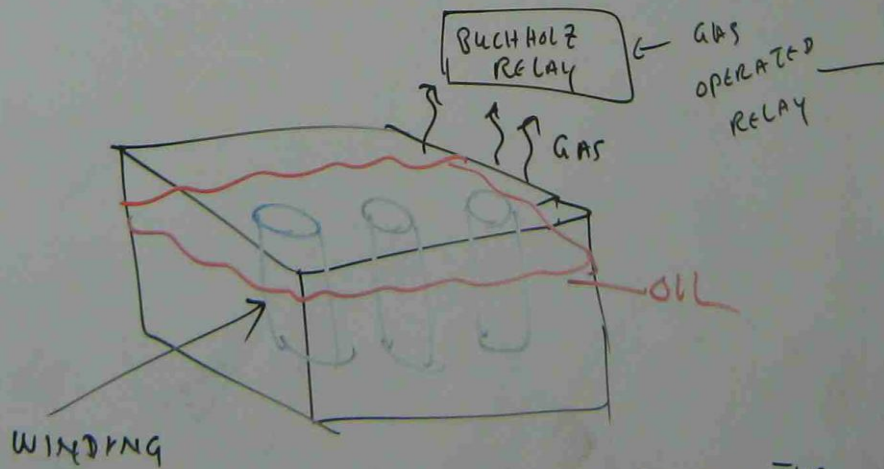
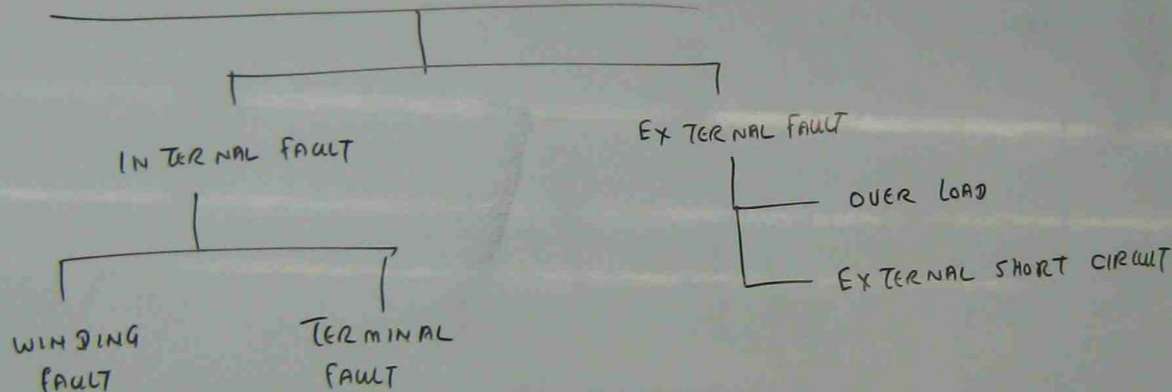


