 A?

a. 5000 A b. 1000 A c. 400 A d. 800 A

$\frac{3}{\log(2)} * 0.1$ $t_{op} = \frac{3}{\log(PSM)} \times TMS$

1.23 For 100/5 CT with PS at 100%, TMS=0.1, using the standard inverse 3/10 curve, the tripping time of the relay for a fault current of 200A is:

a. 10 s b. 1 s c. 0.1 s d. 0.001 s

1.24 A 50-Hz single-phase CVT has C_1 =1 mF and C_2 = 9 mF. The leakage inductance (L) of the transformer should be equal to…., such that there is no phase displacement between the line voltage and the output of the CVT. $L = \frac{1}{\omega^2(C_1+C_2)}$

a. L = 1 mH b. L = 2 mH c. L =0.5 mH d. L = 5 mH

1.25 A 1200:5 CT has a burden (resistance of the C.T. secondary circuit) of 5 Ω. If the fault current seen by the CT primary is 9.6 kA, the terminal voltage that develops across the terminals of the CT secondary is:

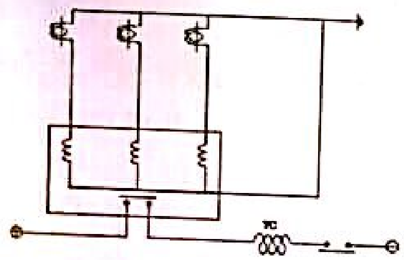
a. Vt = 240 V b. Vt = 40 V c. V_t = 200 V d. Vt = 48 V

1.26 A 500:5 CT with class C250 has a rated burden impedance of …… . Ω $\frac{250}{20 \times I_{secrated}}$ (5A)

a. Z = 2.0 b. Z = 2.5 c. Z = 0.5 d. Z = 5.0

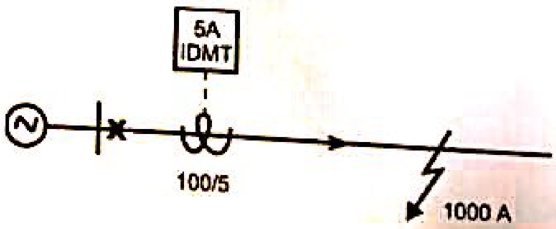
1.27 The circuit shown below has 200:5 class C100 CTs. For a SLG fault of phase A to ground on the line, with fault current magnitude of 8000 A. The phase and residual lead currents are equal to ….. A.

a. I_{res} = 8 b. I_{res} = 4 c. I_{res} = 200 d. I_{res} = 100



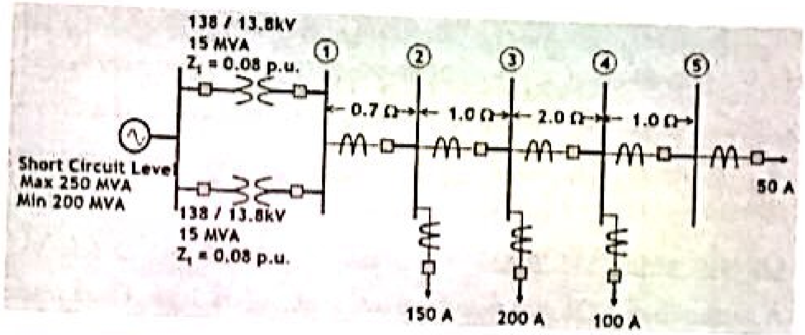
1.28 A 5-A IDMT O/C relay with t-I characteristic given by $t = \frac{0.14}{M^{0.02}-1} \times TMS$ as shown below. If the relay has a plug setting PS = 75% and it is required to trip in 2.5 s for a fault current of 1000 A, the time multiplier setting TMS should be set at TMS =….. .

a. 0.6 b. 0.7 c. 0.8 d. 1.0

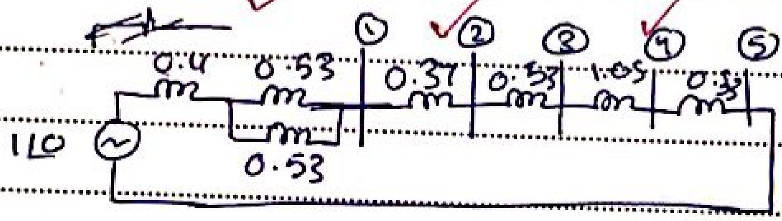


Question # 2 (12 points) **SHOW YOUR CALCULATIONS**

For the power system shown below, use either the Ohmic PU method to calculate the maximum 3-phase fault currents at buses 1, 2, 3, 4 and 5. For the PU method use an MVA base S_b of 100 MVA and a base voltage V_b of 13.8 kV at bus # 1.



