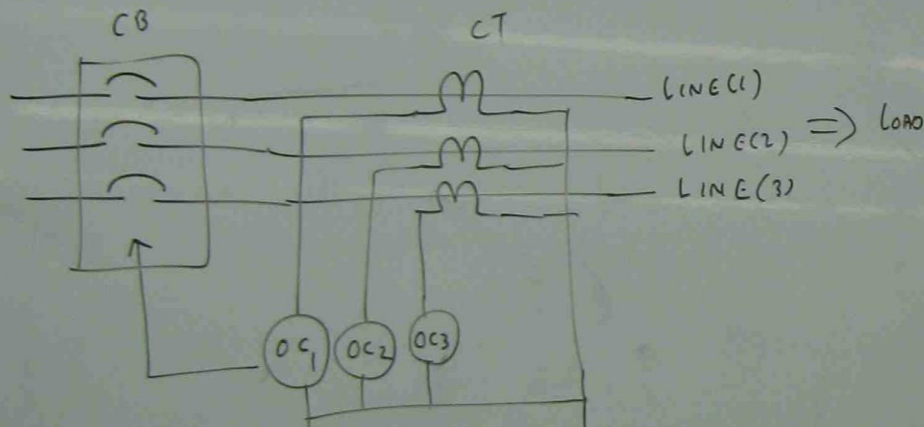


## OVER CURRENT & EARTH FAULT PROTECTION

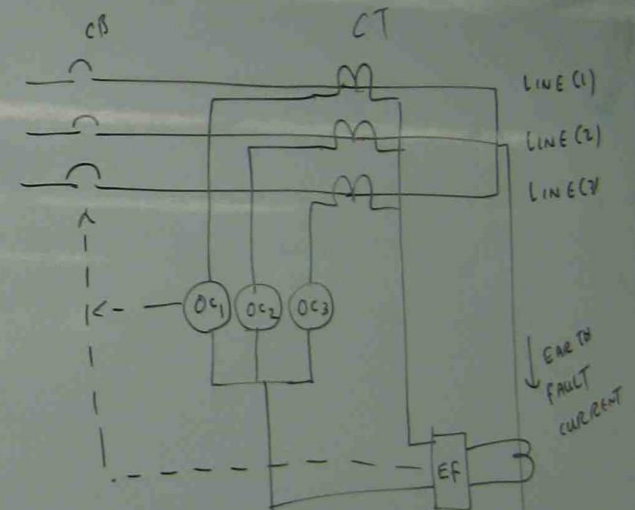
### 3 $\phi$ OVER CURRENT PROTECTION



WHEN 3 $\phi$  OVER LOAD HAPPENS,  $OC_1, OC_2, OC_3$  CAN TRIP THE CIRCUIT BREAKER TO PROTECT THE LINE.

$OC_1, OC_2, OC_3$  - OVER CURRENT RELAYS

### EARTH FAULT RELAY



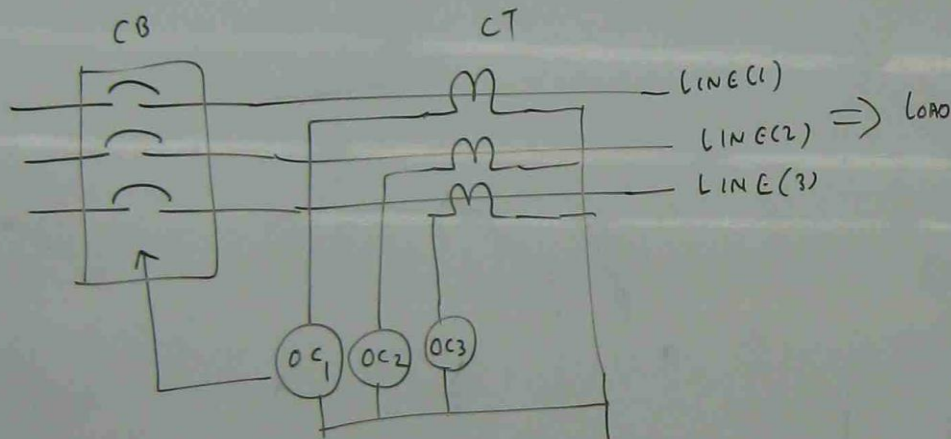
EF: EARTH FAULT RELAY (EARTH LEAKAGE RELAY)

OVER CURRENT RELAYS ARE CONNECTED TO CT SECONDARY COILS. EARTH FAULT RELAY SENSES THE CURRENT FLOW TO EARTH

IF OVER CURRENT & EARTH FAULT OCCURS,  $OC$  AND  $EF$  CAN OPEN THE C.B.