# POWER TRANSFORMER PROTECTION

## Types of faults in power transformer



## MECHANICAL PROTECTION RELAY

→ CUT OFF THE CIRCUIT BREAKER

HOT WINDING HEATS UP THE OIL → HOT → PRODUCE THE GAS

## CAUSES OF TRANSFORMER FAULTS

POOR COOLING

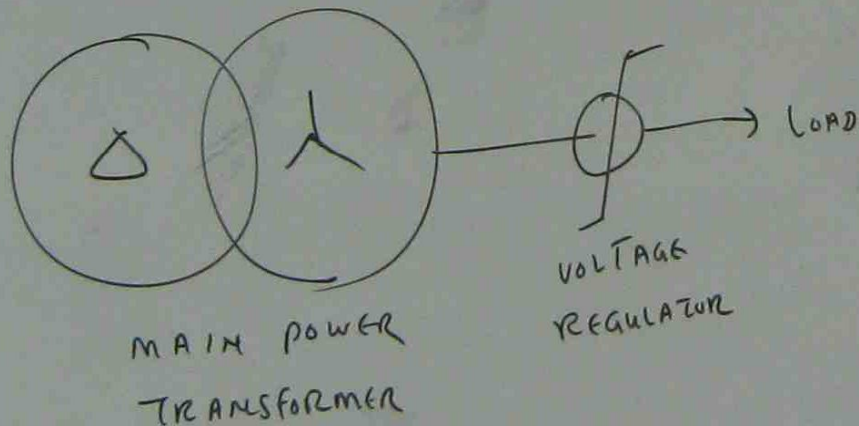
COOLANT FAILURE

OVER HEATING DUE TO

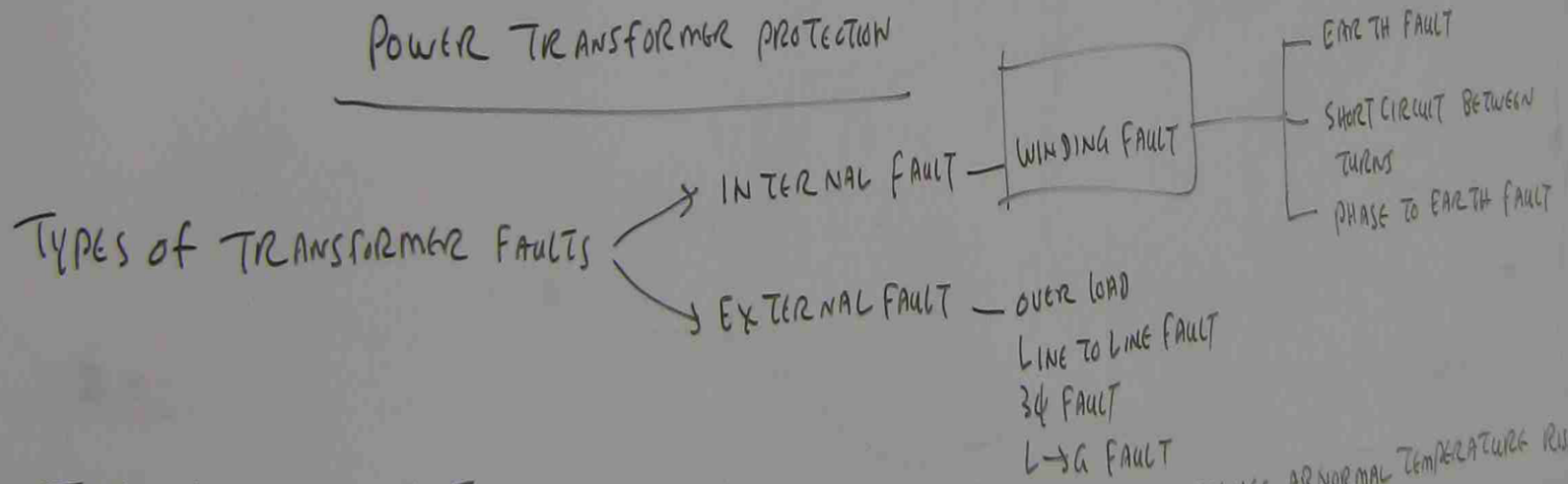
VOLTAGE REGULATOR FAULT

IN CORRECT SETTING

↓  
OVER VOLTAGE  
IN MAIN TRANSFORMER  
WINDING



## POWER TRANSFORMER PROTECTION



WHEN TRANSFORMER GOT THE INTERNAL FAULT, THE HIGHER CURRENT CAUSES ABNORMAL TEMPERATURE RISE. THE ABNORMAL TEMPERATURE RISE HEATS UP THE INSULATION AND PRODUCES THE GAS. THE GAS IS SENSED BY GAS OPERATED RELAY (BUCHHOLZ RELAY) AND THE RELAY CUTS OFF THE SUPPLY.

CAUSES OF INTERNAL FAULTS POOR COOLING, COOLANT FAILURE, OVER HEATING DUE TO VOLTAGE REGULATOR FAULT.