Bus #	①	②	③	④	⑤
I_{fmax} (A)	6292	4042.5	2673	1600	1330



$I_{fmax} = \frac{1}{\Sigma Z}$

$I_{fmax5} = 0.318_{pu} \Rightarrow I_{fmax5} = 1330A$

$I_{fmax4} = 0.382_{pu} \Rightarrow I_{fmax4} = 1600A$

$I_{fmax3} = 0.639 \Rightarrow I_{fmax3} = 2673A$

$I_{fmax2} = 0.966 \Rightarrow I_{fmax2} = 4042.5A$

$I_{fmax1} = 1.503 \Rightarrow I_{fmax1} = 6292A$

$Z_{sc} = \frac{1}{I_{f pu}} = 0.4pu$

$I_{f pu} = S_{MVA_{sc}}^{pu} = \frac{250}{100}$

$Z_{t new} = 0.08 \times \frac{100}{15}$

~~$Z_{12} = 0.7$~~

$Z_b = \frac{V_b^2}{S_b} = 1.904$

$Z_{12} = 0.37$ $\boxed{Z_{pu} = \frac{Z_{actual}}{Z_{base}}}$

$Z_{23} = 0.53$

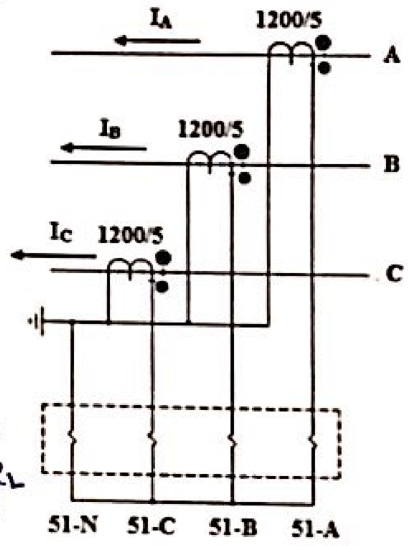
$Z_{34} = 1.05$

$Z_{45} = 0.53$

$I_{f_b} = \frac{S_b}{\sqrt{3} V_b} = \frac{100k}{\sqrt{3}(13.8)}$

$\boxed{I_{f_b} = 4184A}$

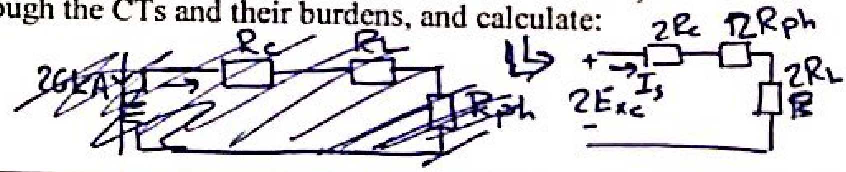
Question # 5 (12 points) **SHOW YOUR CALCULATIONS**



The 3-phase circuit shown below has 1200/5, class C400 CTs connected to OC phase and E/F relays. Given the following:

CT Winding Resistance $R_C = 0.61\ \Omega$,
Burden resistance for phase relay $R_{ph} = 1.75\ \Omega$
Burden resistance for E/F relay $R_{EF} = 2\ \Omega$,
Leeds Resistance (One side) $R_L = 0.25\ \Omega$.

I. Fault records showed that the magnitude of the line-line fault current $I_{fLL} = 26$ kA.
Draw the equivalent circuit showing the path of the I_{fLL} through the CTs and their burdens, and calculate:



a.	the magnitude of the fault current seen by the phase relays B and C (I_{rB}, I_{rC})	I_{rB} = 108.33 A I_{rC} = −108.33 A
b.	the magnitude of the voltage developed across the CT secondary winding V_s fro the L-L fault.	V_s = 282.75 V
c.	Does the core get saturated?	Yes **No**

$V_s = I_s(R_c + R_L + R_{ph})$ .... $I_c = -I_B$

II. IF a LLG fault occurred on phases B and C with $I_B = 27\angle150°$ kA and $I_C = 27\angle30°$ kA, find

d.	the fault current seen by the phase relays B and C (I_{rB}, I_{rC}) and the E/F relay and I_{rEF}.	I_{rB} = $112.5\angle150°$ A I_{rC} = $112.5\angle30°$ A I_{rEF} = $112.5\angle90°$ A
e.	the magnitude of the voltage developed across the CT secondary winding of phases b and C, V_{sb} and V_{sc}.	V_{sb} = 518.625 V V_{sc} = 518.625 V
f.	Does the CT core of phase B get saturated?	**Yes** No
g.	Does the CT core of phase C get saturated?	**Yes** No