## OVER CURRENT & EARTH FAULT PROTECTION

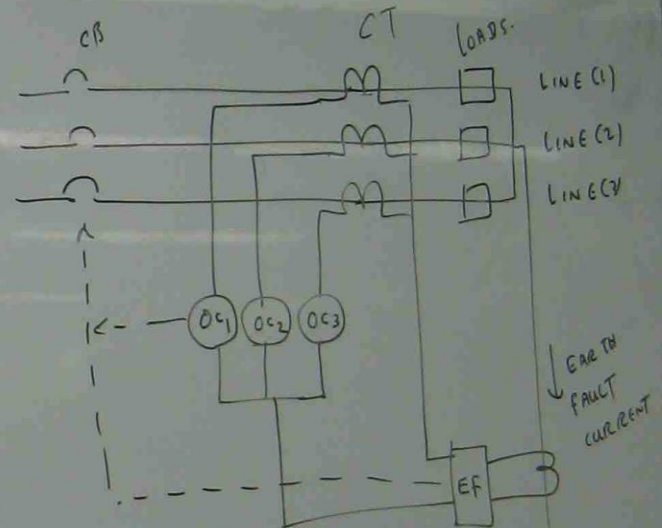
### 3 $\phi$ OVER CURRENT PROTECTION



WHEN 3 $\phi$  OVER LOAD HAPPENS, OC<sub>1</sub>, OC<sub>2</sub>, OC<sub>3</sub> CAN TRIP THE CIRCUIT BREAKER TO PROTECT THE LINE.

OC<sub>1</sub>, OC<sub>2</sub>, OC<sub>3</sub> - OVER CURRENT RELAYS

### EARTH FAULT RELAY



EF: EARTH FAULT RELAY  
(EARTH LEAKAGE RELAY)

OVER CURRENT RELAYS ARE CONNECTED TO CT SECONDARY COILS.

EARTH FAULT RELAY SENSES THE CURRENT FLOW TO EARTH

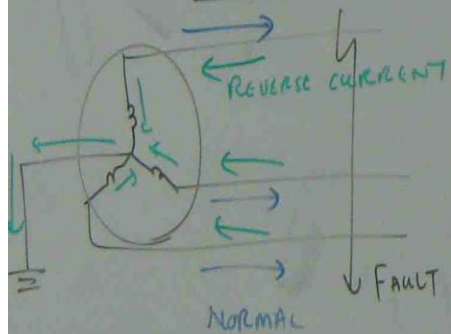
IF OVER CURRENT & EARTH FAULT OCCURS, OC AND EF CAN OPEN THE C.B.



WITH FAULT CURRENT IS NORMALLY LESS THAN NORMAL LINE CURRENT.  
 WITH FAULT CAN NOT BE PROTECTED BY OVER CURRENT RELAY

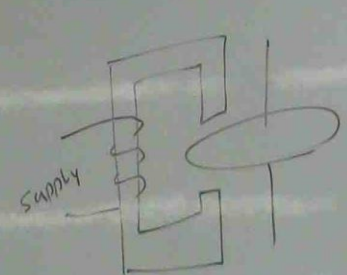
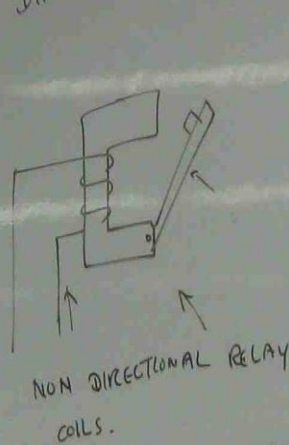
3 $\phi$  OVER CURRENT, ANY PHASE OVER CURRENT,  $L \rightarrow G$   
 FAULT,  $2L \rightarrow G$  FAULT CAN BE PROTECTED BY EARTH  
 FAULT RELAY.

