

<b>Hanoi University of Science &amp; Technology</b> <b>School of Electrical Engineering</b>	<b>Final Exam</b> <b>Power System Protection and Control 1 (EE4040)</b>	<b>Instructor</b>
	<b>No. 01</b> <b>Duration: 90minutes</b>	<b>Dr. Nguyen Xuan Tung</b>

Student name:

Signature:

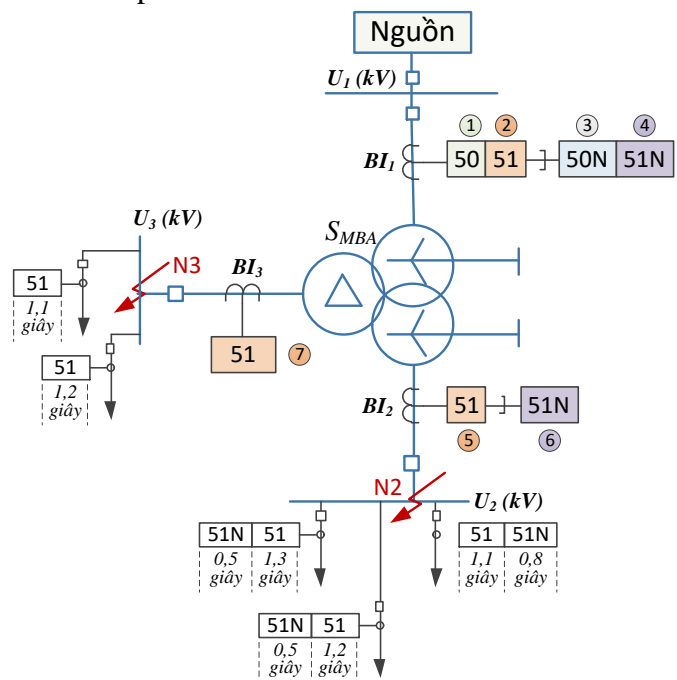
Student ID:

**Question 1:** Explain meaning of voltage transformer's specification (1point):

Voltage level (V)	Total core	Core 1	Core 2 & Core 3
$\frac{115000}{\sqrt{3}} : \frac{100}{\sqrt{3}} : \frac{100}{\sqrt{3}} : \frac{100}{\sqrt{3}}$	3	100VA; 0,2	200VA; 3P

**Question 2:** Calculate setting values for overcurrent protection of 110kV transformer:

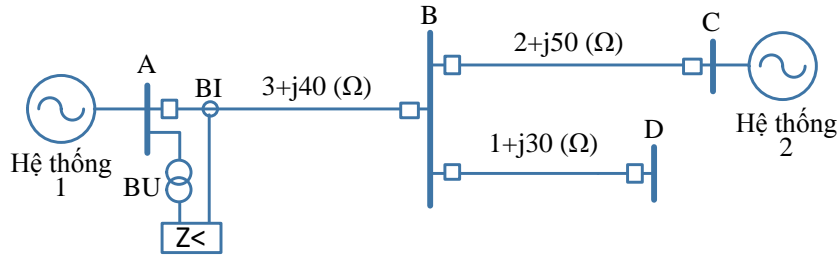
Transformer rated power: 32 MVA					
Voltage level $U_1/U_2/U_3$ (kV): 110/23/35					
Permissible overload factor: 1,2					
Current measured by $BI_1$ when fault occurs at N3 (kA)					
N <sup>(3)</sup>			N <sup>(2)</sup>		
1,47			1,27		
Current measured by $BI_1$ when fault occurs at N2 (kA)					
N <sup>(3)</sup>	N <sup>(2)</sup>	N <sup>(1)</sup>	N <sup>(1,1)</sup>	3I <sub>ofault</sub> type N <sup>(1)</sup>	3I <sub>ofault</sub> type N <sup>(1,1)</sup>
2,3 7	1,9 3	2,1 5	2,2 5	1,68	1,47



**Require:**

- Determine current transformer ratios for  $BI_1$ ;  $BI_2$ ;  $BI_3$  (0,5point)  
(Rated primary current of BI can be chosen as: 10 - 12,5 - 15 - 20 - 25 - 30 - 40 - 50 - 60 - 75A and its multiple of 10, 100, 1000 times).
- Calculate pickup current and time delay for relay 2 & 3 (1point)
- Evaluate minimum sensitivity of relay 2? Determine if this sensitivity of relay 2 meets regulation or not (0,5 point)?

