Digital Assignment-1

Power System Protection And Switchgear

SUBMITTED BY:

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SCHOOL: SELECT

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SLOT: C1+TC1

Aim: To calculate the time taken by the relay to operate and to find whether the differential relay will trip or not trip using web application.

Description About The Assignments:

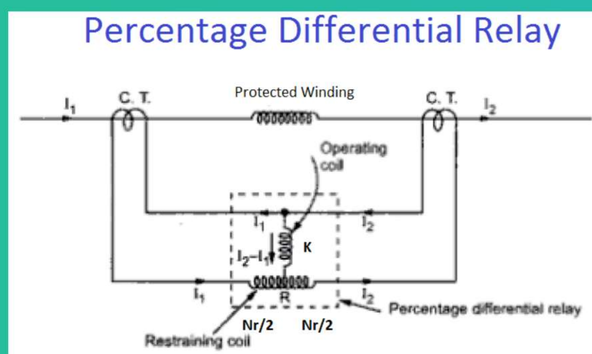
We have created a web application which includes:

1)Brief information on Percentage Differential Relay and it's Operating Characteristics:

Theory   Time Of Operation   Relay Tripping

Overview of The Differential Relays

The relays used in power system protection are of different types. Among them differential relay is very commonly used relay for protecting transformers and generators from localised faults.



The differential relay is one that operates when there is a difference between two or more similar electrical quantities exceeds a predetermined value. In the differential relay scheme circuit, there are two currents come from two parts of an electrical power circuit. These two currents meet at a junction point where a relay coil is connected. According to Kirchhoff Current Law, the resultant current flowing through the relay coil is nothing but the summation of two currents, coming from two different parts of the electrical power circuit. If the polarity and amplitude of both the currents are so adjusted that the phasor sum of these two currents, is zero at normal operating condition. Thereby there will be no current flowing through the relay coil at normal operating conditions. But due to any abnormality in the power circuit, if this balance is broken, that means the phasor sum of these two currents no longer remains zero and there will be non-zero current flowing through the relay coil thereby relay being operated.

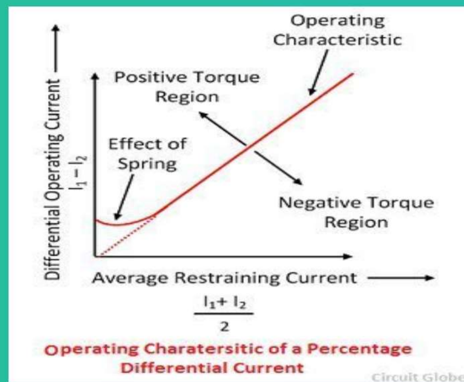
Working of Percentage Differential Relays

In this type of relay, there are restraining coils in addition to the operating coil of the relay. The restraining coils produce torque opposite to the operating torque. Under normal and through fault conditions, restraining torque is greater than operating torque. Thereby relay remains inactive. When internal fault occurs, the operating force exceeds the bias force and hence the relay is operated. This bias force can be adjusted by varying the number of turns on the restraining coils. As shown in the figure below, if I1 is the secondary current of CT1 and I2 is the secondary current of CT2 then current through the operating coil is I1-I2 and current through the restraining coil is (I1 + I2)/2. In normal and through fault condition, torque produced by restraining coils due to current (I1+ I2)/2 is greater than torque produced by operating coil due to current I1-I2 but in internal faulty condition these become opposite. And the bias setting is defined as the ratio of (I1-I2) to (I1+ I2)/2.

$$\text{Bias setting in percentage} = \frac{I_1 - I_2}{(I_1 + I_2)/2} \times 100\%$$