REVERSE POWER FLOW



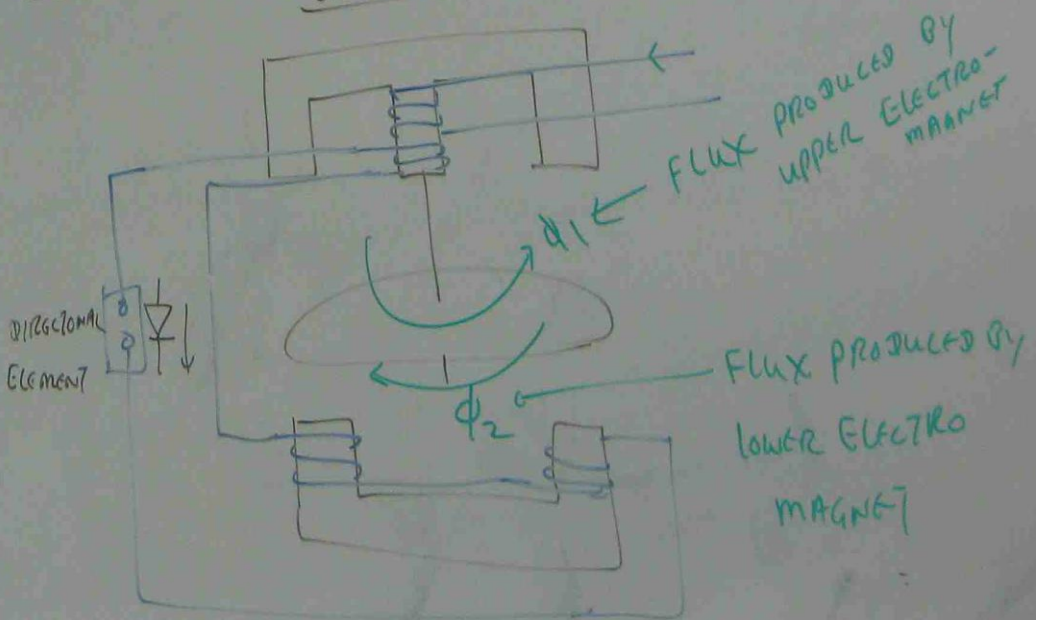
REVERSE FLOW HAPPENS WHEN THE FAULT OCCURS.  
 WE NEED TO PROVIDE REVERSE POWER RELAY FOR  
 REVERSE POWER FLOW PROTECTION.

DIRECTIONAL ELEMENT IS INTEGRATED TO OVER CURRENT RELAY.



THEY ARE INTEGRATED  
 IN OVER CURRENT RELAYS

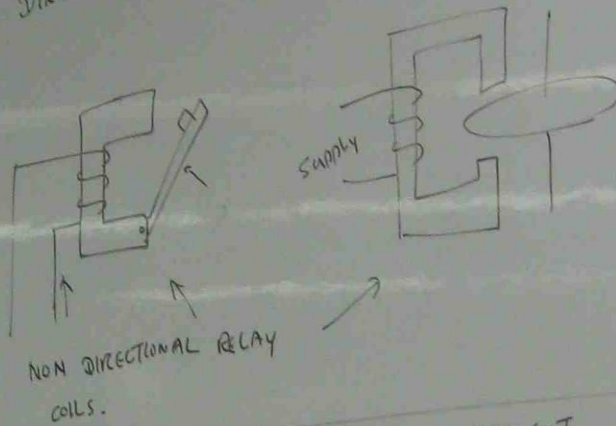
DIRECTIONAL ELEMENT



EARTH FAULT CURRENT IS NORMALLY LESS THAN NORMAL LINE CURRENT.  
EARTH FAULT CAN NOT BE PROTECTED BY OVER CURRENT RELAY

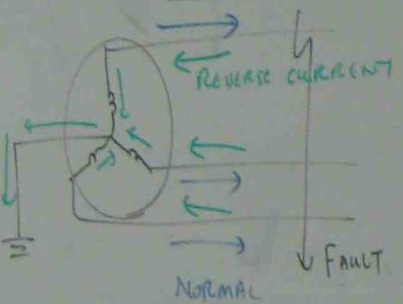
3 $\phi$  OVER CURRENT, ANY PHASE OVER CURRENT,  $L \rightarrow G$  FAULT,  $2L \rightarrow G$  FAULT CAN BE PROTECTED BY EARTH FAULT RELAY.

DIRECTIONAL ELEMENT IS INTEGRATED TO OVER CURRENT RELAY.



