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Experiment #07

Aim :-

To determine the volume Magnetic Susceptibility of Manganese sulphate solution at different concentration.

theory :-

In electromagnetism, the magnetic susceptibility χ_m is a proportionality constant

$$\chi_m = \frac{M}{H} = \mu_r - 1$$

M = Magnetisation

H = applied field

μ_r = relative permeability

$$\chi_2 - \chi_1 = \frac{2gh(\rho - \sigma)}{\mu_0 H^2 m}$$

Observation table :-

Setup 1

Current	Magnetic field B (Gauss)
0.5A	0.113
1A	0.227
1.5A	0.340
2A	0.453
2.5A	0.567
3A	0.680
3.5A	0.793
4A	0.907

Observation:

ferromagnetic have some permanent magnetic effect in presence of external magnetic field

when a external field is applied there is sudden jump that happens when domains to switch orientation that result in notable voltage spike this produces a current that produce sound in the system at current $i = \cancel{2}A\ 0.5A$

Molarity	Magnetic Susceptibility
0.5 M	9.13×10^{-6}
0.6 M	9.14×10^{-6}
0.7 M	9.16×10^{-6}
0.8 M	9.18×10^{-6}
0.9 M	9.20×10^{-6}
1.0 M	9.21×10^{-6}
1.1 M	9.23×10^{-6}
1.2 M	9.25×10^{-6}
1.3 M	9.27×10^{-6}
1.4 M	9.28×10^{-6}
1.5 M	9.30×10^{-6}

Barkhausen effect

Aim :- to understand the barkhausen effect on ferromagnetic material

Apparatus :-
~~an~~ circular coil, ferromagnetic material, bar magnet, speaker, connecting wire etc.

theory :-
A ferromagnetic have a spontaneous magnetic moment. the atoms (or molecules) ferromagnetic material have a net intrinsic magnetic dipole moment which is primarily due to spin of electron.

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	Current Registered	Power across Inductor		Power across Resistor		Power across source	
		Real	Reactive	Real	Reactive	Real	Reactive
1.	0.037A	0	3.85	3.89	≈ 0	3.881	3.85
2.	0.0074A	0	0.7	0.7791	≈ 0	0.776	0.7707
3.	0.0037A	0	0.385	0.389	≈ 0	0.3881	0.385

Now, for capacitor

$R = \frac{1}{\omega C}$ (Resistor of capacitor)

$= \frac{1}{2\pi f C}$

$R = \frac{1}{(314)C}$

	Current Registered (RMS)	Power across capacitor	Power across Resistor	Power across sources
1.	0.04303	-0.0238 - 6.917	2.166 ≈ 0	2.142 - 6.925
2.	0.04041	-0.042 - 6.221	2.897 ≈ 0	2.85 - 6.221
3.	0.03783	-0.075 - 5.45	3.52 ≈ 0	3.27 - 6.45

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LAB#2

objective:-

on Simulink, design a circuit with Y connected 3-phase AC sources (220V, 50Hz) and Y connected 3-phase RLC branch and perform the following activities:

(1) connect the three AC sources (with difference in phase 120° each) in Y configuration.

(2) connect the current meter in phase A. measure and display the RMS value of current.

(3) connect the voltage meter across phase A, measure and display the RMS value of phase voltage.

(4) connect the power meter in phase A and measure the real and reactive power.

(5) connect the voltage meter across phase A and phase B measure and display the RMS value of line voltage.

(6) connect the 3 phase V-I measurement tool to the 3-phase sources and three phase RLC branch should be Y-connected.

(7) connect the 3-phase ~~V-I~~ voltage and current output to the 3-phase power measurement tool, display the 3-phase real and reactive power.

(8) connect the 3-phase voltage and current to the two port scope to observe the time-varying 3-phase voltage and currents.

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(9) Run the simulation and analyze the current, voltages and power displayed, verify the reading displayed as phase voltage and line voltage

(10) Record and report the same as observation for atleast 3 different choices of the parameter in the RLC branch

(11) observe time varying 3-phase I, V and P in scap ~~cor~~ correlate observed waveform on scope with values on display

(12) ~~display~~ list correlation b/w phase and line values, verify that total power in phase power say's is constant with time.

$I_{RMS}(Ph-A) = 155.6V$

$P_{RMS}(Ph-A) = 175.1W$

$Q_{RMS}(Ph-A) = 66.83\,VAR$

$V_{LL}(RMS)(Ph-A-B) = 269.4$

$R = 100\Omega$

$X_L = 100\Omega$

$L = \frac{X_L}{\omega} = 0.3185\,H$

		RMS		Single phase				three phase	
	R(Ω)	L(H)	VAB(V)	VAB	IAΦ	PAΦ	QAΦ	P3Φ	Q3Φ
1.	100	0.3185	269.4	155.6	1.41	175.11	66.8	7.02	0
2.	200	0.637	269.4	155.6	0.91	1.05	15.94	3.51	0
3.	300	0.955	269.4	155.6	0.76	81.69	-1.022	2.34	0

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LAB 03

Objective :-

Design a circuit with AC source, Series RLC branch and a Series RLC load.