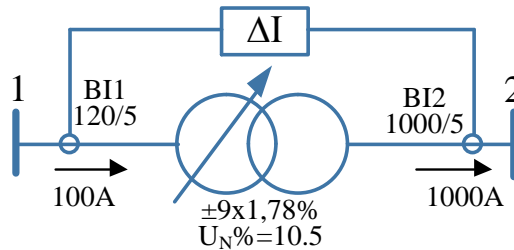
**Question 3:** Calculate setting values for distance protection in following scheme:



Network rated voltage: 115kV

- Calculate setting values for 3 protection zones of distance protection (1,5 point)
- Assume that maximum line load is 300MVA with power factor  $\cos\phi=0.85$ . Determine maximum resistive reach value of protection zone (1,5point)

**Question 4:** Consider following differential protection scheme:



Given data:

- Rated current of side 1 is 100 (A) ; CT ratio (BI1)is 120/5
- Rated current of side 2 is 1000 (A) ; CT ratio (BI2)is 1000/5
- Maximum CT ratio error is 10%
- Voltage regulation range of transformer:  $\pm 9 \times 1,78\%$
- Short-circuit voltage (percent)  $U_N\% = 10,5$

**Require:**

- Evaluate maximum bias current during normal operation of transformer with permissible overload factor of 120% (1 point).
- If differential relay has ability to compensate for current transformer ratio at both side then what could be value of that bias current? (1 point)?
- Determine minimum low-set value of differential relay characteristic (in per unit of  $I_{\text{secondary CT}}=5\text{A}$ )? (1point);
- If high-set value of differential relay characteristic is 10 (in per unit of transformer rating current) then what could be minimum short-circuit voltage value of transformer?(1point)

Hanoi University of Science and Technology	<b>Final Examination</b>		
	Course: <b>Power Delivery System (EE3425)</b>	Duration: 90min	No. 1

Item 1. Analyse advantages and disadvantages of distribution network configurations and bus schemes at substations and their applications.

Item 2. Allocate kVAr compensation in the 10kV industrial distribution system as shown in Fig. 1.

Followings are concerned parameters:

$$r_1 = 0.03\Omega ; \quad Q_1 = 600\text{kVAr}$$

$$r_2 = 0.06\Omega ; \quad Q_2 = 500\text{kVAr}$$

$$r_3 = 0.04\Omega ; \quad Q_4 = 400\text{kVAr}$$

$$r_4 = 0.04\Omega ; \quad Q_5 = 250\text{kVAr}$$

$$r_5 = 0.08\Omega ; \quad Q_6 = 50\text{kVAr}$$

$$r_6 = 0.08\Omega ;$$

Total allocated kVAr compensation:  $Q_c = 1000\text{kVAr}$ .

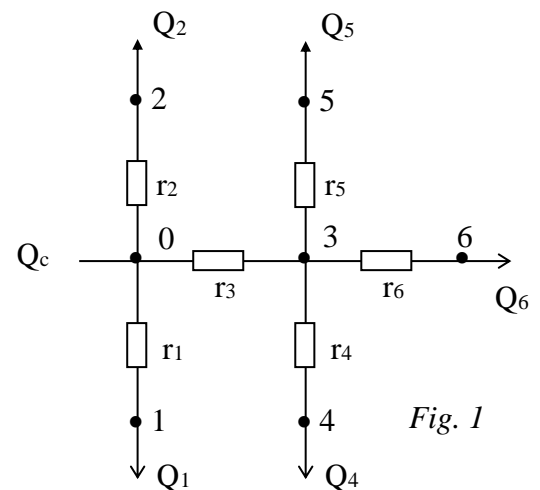


Fig. 1

Item 3. Consider a 35kV distribution network feeding three factories as Fig. 2. Followings are related parameters

- Factory demands

$$S_1 = 4000\text{kVA}, \cos\phi_1 = 0.6$$

$$S_2 = 2000\text{kVA}, \cos\phi_2 = 0.8$$

$$S_3 = 2500\text{kVA}, \cos\phi_3 = 0.6$$

- OHL, ACSR-70 conductor,  $r_o = 0.46\Omega/\text{km}$ ,  $x_o = 0.38\Omega/\text{km}$

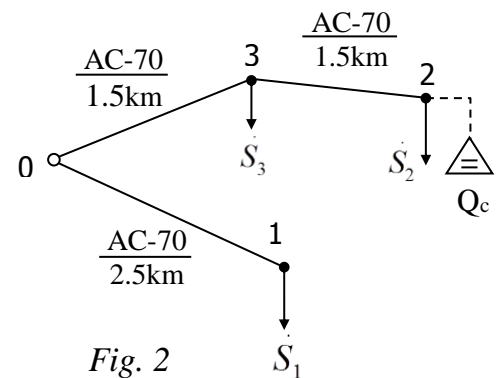


Fig. 2

Maximum loss hours of 5000h is applicable for all three loads.

Question 1. Determine annual energy loss of the whole distribution network in the case of switching off the compensation capacitor bank at the node 2.

Question 2. In the case of switching on the compensation capacitor bank at the node 2, how does its voltage change if the source voltage is kept at 36.5kV?

Notes : Open-book exam.