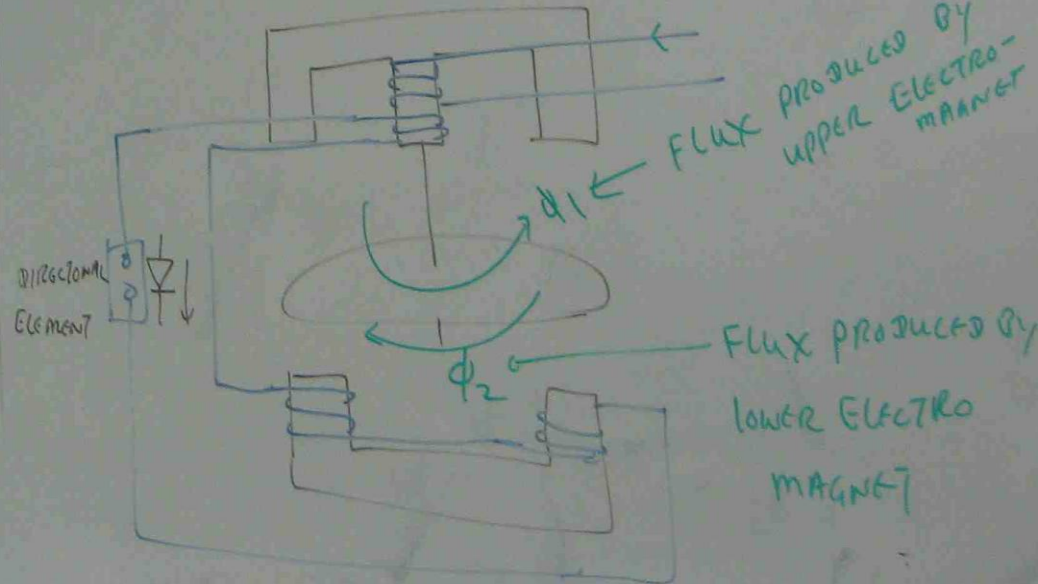
THEY ARE INTEGRATED IN OVER CURRENT RELAYS

REVERSE POWER FLOW



REVERSE FLOW HAPPENS WHEN THE FAULT OCCURS.  
WE NEED TO PROVIDE REVERSE POWER RELAY FOR REVERSE POWER FLOW PROTECTION.

DIRECTIONAL ELEMENT





## OPERATING PRINCIPLE

DIRECTIONAL OVER CURRENT RELAY CONSISTS OF TWO ELECTROMAGNETS.

UPPER ELECTROMAGNET IS CONNECTED TO LINE AND DIRECTIONAL ELEMENT IS PLACED FOR LOWER ELECTROMAGNET.

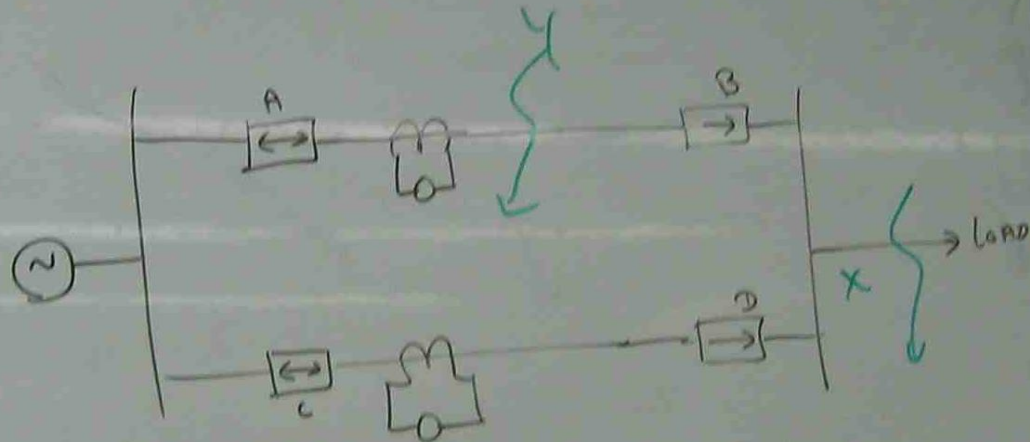
FLUX  $\phi_1$  IS PRODUCED BY UPPER ELECTROMAGNET AND FLUX  $\phi_2$  IS PRODUCED BY LOWER ELECTROMAGNET.

AT NORMAL CONDITION, BOTH MAGNETS RECEIVE THE CURRENT.  $\phi_1$  IS OPPOSED BY  $\phi_2$ . RELAY DOES NOT OPERATE.

WHEN REVERSE POWER FLOW HAPPENS,  $\phi_1$  IS STILL PRODUCED BUT DIRECTIONAL ELEMENT BLOCKS THE CURRENT FLOW INTO LOWER MAGNET. AS THERE IS ONLY  $\phi_1$  IS LEFT, IT

TURNS THE INDUCTION DISC AND TRIPS THE RELAY TRIPPING CIRCUIT.