① connect AC sources to series RLC branch and a series RLC load.

② connect Series RLC branch as RL and RLC load as RL load

③ connect current meter to measure display RMS values of current in the circuit.

④ connect voltage meter across source and load, measure and display RMS value of phase voltage.

⑤ connect power meter to source and load measure real and reactive powers displays it.

⑥ find difference of real power supplied to ~~boat~~ load from Source.

⑦ Calculate power factor of the load $\left[\frac{\text{Real power}}{\text{Apparent power}}\right]$

⑧ Run simulator and analyze values displayed, value of power factor.

⑨ Now, to enhance the power factor, connect a load capacitor in parallel with the RL load.

⑩ Run Simulator and analyze the changes. in the value displayed. Is the power factor increasing / decreasing?

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→ for AC source $V_{peak} = 311 volt$

$f = 50 Hz$

→ for RLC Branch

$R = 100 \Omega$

$L = 0.316 H$

$C = 0F$

for RLC load

$R = 200 \Omega$

$L = 0.636 H$

$C = 0F$

→ $i_{rms} = 0.5508$ Amp

→ $(V_{rms})_{load} = 150.7$ volt | $(V_{rms})_{source} = 225.8$ volt

→ Source

$P_{real} = 37.7$ watt

$P_{reactive} = 72.74$ VAR

load

$P_{real} = 58.47$ watt

$P_{reactive} = 48.59$ VAR

→ $(P_{real})_{source} - (P_{real})_{load}$

⇒ $37.7 - 58.47$

⇒ 29.23 watt

→ apparent power $= \sqrt{(P_{real})^2 + (P_{reactive})^2}$

$= \sqrt{(58.47)^2 + (48.59)^2}$

$= 76.02$ V-Amp

so,

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so, $\cos\theta$ = Power factor of the load $= \frac{P_{real}}{P_{apparent}} = \frac{58.47}{76.02} = 0.768$

→ I take $C = 10^{-4}$ F

then,

i_{real} = 109.2 watt → $P_{apparent}$ = 110.61 VA

P_{real} = -17.65 V.A.R

$\cos\theta = p.f = \frac{P_{real}}{P_{app}} = \frac{109.2}{110.61} \approx 0.98$

→ when, C increase (↑) → power factor increase (↑)

C decreases (↓) → power factor decrease (↓)

SNO	C	L	R	$P_{real} = P$	$P_{reactive} = Q$	$P_{app} = \sqrt{P^2+Q^2}$	$\cos\theta = \frac{P}{P_{app}}$
	10^{-6}	0.636	200	59.39	49.69	77.43	0.76
	10^{-5}	0.636	200	26.26	47.49	54.26	0.875
	10^{-4}	0.636	200	109.2	-17.65	110.61	~0.98
	10^{-2}	0.636	200	103.6	-0.1399	103.6008	~1

diagram not complete

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Experiment 04

A) • Voltage Source

$V_{max} = 480V$

frequency = 50 Hz

1) line current = 90.79 A

phase angle = -37.76

2) load voltage = 453.8 V

phase angle = ~~-37.76~~ 0.9128

3) Phase difference = between line current and voltage source

= -37.76 - 0

= -37.76

4) phase difference between load current and load voltage

= 37.76 - 0.9128

= -38.6728

5) power loss in transmission line = 14.84 watt

6) voltage drop across line impedance = 27.25 V

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B) suppose a 1:10 step up transformer is placed at the generator end of the transmission line and 10:1 step down transformer is placed at the load end of the line.

1) source current = 96.05 A | Phase angle (source) = -36.86
line current = 9.605 A | phase angle (line) = -36.86
load current = 95.98 A | phase angle (load) = -36.86

2) load voltage = 479.7 V   phase angle = -0.0097

3) phase difference between line current & source voltage = -36.86 - 0 = -36.86

4) phase difference b/w line current and source voltage = 36.86 - 0 = 36.86

5) phase difference b/w load current and load voltage = -36.85 + 0.0097 = -36.8403

6) powerloss in transmission line = 16.6 watt

7) voltage drop across the line impedance = 2.882 V

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[C] we can see that in part (A), powerloss is 1484 watt ~~from~~ the while in part [B], it is 180 watt, from this we can see that the powerloss decreases by using the transformer so we can conclude, by using transformers, we can reduce the power factor.

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LAB-5

→ Objective :- To ~~get~~ compute the value of X_m, R_c, R_s, X_s for a open and closed circuit circuit transformer.

