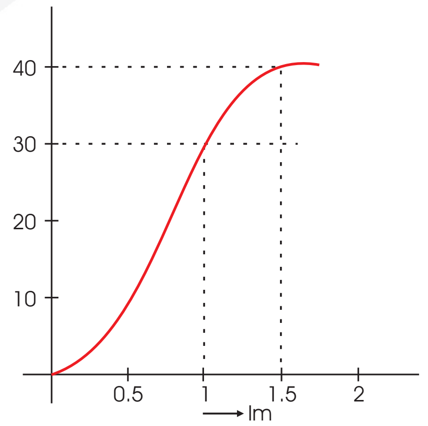
Special Purpose Current Transformers Type 'PS'

Introduction:
In previous issue, we have discussed differential protection which is a form of circulating current protection. For such application PS Class CT's are being used. In this issue, we will discuss the Selection Procedure, Working Principle & Difference with measuring CT's. Before entering into further discussion, we will discuss some relevant terminology.

Magnetizing Current:
In ideal condition primary ampere turns completely transformed into secondary ampere turn. But in practice some ampere turn shall be used to excite the core. The current corresponding to exciting MMF is called 'Magnetization Current'. This is the current responsible for error in CT's.

Magnetization Curve:
It is the characteristic curve of magnetic material used in CT. this curve explains the relationship between exciting ampere turn and flux density. See figure below for more clarity.

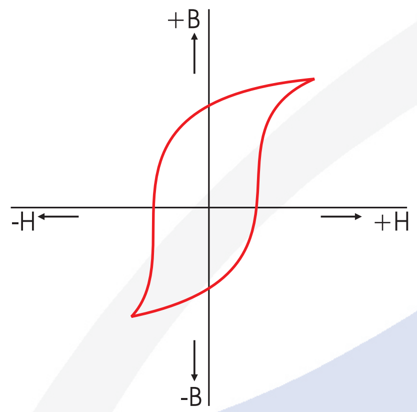
Knee-Point Voltage:



Im-Exciting Current

Defined in IS as that point where an increase of 10% in the flux density produces an increase of 50% in the exciting ampere turns thus limiting the secondary output to a required level

Magnetizing Curve



B - Flux Density
H - Magnetizing Force
B - μH
Where μ - Permeabilites of magnetic Material

Exciting Current Im Magnetization curve

The performance of PS class CT is defined in terms of its internal characteristics. The knee point voltage, the exciting current at the knee point or ½ or ¼ of the knee point voltage (kpv) and CT secondary winding resistance (RCT) corrected to 75° C. The value of minimum knee point voltage is given by K x Is x (RCT + Rb) where k is any factor determined from relay characteristics.

Difference with Other CT's:
In metering CT's the main criterion is accuracy over the operating range of 5% to 120%. A protection CT has to be accurate in the event of faults and this may be at 10, 15 or 20 times the rated primary current. The design of CTs kept in such way because measuring CTs are used for measurement purpose where only full load current has the relevance. If the over current crosses the instrument safety factor limit 'which is normally low for measuring instruments, then instrument will get damaged, therefore, it is desirable to keep the saturation level of measuring CT's at low value. By keeping saturation level of measuring CT low 'normally it is 120%' transfer of fault current to measuring instrument can be prevented. But in case of protection CT primary fault current to be transformed accurately for propose of sensing by protection relay to act accurately. Though metering CT's are not supposed to transform fault current but still the are designed with a short time rating 'STR' in kA so it should not damage itself during fault condition.

Protection CTs are represented by Accuracy class and accuracy limit factor e.g. 5P10 where 5 is accuracy class at 10 times of primary current.

PS Class CT's are special application CT's used in biased differential protection, restricted ground fault and distance protection schemes. These CTs are used where it is not possible to easily identify the class of accuracy limit factor and the rated burden on the CTs and where a full primary fault current is required to be transformed.

Selection of PS Class CTs:

Say Generator capacity is P mva - at 415 VAC

Full load current - Ir = P x 10 3

3 X 0.415

The Fault level of the system

Isc = Ir x 100
Xd"

Where Xd" is sub transient reactance of alternator.

Consider CT resistance as Rct and connecting a lead resistance is Rb

Then total resistance R = Rct + 2 Rb

Fault current in terms of secondary

isc = Isc x N2

N1

Where N1
----- = CT Ratio
N2

Relay voltage setting Stability Limit

Voltage developed across relay coil in fault condition

Uft = isc (Rct + 2Rb)

Therefore minimum knee point voltage kpv ≥2 Vft

Magnetizing current of CT can be found from magnetization curve of CT core material at kpv .
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