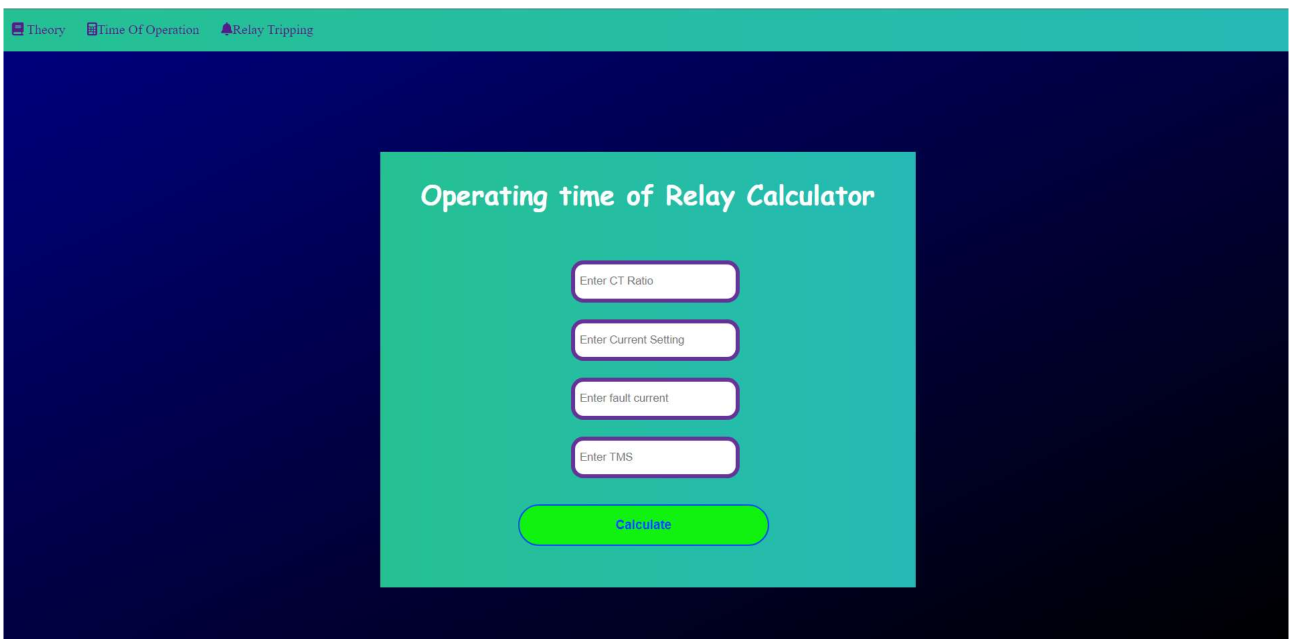
the current required for operating coil to be operated. The relay is called percentage relay because the operating current required to trip can be expressed as a percentage of through current.

Operating Characteristics of Biased Differential Relay



The operating characteristic of the relay is shown in the figure below. The above graph shows that the ratio of their operating current and restraining current is fixed percentage. This relay is also called the biased differential relay because the restraining coil is also called a bias coil as it provides additional flux.

2)To calculate time of operation of Relay: It will take parameters like CT Ratio, Current Setting, Fault Current and TMS and calculate the operating time of the relay.



Problem Statement to calculate time of operation of Relay:

Question:

c) An IDMT over current relay has a current setting of 180% and a time multiplier setting of 0.7. The primary of relay is connected to secondary of current transformer having ratio 550/5. Calculate the time of operation if the circuit carries a fault current of 4800A.