# ELECTRICAL RELAY (DIFFERENTIAL RELAY)

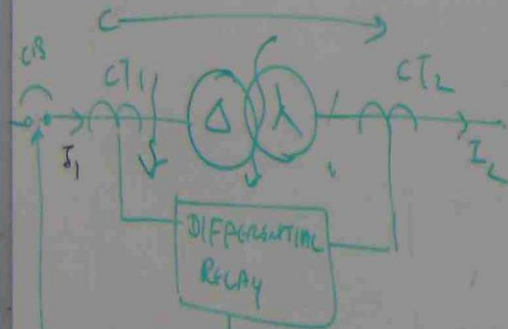


NORMAL CONDITION  
 $a I_1 = I_2$



$a I_1 \neq I_2$

INTERNAL FAULT



TRIP SIGNAL

$CT_1, CT_2$  - CURRENT TRANSFORMERS

$$\frac{I_2}{I_1} = a$$

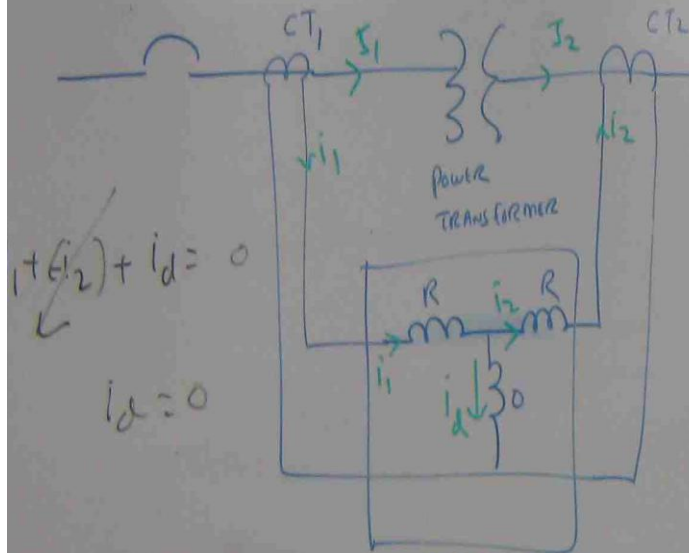
## OPERATION PRINCIPLE

THE DIFFERENTIAL RELAY SENSES THE PRIMARY (INCOMING) AND SECONDARY (OUT GOING) CURRENTS OF THE POWER TRANSFORMER. SO LONG AS THE PRIMARY AND SECONDARY CURRENT RATIO IS WITH IN THE LIMIT, THE DIFFERENTIAL WILL NOT OPERATE.

BUT DUE TO THE INTERNAL FAULT IN IT'S PROTECTION ZONE, THE RATIO OF PRIMARY AND SECONDARY CURRENTS CAUSES THE QUANTITY BEYOND THE LIMIT, THE DIFFERENTIAL RELAY OPERATES AND CUTS OFF THE SUPPLY.



# CONNECTION OF DIFFERENTIAL RELAY



$$i_1 + i_2 + i_d = 0$$

$$i_d = 0$$

R - RESTRAINING COIL

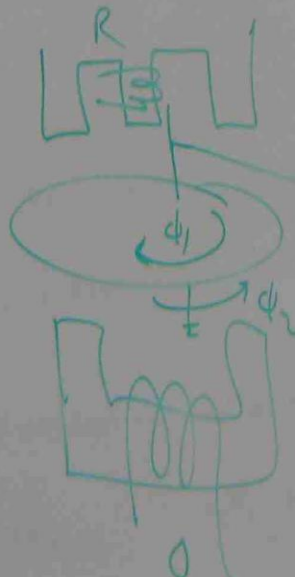
O - OPERATING COIL

DIFFERENTIAL RELAY

FAULT

$$i_1 > i_2$$

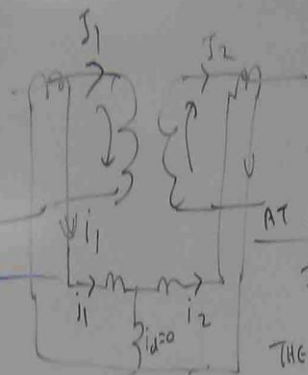
$i_d$  flows



NORMAL

$$I_1 = I_2$$

$$i_1 = i_2 \rightarrow i_d = 0$$



AT NORMAL CONDITION

$$I_1 = I_2, i_1 = i_2, i_d = 0$$

THE FLUX  $\phi_r$  PRODUCED BY RESTRAINING COILS TURNS THE DISC AWAY FROM CONTACT CLOSING.