$V_{sb} = I_{rb}(R_c + R_{ph} + R_{EF} + R_L)$ .... ~~$V_{sb} = 518.625\angle{-120°}$~~

~~$V_{sc} = 518.625\angle120°$~~

(−3)

Question # 6 (10 points) **ABET outcome c Assessment** **SHOW YOUR CALCULATIONS**

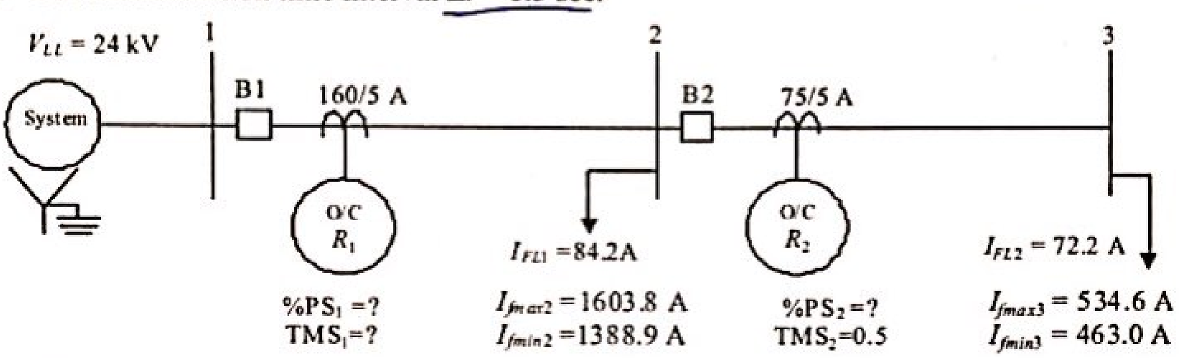
For the radial power system shown below, the maximum and minimum fault currents at buses 2 and 3 are given below. Design an overcurrent protection with the following Extremely Inverse Relay Characteristics, current plug settings and time multiple settings:

$$t = \left(\frac{3.88}{PSM^2 - 1} + 0.0963 \right) \times TMS$$

%PS of {50%, 75%, 100%, 125%, 150%, 175% and 200%} and
TMS of {0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, ……, 10}.

In your design consider the following:

1. Set time dial for relay R_2 at the minimum, i.e. $\mathbf{TMS_2 = 0.5}$
2. Set the pick up current I_{pickup} to be approximately twice maximum load current $I_{pickup} = 2I_{Lmax}$
3. Use a coordination time interval $\Delta t = 0.3$ sec.



Find

a.	the pickup secondary current of R_1 and R_2.	I_{p1} =	10 A
		I_{p2} =	10 A
b.	the % plug settings of R_1 and R_2, I_{p1} and I_{p2}.	$\%PS_1$ =	200 %
		$\%PS_2$ =	200 %
c.	the time multiple settings of R_1.	TMS_1 =	3

for Relay 2 $I_{FL2} = 72.2A \Rightarrow I_{pickup} = 2 \times I_{FL}$ $= 144.4A$ $PS\% = \frac{144.4}{75} = 192.5\% = 200\%$

$I_{pickup_2} = 150A$ (Primary)

$= 10A$ (Secondary)

for Relay 1 $I_{12} = I_{FL_1} + I_{FL_2}$

$= 156.4A \Rightarrow I_{pickup} = 312.8 \Rightarrow PS\%_2 = 195\% = 200\%$

$I_{pickup_1} = 320A$ (Primary)

$= 10A$ (Secondary)

for $I_{f_{max2}} = 1603.8A$

[main]

$t_{op_2} = \left(\frac{3.88}{\left(\frac{I_{f_2}}{I_{pickup_2}}\right)^2 - 1} + 0.0963 \right) * TMS_2 \Rightarrow t_{op2} = 0.065$

$I_{f_2} \to 1603.8$, $I_{pickup_2} \to 150$

-1

{backup}

$$0.365 = \left(\frac{3.88}{\left(\frac{I_{fmax_2}}{I_{pickup_1}}\right)^2 - 1} + 0.0963 \right) * TMS_1$$

$TMS_1 = 2.838 \Rightarrow$ $\boxed{TMS_1 = 3}$

1.5