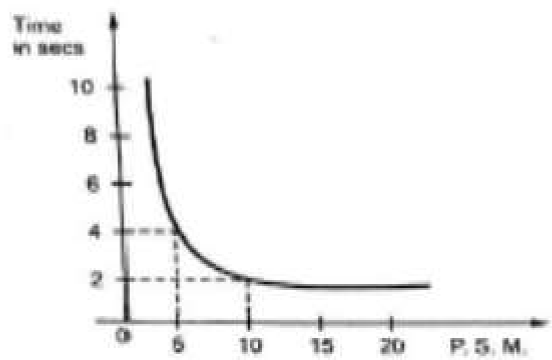
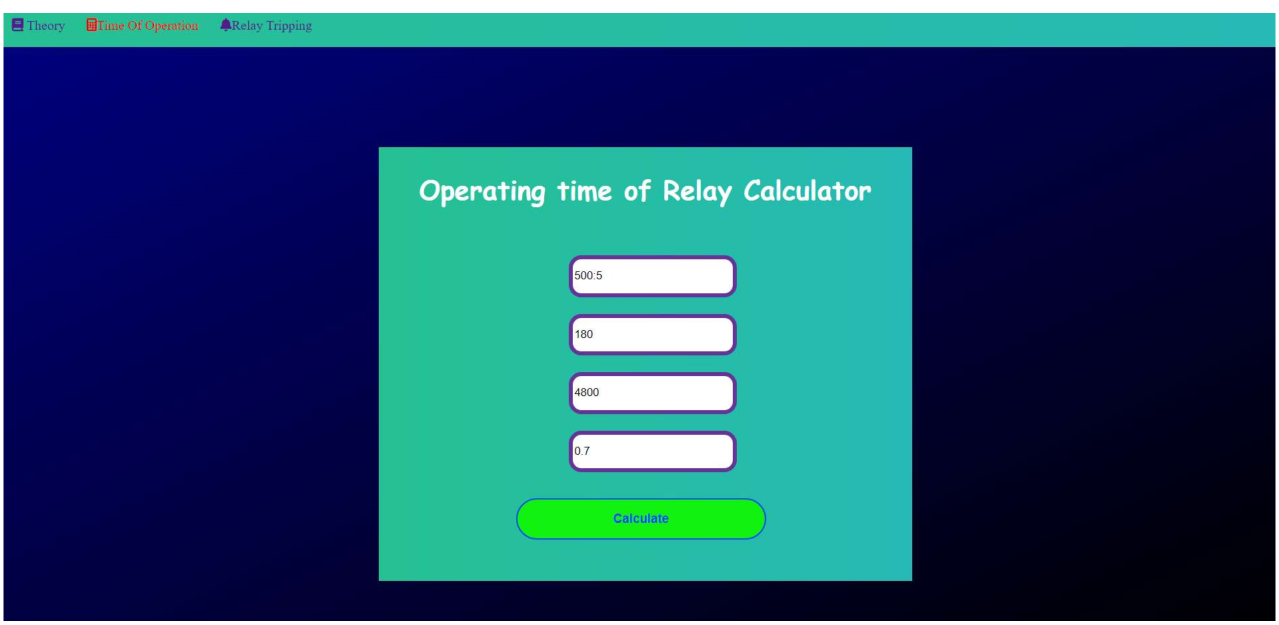
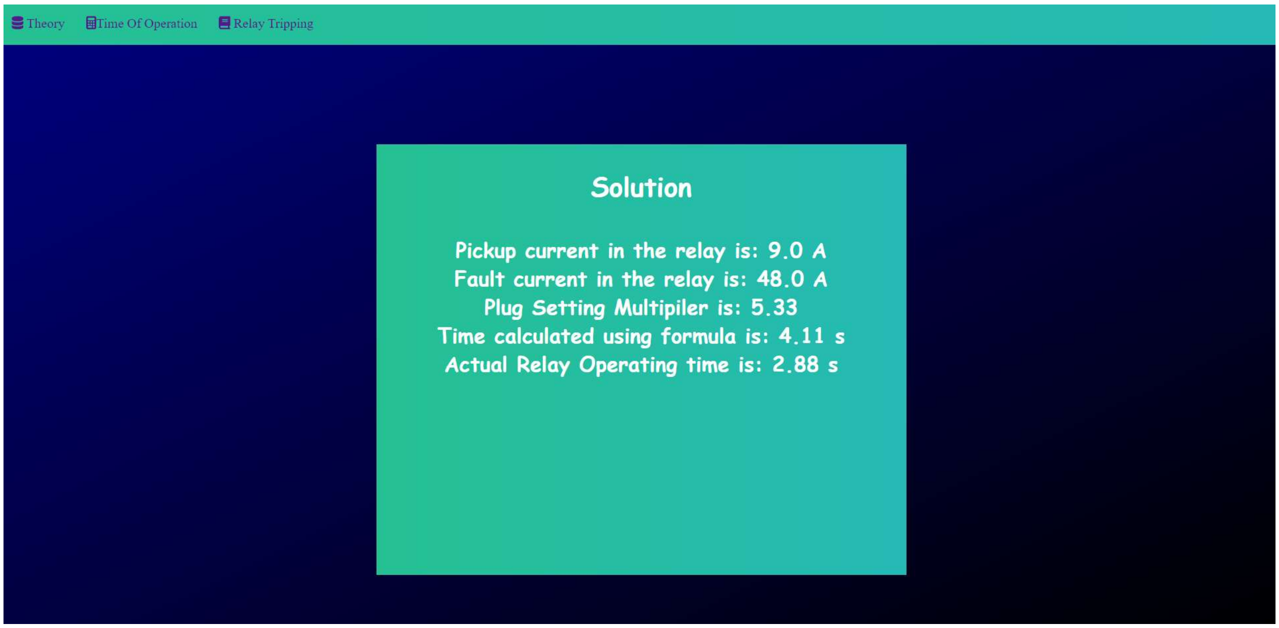