## LOCATION OF REVERSE POWER RELAYS IN POWER LINE



A, C - NON DIRECTIONAL  
RELAYS

THEY NEED TO BE ALLOCATED  
NEAR MAIN POWER SOURCE



B, D - DIRECTIONAL RELAY

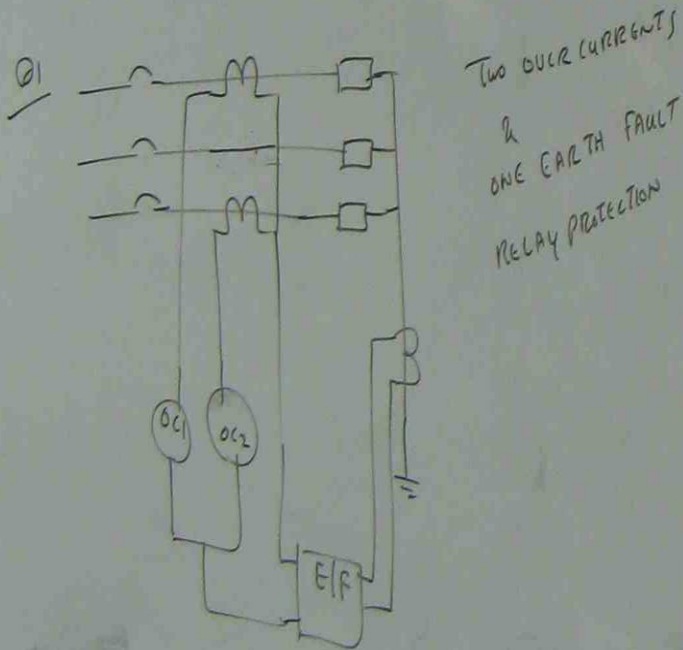
FAULT PROTECTION  
(L-L FAULT  
3  $\phi$  FAULT ETC)

FAULT AT X  $\rightarrow$  B, D OPERATE  
FAULT AT Y  $\rightarrow$  A, C OPERATE

### TUTORIAL (3)

Q1 SKETCH THE CONNECTION DIAGRAM OF COMBINED PROTECTION SCHEME THAT CONTAINS TWO OVER CURRENT RELAYS AND ONE EARTH FAULT RELAY TO PROVIDE PHASE TO PHASE AND PHASE TO EARTH PROTECTION.

Q2 HOW DOES DIRECTIONAL ELEMENT OF A RELAY PER FORM ?

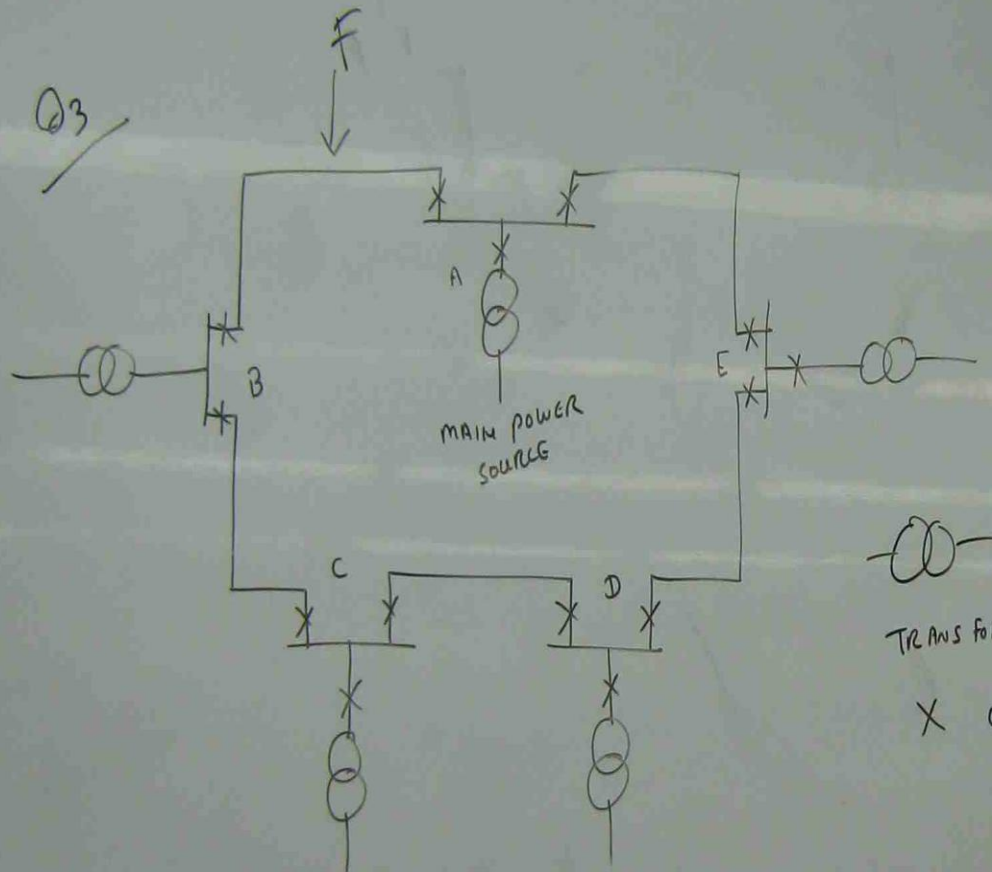


Q2 DIRECTIONAL ELEMENT ALLOWS ONLY ONE DIRECTION OF CURRENT FLOW. IF THE REVERSE DIRECTION CURRENT FLOWS IN LINE DUE TO LINE TO LINE FAULT (OR) 3 $\phi$  FAULT, THAT REVERSE DIRECTION CURRENT IS BLOCKED BY DIRECTIONAL ELEMENT.

