UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

FIRST SEMESTER EXAMINATIONS, NOV/DEC 2018

COURSE NO: EL 471
COURSE NAME: Power Systems Protection and Control
CLASS: EL IV **TIME**: 3 Hours

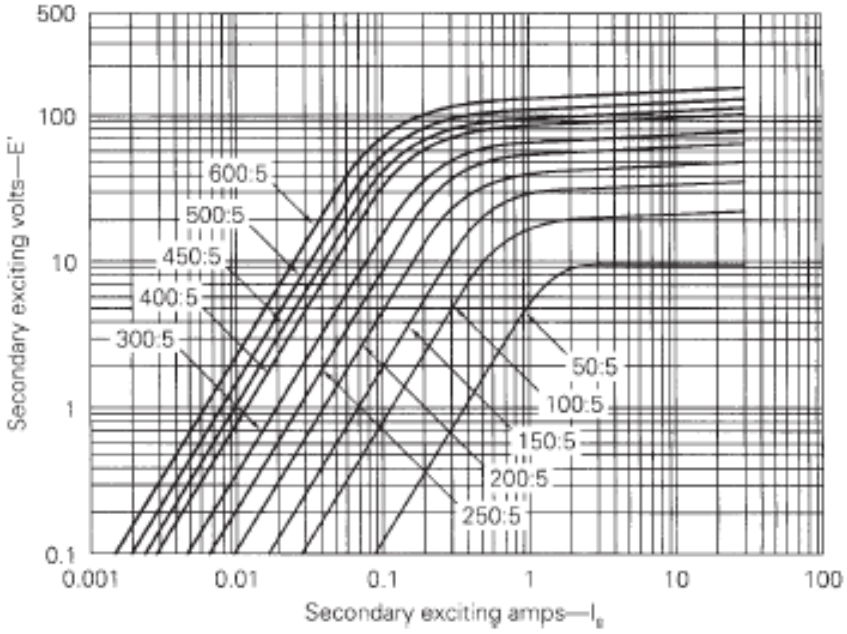
Name**:** _____Index Number: _____

INSTRUCTION: ATTEMPT ALL QUESTIONS IN THE ANSWER BOOKLET PROVIDED

QUESTION 1

(a) Sketch an **approximate equivalent circuit diagram** of a current transformer. ***(5 mks)***

(b) Evaluate the performance of the multiratio CT in Figure 1 with a 100:5 CT ratio, for the following secondary output currents (I_s) and burdens (Z_B):
(i) I_s = 5 A and Z_B = 0.5 Ω;
(ii) I_s = 8 A and Z_B = 0.8 Ω; and
(iii) I_s = 15 A and Z_B = 1.5 Ω.
Also, compute the CT error for each output current. ***(8 mks)***



CT ratio	Secondary resistance Ω
50:5	0.061
100:5	0.082
150:5	0.104
200:5	0.125
250:5	0.146
300:5	0.168
400:5	0.211
450:5	0.230
500:5	0.242
600:5	0.296

Figure 1 Excitation Curves for a Multiratio Bushing CT with A C100 ANSI Accuracy Classification

(c) Sketch the inverse-time characteristics of an induction disc overcurrent relay. ***(2 mks)***

(d) Sketch a diagram of the voltage balance differential relay. ***(2 mks)***

QUESTION 2

(a) State and explain briefly any **FOUR** qualities of a protection system. ***(4 mks)***

(b) Explain using appropriate diagrams the term "protection coordination. . ***(9 mks)***

(c) Give the classifications of relays according to:
(i) construction.
(ii) application.
(iii) characteristics. ***(9 mks)***

(d) Describe any one method employed for the protection of bus bars. ***(5 mks)***

(e) Describe with the aid of an appropriate diagram the Merz price system used for the protection of three-phase transmission lines. ***(6 mks)***

QUESTION 3

(a) (i) All the functions and characteristics available with electromechanical relays can be performed by *solid-state devices (relays)*, either as discrete components or as integrated circuits. Explain the term in italics.

(ii) Mention **THREE** advantages of the solid-state relays. ***(7 mks)***

(b) Using appropriate diagrams, differentiate between magnitude comparison relaying and phase angle comparison relaying. ***(10 mks)***

(c) Consider a Δ/Y-connected, 20 MVA, 33/11 kV transformer with differential protection applied, for the current transformer ratios shown in Figure 2. Calculate the relay currents on full load. Find the minimum relay current setting to allow 125% overload. ***(7 mks)***

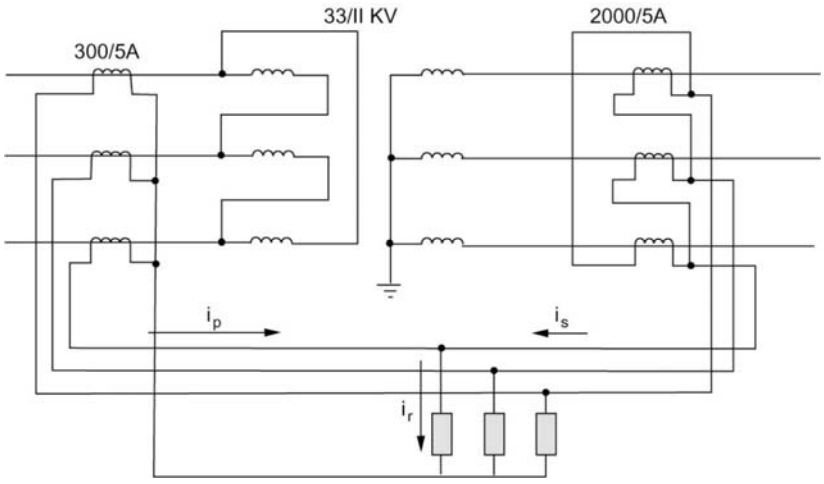


Figure 2 Differential Protection of a Δ/Y Transformer

QUESTION 4

(a) State **TWO** objectives of power system protection. ***(2 mks)***

(b) Mention **FIVE** causes and **FIVE** undesirable effects of short-circuit faults. ***(10 mks)***

(c) Give the classification of relays based on the following:
   (i) general function.
   (ii) construction.
   (iii) incoming signal.
   (iv) type of protection. ***(8 mks)***

(d) An electromagnetic relay of attracted armature type has constants $k_1 = 0.6$ and $k_2 = 10$ find whether the relay will operate or not when:
   (i) A current of 4 A flows through the relay winding.
   (ii) A current of 5 A flows through the relay winding.
   (iii) Find the minimum current required to operate the relay. ***(6 mks)***