Figure 1

Implementation:



Output:


Theory
Time Of Operation
Relay Tripping
Solution
Pickup current in the relay is: 9.0 A
Fault current in the relay is: 48.0 A
Plug Setting Multipiler is: 5.33
Time calculated using formula is: 4.11 s
Actual Relay Operating time is: 2.88 s

Manual Calculations:

(sol) CT ratio = ~~400/5~~

550/5

current setting = 180% of 5A

$= 1.8 \times 5 = 9$

Plug setting multiplier = (PSM) = $\dfrac{\text{secondary current}}{\text{Relay current setting}}$

$= \dfrac{\text{Primary current}}{\text{RCS} \times \text{C.T ratio}}$

$= \dfrac{4800 \times 5}{550 \times 9}$

$= 4.84$

as it is IDMT over current relay, if PSM is < 10, the characteris-tics are inverse

→ for PSM 4.84, time is ≃ 4.2 seconds for TMS = 1 sec

→ from the given graph

→ for TMS = 0.7, the time of operation

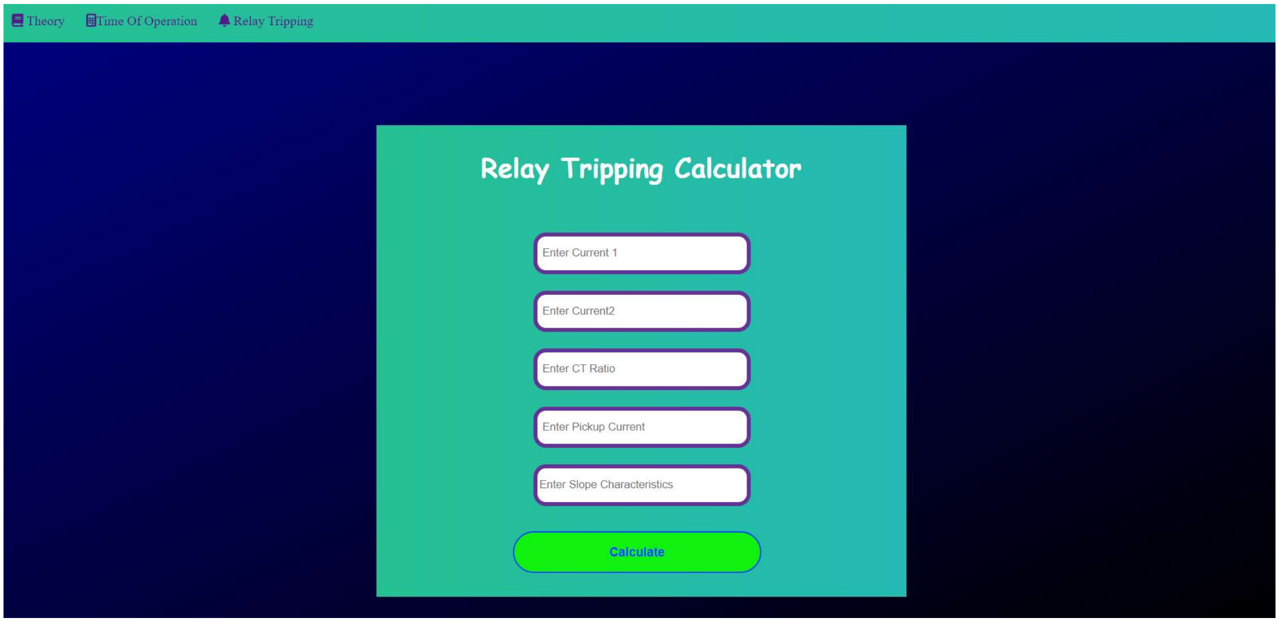
$= 4.2 \times 0.7$

$= 2.92$ seconds.

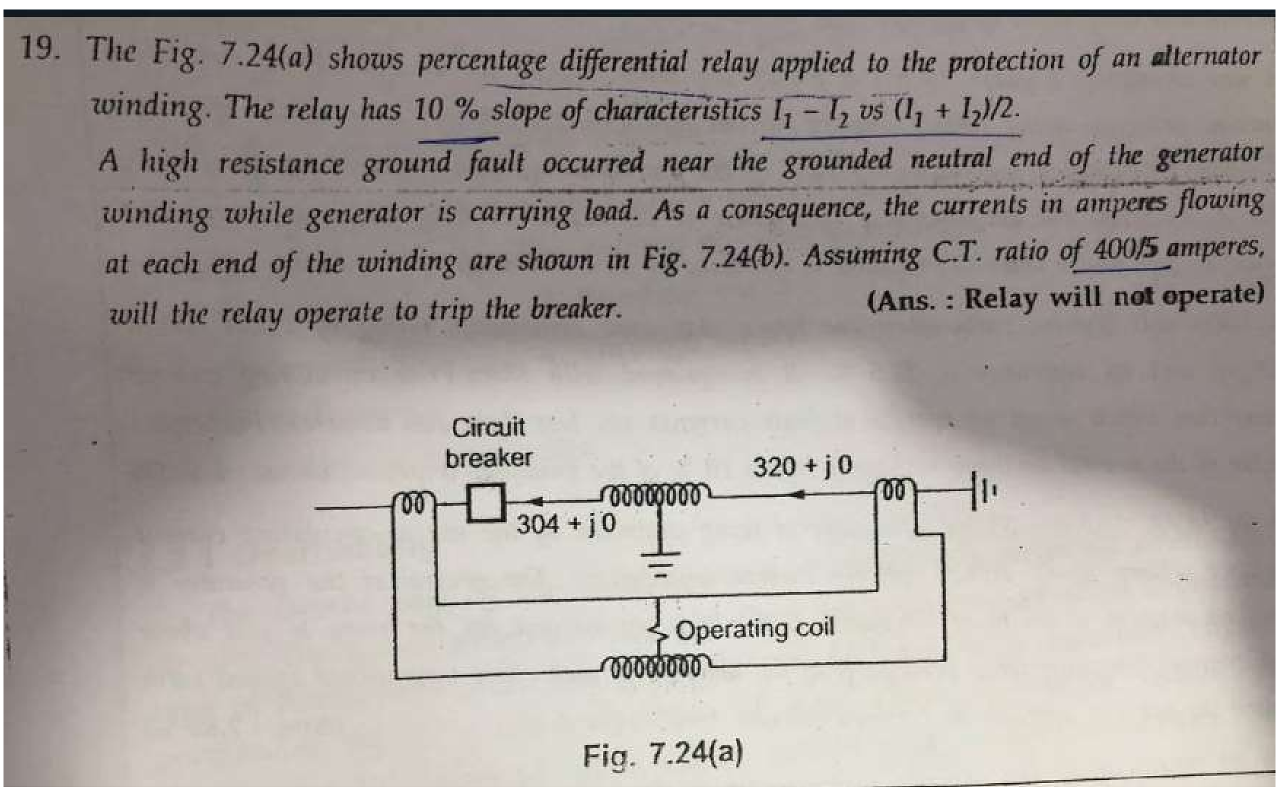
Observation:

We see that the time taken for relay to operate from simulation is 2.88A while the time taken for relay to operate from manual calculation is 2. 92A.We see that the time taken by relay to operate in both cases are close.