NORMALLY DIRECTIONAL ELEMENT IS CONNECTED TO RELAY RESTRAINING COIL. NORMALLY RESTRAINING COIL PROVIDES THE FLUX OPPOSED TO THAT IN OPERATING COIL AT NORMAL OPERATION CONDITION. WHEN REVERSED POWER FLOWS DUE TO FAULT, DIRECTIONAL ELEMENT BLOCKS RESTRAINING COIL CURRENT AND FLUX. THUS ONLY OPERATING COIL FLUX OPERATES THE RELAY



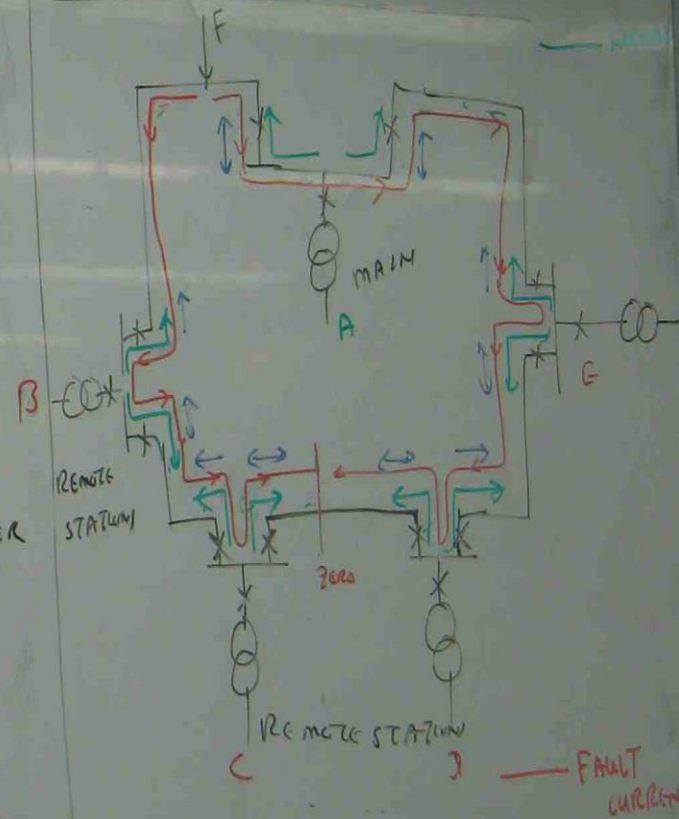
Q3



↑ DIRECTIONAL RELAY  
 ↓ NON DIRECTIONAL RELAY

LOCATE RELAY PROTECTION SCHEME FOR GIVEN SYSTEM  
 WHEN FAULT OCCURS AT POINT (F).