→ Performing open circuit :-

$V_{oc} \Rightarrow 7998$ volt

$I_{oc} \Rightarrow 0.01042$ A

$P_{oc} \Rightarrow 59.3$ watt

calculating p.f

$$P.F = \cos\theta = \frac{P_{oc}}{V_{oc} I_{oc}} = \frac{59.3}{7998 \times 0.01047}$$

$$\cos\theta = 0.7 \rightarrow \text{lagging}$$

$$\theta = 45.57$$

$$Y_E = \frac{I_{oc}}{V_{oc}} \angle -\theta \Rightarrow 1.63 \times 10^{-6} \angle -45.57^\circ$$

$$Y_E \Rightarrow 1.36 \times 10^{-5} (\cos(+45.57) - \sin(\angle -45.57^\circ))$$

$$\boxed{Y_E \Rightarrow \frac{1}{R_C} - \frac{j1}{X_m}} \; : \downarrow$$

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$$\boxed{R_c = \frac{1}{Y_e \cos\theta} \; .1099\,k\Omega}$$ ans

$$\boxed{X_m = \frac{1}{Y_e \sin\theta} \Rightarrow 1077\,k\Omega}$$ ans

→ calculated value

Expected value
$R_c = 1.08\times10^6\,\Omega$
$L = 2866H$

$$\boxed{L \Rightarrow \frac{X_m}{2\pi f} = 2856\ H}$$

Short circuit →

$V_{sc} = 1.07\times10^5 = 107000$

$I_{sc} = 344.1$

$P_{sc} = 1.14\times10^6 = 1140000$

$$\boxed{\theta = \cos^{-1}\left(\frac{P_{sc}}{V_{sc}.I_{sc}}\right)} = \cos^{-1}(0.0309) =$$

$= 10539891$

Z_{sc}

↳ $\frac{V_{sc}}{I_{sc}} = \frac{107000}{344.1} = 310.956$ → (same current = ?)

$Z_{sc} = 310.956\times\cos(1.539) + j(310.956\times\sin(1.539))$

$= \underbrace{9.60866}_{R_{eq}} + j\,\underbrace{(310.8075)}_{X_{eq}}$

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$\underbrace{a = 2.34}$ → $1.852 = R_p/\text{turn}$

$\underbrace{R_{eq}}_{9.60866} = 4.318 + (2.34)^2(x))$

$5.28686 = (2.34)^2(x)$

$\Rightarrow \boxed{x = 0.9655}$ ← given

OCM

$V_{oc} = 7.644 \times 10^5$

$I_{oc} = 1.127$

$P_{oc} = 5.837 \times 10^5 = 583700$

$\cos\theta = \frac{P_{oc}}{V_{oc} I_{oc}} = \frac{5.837}{7.644 \times 1.127} = \boxed{0.677}$ → $\cos^{-1}(0.677) = 0.8271 = \theta$

$Y_0 = \frac{I_{oc}}{V_{oc}} = 0.1474 \times 10^{-5}$

$= (0.1474 \times 10^{-5})(0.677) + (0.1474 \times 10^{-5})(0.1096)$

$= (0.0997) \times 10^{-5} + (-0.01615504)$

$\frac{1}{R_c} = 0.0997 \Rightarrow \boxed{10 = R_c} \times 10^5$

$\boxed{X_m = 61.9 \times 10^6}$

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LAB-6

Objective :-

Perform simulation of DC motor under varying load condition.

Value taken :-

Model : 5HP 240V, 1750 RPM field = 300V

In step block :-

Ist step block - step time = 2 Initial value = 0

(20% of Maximum)

final value = $\left[\frac{5\times746\times60}{2\times\pi\times1750}\right]\times0.2$

II^{2nd} step block - step time = 2

final value = $\left(\frac{5\times746\times60}{2\pi\times1750}\right)\times0.5$ (50% of Max)

IIIrd step block - step time = 6 initial value = $\frac{5\times746}{2\pi\times1750}$

final value (T_{FL}) = $\frac{5\times746\times60}{2\pi\times1750}$ (maximum)

$$T_{FL} = \frac{P_{mech}}{\omega_m}$$

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using bus selector

(i) speed (ωm) = 1409 rad/s
(ii) Electrical torque = 35.55 nm
(iii) Armature current = 35.14A
(iv) field current = 1.067A

Observation:-
(i) Speed (ωm)
- we take applied no load at t = 0 and we have increased that till t = 2s upto 20% of maximum from t = 2s to t = 4s we have increased 20% to 50% of Maximum and after t = 4s ~~we have~~ we have applied ~~for~~ fullload.

- As we applied no load speed is close to base speed (1750 RPM) but as we have increased load, torque ~~sped~~ speed decreased and becomes constant where full load is applied.