AT FAULT CONDITION

$$I_1 > I_2$$

$$i_1 > i_2$$

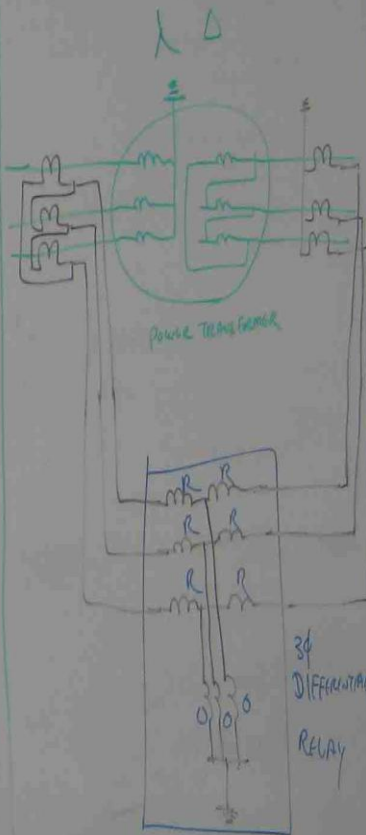
$$i_d \neq 0$$

THE  $i_d$  FLOWS INTO OPERATING COIL.

THE OPERATING COIL MAGNETIC FLUX  $\phi_o$  TURNS THE DISC

TO CLOSE THE RELAY CONTACT.