① DRAW THE NORMAL POWER FLOW DIAGRAM



(2) DRAW THE FAULT CURRENT DIRECTION

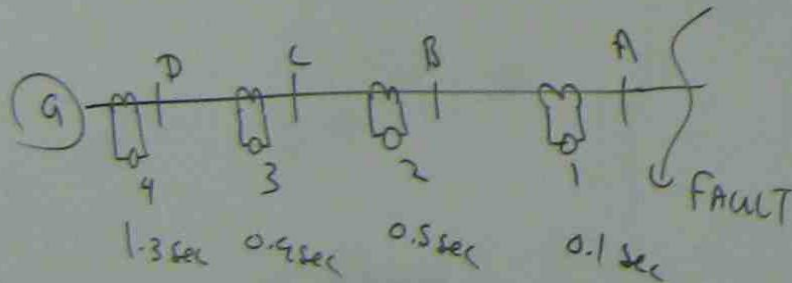


Closest to main power source - Non directional  
← →

Fault current opposes the normal current → DIRECTIONAL  
→

Fault current & normal current in same direction  
NON DIRECTIONAL  
← →


### TIME GRADING SYSTEM

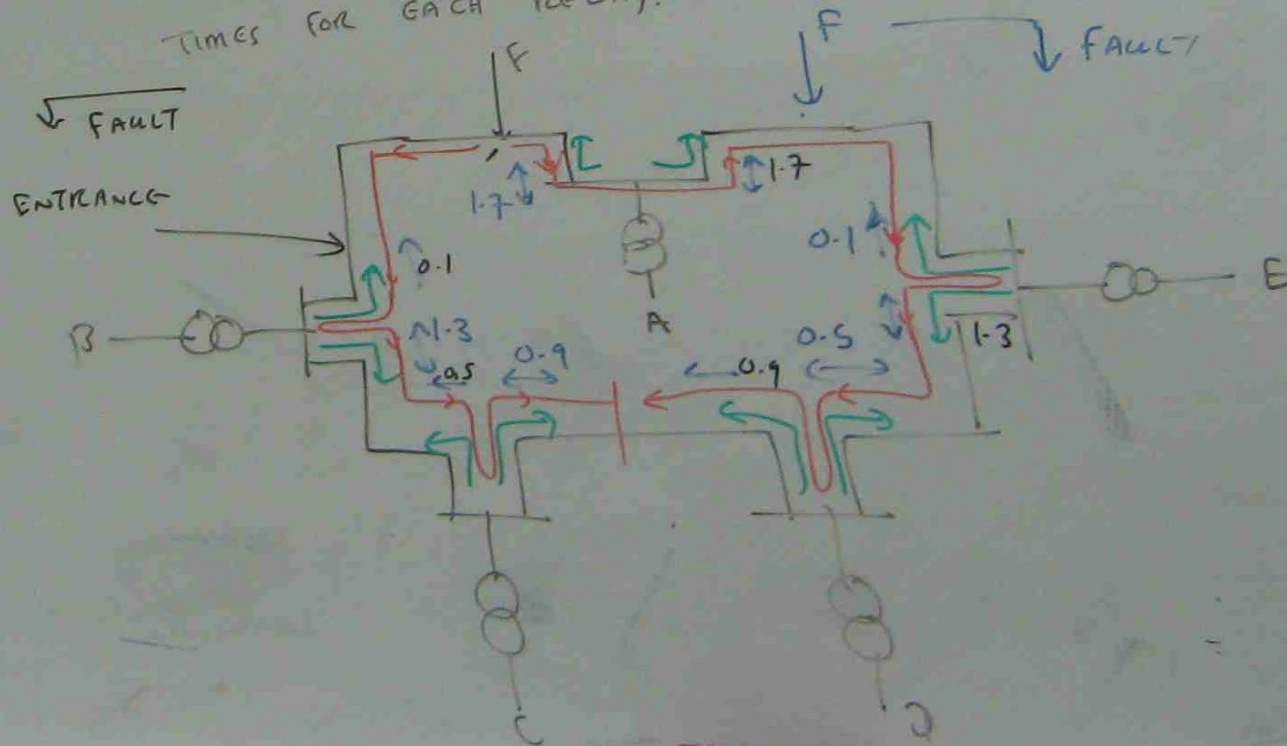


If 0.4 sec time difference & minimum time 0.1 sec is applied.

BY ALLOCATING THE TIME GRADING SYSTEM, THE RELAY CLOSEST TO THE FAULT MUST OPERATE FIRST AND THE OTHERS OPERATE IN SEQUENCE. SYSTEM STABILITY CAN BE MAINTAINED

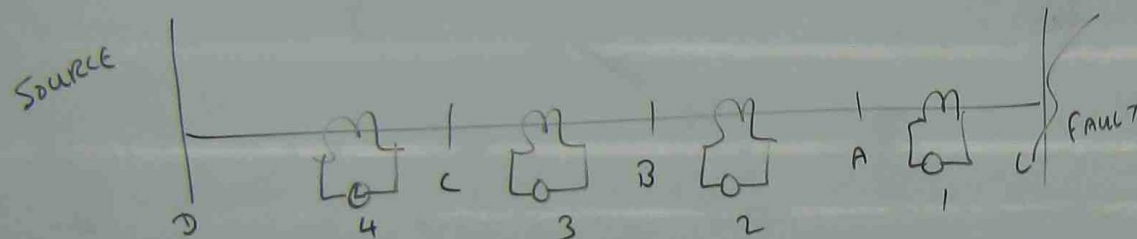
② IN PREVIOUS Q<sub>3</sub>, MINIMUM RELAY OPERATION TIME IS 0.1 SEC AND TIME GRADING IS 0.4 SEC. ALLOCATE THE OPERATING TIMES FOR EACH RELAY.