3) To find whether the relay will operate or not: It will take parameters like Current 1, Current 2, CT Ratio, Pickup Current, and Slope Characteristics and calculate whether the relay will operate.



Problem Statement to check whether the differential relay will operate:

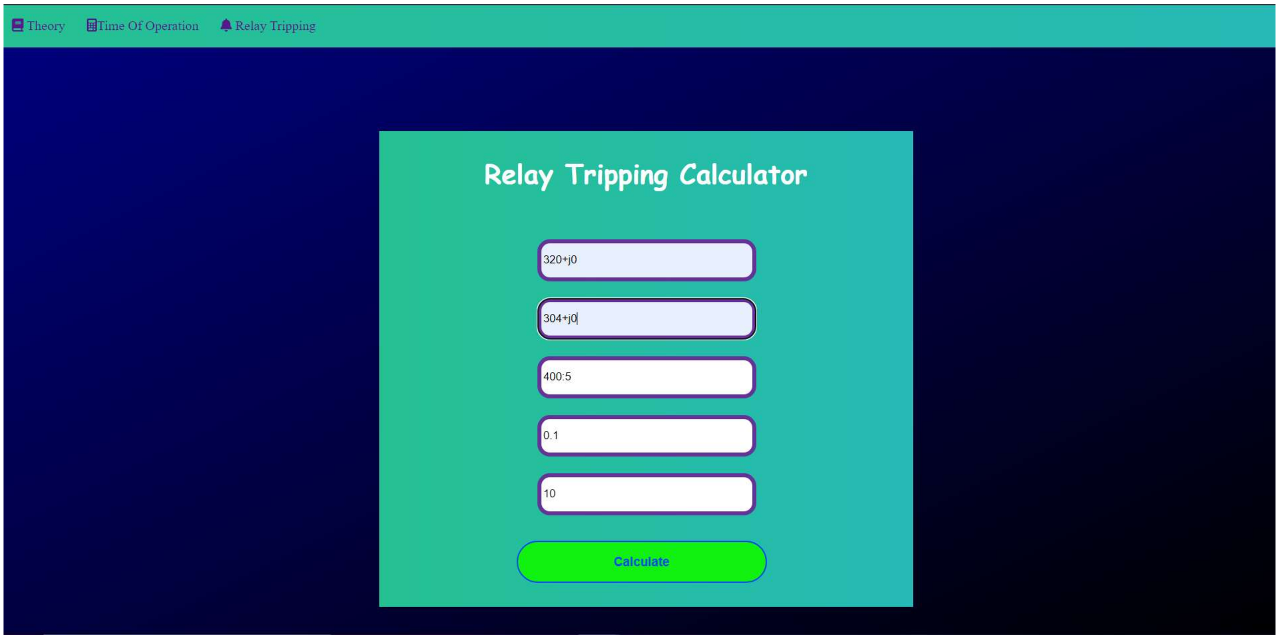


19. The Fig. 7.24(a) shows percentage differential relay applied to the protection of an alternator winding. The relay has 10 % slope of characteristics $I_1 - I_2$ vs $(I_1 + I_2)/2$.