## 3 $\phi$ DIFFERENTIAL RELAY CONNECTION

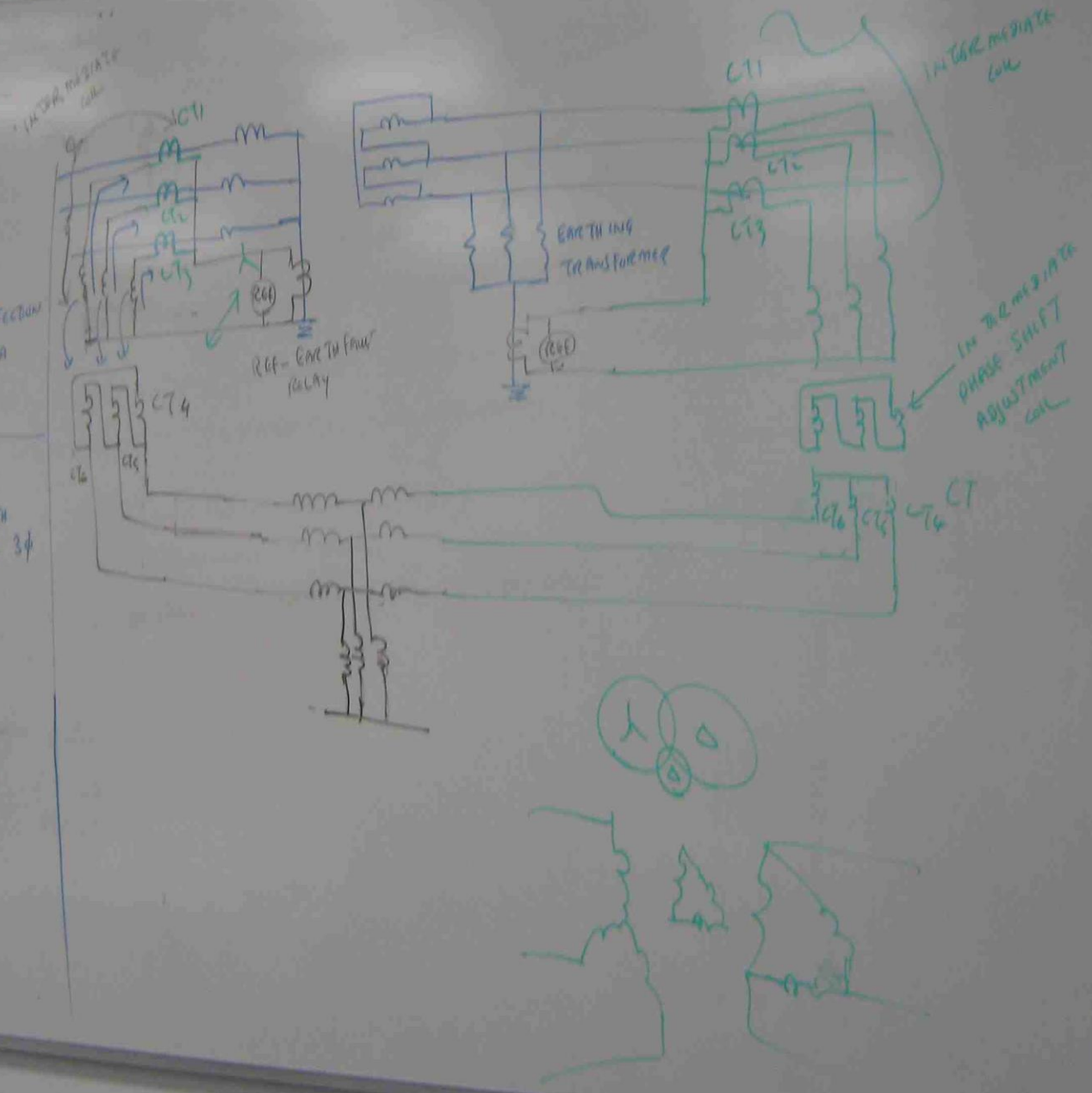


MAIN POWER TRANSFORMER

PRIMARY  $\Delta \rightarrow CT \Delta$   
 SECONDARY  $\Delta \rightarrow CT \Delta$  } TO MINIMIZE THE PHASE DISPLACEMENT

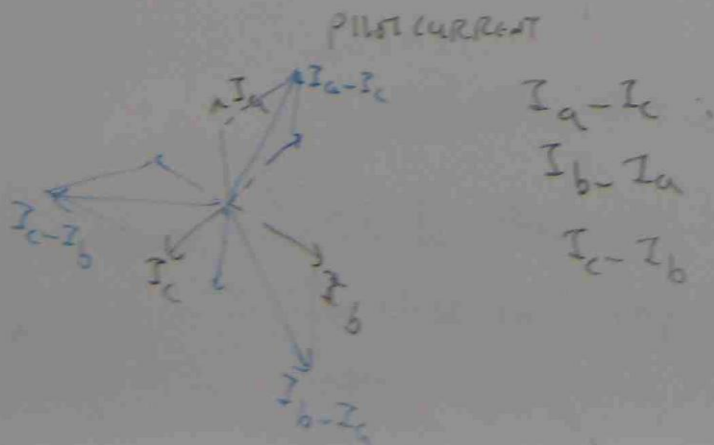
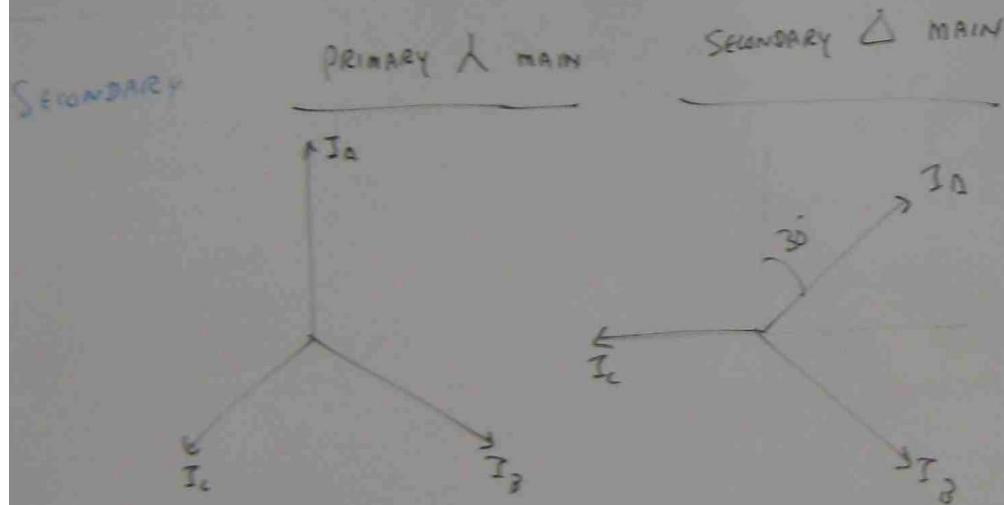
Question Tutorial 5  
 Q2(a) SKETCH DIFFERENTIAL PROTECTION DIAGRAM FOR 3 $\phi$  STAR DELTA TRANSFORMER

Tutorial 5  
 Q2(b) SKETCH THE DIAGRAM TO PROVIDE EARTH FAULT AND DIFFERENTIAL PROTECTION FOR 3 $\phi$  STAR / DELTA TRANSFORMER



# TUTORIAL 9

Q3 SKETCH THE VECTOR DIAGRAM FOR PRIMARY AND SECONDARY MAIN WINDINGS OF STAR DELTA POWER TRANSFORMER



## 3 $\phi$ DIFFERENTIAL RELAY CONNECTION