IF 





# TIME GRADING & CURRENT GRADING



TIME GRADING  
FAULT CURRENT

1.3

$I_{sh4}$

0.4

$I_{sh3}$

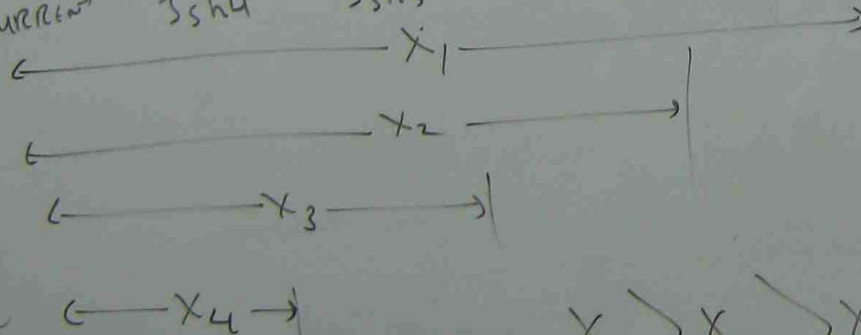
0.5

$I_{sh2}$

0.1

$I_{sh1}$

DISTANCE



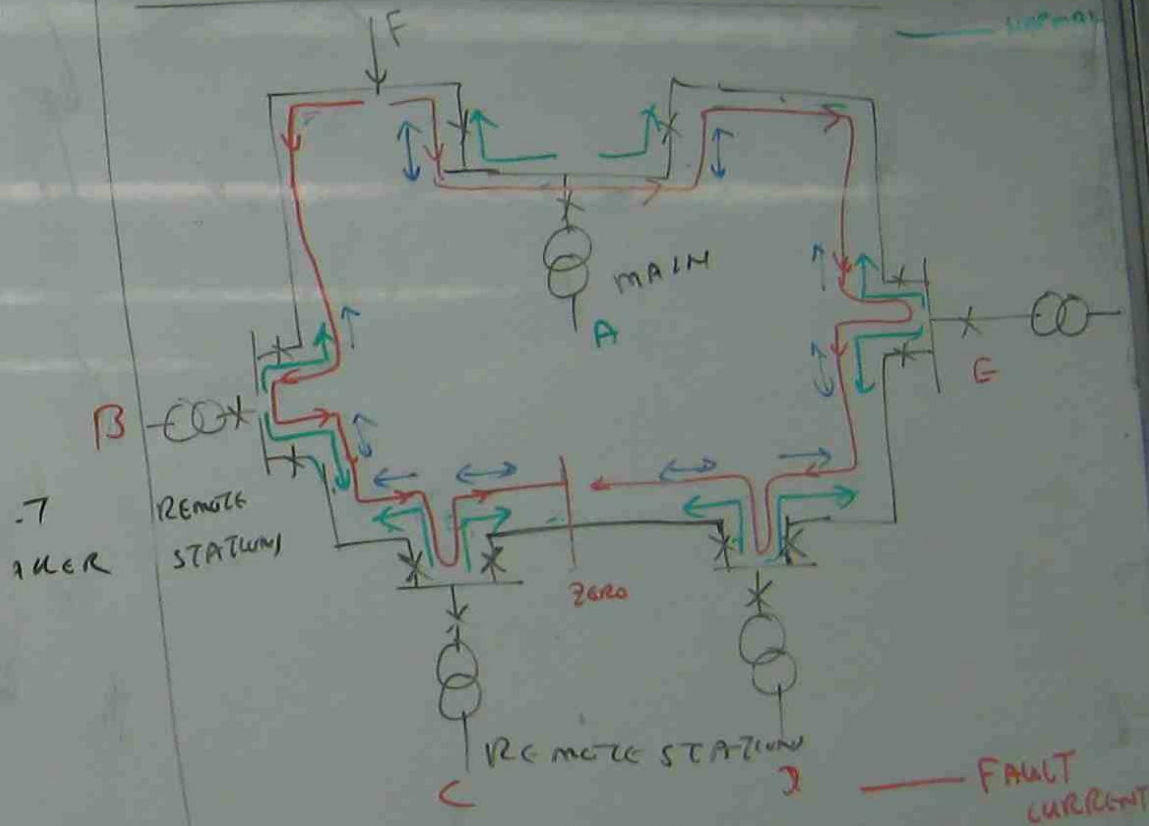
$$X_1 > X_2 > X_3 > X_4$$

CURRENT  
GRADING.

$$I_{sh1} < I_{sh2} < I_{sh3} < I_{sh4}$$

10A    20A    30A    40A

① DRAW THE NORMAL POWER FLOW DIAGRAM



(2) DRAW THE FAULT CURRENT DIRECTION