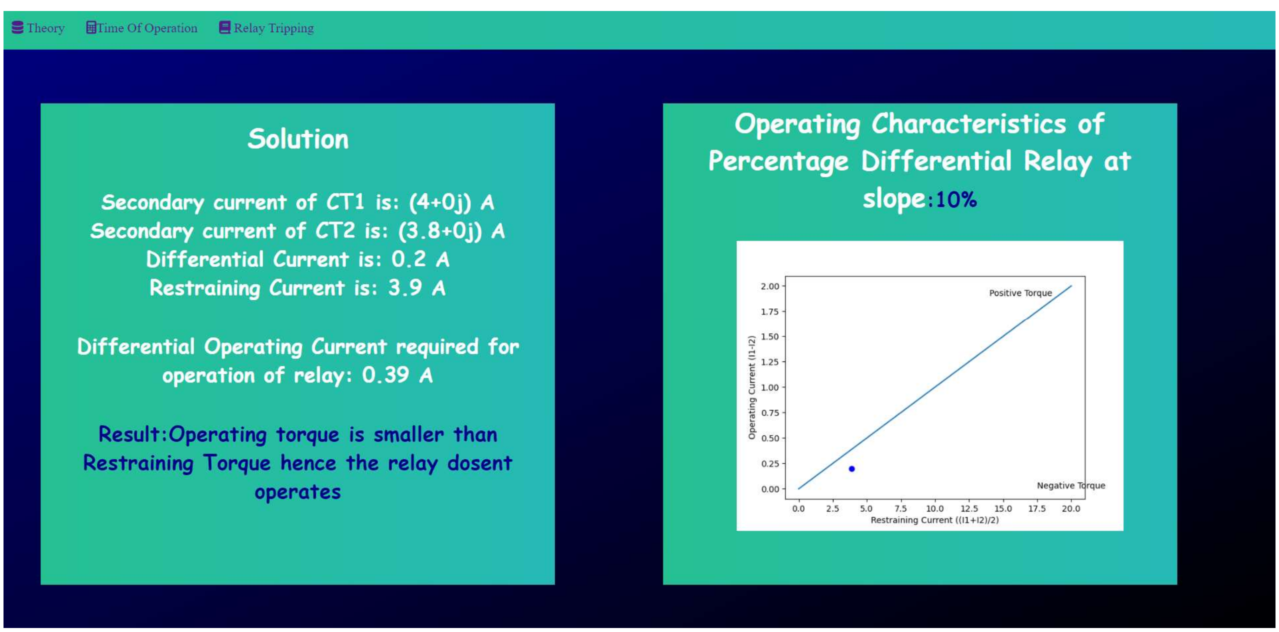
A high resistance ground fault occurred near the grounded neutral end of the generator winding while generator is carrying load. As a consequence, the currents in amperes flowing at each end of the winding are shown in Fig. 7.24(b). Assuming C.T. ratio of 400/5 amperes, will the relay operate to trip the breaker. **(Ans. : Relay will not operate)**

Fig. 7.24(a)

Implementation:



Output:



Manual Calculations:

Sol:

Given,

$I_1 = 320 + j0$

$I_2 = 304 + j0$

CT ratio = 400 : 5

Calculating the secondary currents,

$I_{S1} = 320 \times \frac{5}{400} = \cancel{3.75A}\ 4A$

$I_{S2} = 304 \times \frac{5}{400} = 3.8A$

Differential operating current,

$I_d = I_{S1} - I_{S2}$

$= (4 - 3.8) = 0.2A$

Restraining current,

$I_r = \frac{I_{S1} + I_{S2}}{2} = \frac{4 + 3.8}{2} = 3.9$

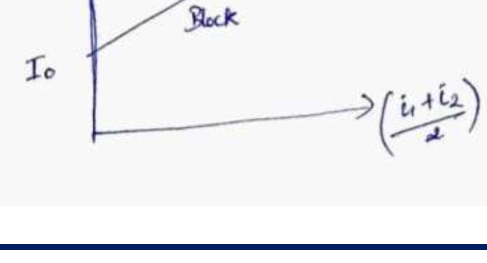
$\boxed{K = 0.1}$

The Id required for the operation of the relay corresponding to Ir is

$\cancel{as}$ 0.1×3.9

$= 0.39$

Since, Id = 0.2, the relay doesn't trip.



Observation:

We see that since point lies in negative torque so the relay does not operate which is also confirmed from manual calculations.

Video Demonstration:

https://drive.google.com/file/d/1SZk1phco1z6ZRRe-H7yBONwdzazVSUF7/view?usp=sharing