~~(iii)~~ ~~Armat~~
(iii) Armature current (IA (A))
The armature current is increasing as we increase load torque.

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(iii) field current :-
the field current is constant as we increase load torque.

(iv) Electrical torque :-
It increase as as we increase load. torque is directly proportional to armature current and inversely proportional to speed.

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lab 7

Objective :-

Create and ~~exett~~ execute a Matlab Program that.

(a) Rotating magnetic fied

Description of Model to be created and Executed :-
If a three phase set of currents each of equal Magnitude and differing in phase by 120° flows in a three phase winding, then it will produce a Induced EMF.

Matlab Code :-

```
bmax = 1 ;
freq = 60 ;
w = 2 * Pi * freq;

t = 0.1/6000:1/60 ;
Baa = sin(w*t).* cos (0 )+ j * sin(0)))
Bbb = sin(w* t - 2* Pi/3).* cos (2* Pi /3) + j sin (2*Pi/3
Bcc = sin(w* t + 2* Pi/3).* ((cos (- 2* Pi/3) + j* sin(-2* Pi/3

Bnet = Baa + Bbb + Bcc ;
```

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lab 7

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freq = 60;
w = 2*pi*freq;

t = 0.1/6000:1/60;
Baa = sin(w*t).*cos(0)+j*sin(0)))
Bbb = sin(w*t - 2*pi/3).*cos(2*pi/3)+j sin(2*pi/3)
Bcc = sin(w*t + 2*pi/3).*((cos(-2*pi/3) + j* sin(-2*pi/3

Bnet = Baa + Bbb + Bcc ;
```

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```
circle = 1.5 * (cos(w* t) + j*sin (w* t)) ;
for ii = 1 : length (t)
      plot (circle , 'R');
       hold on ;

   plot ([0 real (Baa(11)] [0, mag( Baa(11))]
                'R' ;  Line width ' 2);

   plot([0 real (Bbb (11))], [0 mag (Bbb(11))]
              'b' ,  Line width ; 2);

   plot ([0 real (Bcc(11))] , [0 mag (Bcc(11))]
              'm' , '(me width', 2);

   plot ([0 real (Bnet (11))], [0 imag(Bnet(ii))]
            'r' , Line width', 3);

   axis square
   axis([-2 2 -2 2]);
   draw now ;
   hold off
```

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Description :-

$I_{a'a'}(t) = I_m \sin \omega t$

$I_{bb'}(t) = I_m \sin(\omega t - 120)$

$I_{cc'}(t) = I_m \sin(\omega t - 240)$

Magnetic field intensity varies so,

$B_{aa'}(t) = B_m \sin(\omega t) \angle 0^\circ$

$B_{bb'}(t) = B_m \sin(\omega t - 120^\circ) \angle 120$

$B_{cc'}(t) = B_m \sin(\omega t - 240^\circ) \angle 240^\circ$

$B_{net} = \vec{B_{aa'}} + \vec{B_{bb'}} + \vec{B_{cc'}}$

$(\Sigma \vec{B}_{net})_{max} = \frac{3}{2} B_m \angle 0^\circ = 1.5\, B_m$

Observation:-

(a) we swapped BCC' and BDD', we observerd that dirn of magnetic field's rotation was reversed.

(b) Magnetic field strength becomes ~~assy~~ assymetrical and contribution of highest amplitude is more in net magnetic field, dirn remains unchange

(c) we changed the phase angle, we observed that the varying phase angle alter the speed of Magnetic field, dirn remains unchanged. Sped was fast.

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(d) Increasing the frequency increases the speed while decreasing the frequency decrease the speed

(e) speed of rotation of Magnetic field increases.

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LAB # 08

Aim :- Create and ~~Exet~~ Execute a Matlab Program that models the Synchronous ~~Gen~~ Generator operating alone.

Matlab code :->

```
i_a = (0:1:20) * 3;
v_phase = zeros(1,21);
e_a = 277.0;
x_s= 1.0;
theta = 3687 *(pi/180);

for ii = 1.21
     vphase (ii)= Sqrt(e_a^2 - (x_s* i_a(ii)* cos(theta)
                    - (x_s* i_a(ii)* sin(theta))
end
v_t = vphase * sqrt (3);

plot(i_a, v_t, 'color', 'R', 'linewidth',2.0);
x label ('line current (A)', 'footweight', 'Bold');
y label ('terminal voltage(V);
title (' terminal characteristic for 0.8 PF lagging
        load', Fontweight, 'Bold');
grid on;
axis([0 60 400 650]);
```

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observation :-

→ with a lagging Power factor, the terminal voltage decreases as line current increases this result in a negative slope.

→ with a leading Power factor, the terminal voltage increases as time constant increases this result in a positive slope.

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