Load Test on Single - Phase Squirrel Cage Induction Motor

Aim:
To conduct the load test on single phase squirrel cage induction motor and to draw the performance characteristics curves.

NAME PLATE DETAILS:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the Apparatus</th>
<th>Type</th>
<th>Range</th>
<th>qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ammeter</td>
<td>MI</td>
<td>(O-20)A</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>voltmeter</td>
<td>MI</td>
<td>(0-300)v</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Capacitor</td>
<td>Electrolytic</td>
<td>440V/20Mfd</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Wattmeter</td>
<td>UPF</td>
<td>(300V,10A)</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Fuse Rating:
125% of rated current (Full load current)

Apparatus required:

Formulae used:
1. Torque \[= (S_1 \approx S_2) (R+t/2) \times 9 \text{, } 81 \text{ N-m.}\]
   i. \(S_1\), \(S_2\) – spring balance readings in Kg.
   ii. \(R\) – Radius of the brake drum in m.
   iii. \(T\) – Thickness of the belt in m.
2. Output power \[= 2\pi NT/60 \text{ Watts}\]
   i. \(N\) – Rotor speed in rpm.
   ii. \(T\) – Torque in N-m.
3. Input power \[= W\]
   i. \(W\) – Wattmeter readings in watts.
4. Percentage of efficiency \[= (\text{Output power}/\text{Input power}) \times 100\%\]
5. Percentage of slip \[= (N_s - N)/N_s \times 100\%\]
   i. \(N_s\) – Synchronous speed in rpm.
   ii. \(N\) – Speed of the motor in rpm.
6. Power factor (\(\cos \phi\)) \[= \text{Input power}/V_LI_L\].
Precaution:

i. The autotransformer should be kept at minimum voltage position
ii. The motor is started without any load

Procedure:

1. Note down the name plate details of motor.
2. Connections are made as per the circuit diagram.
3. The DPSTS is closed and the autotransformer is adjusted to obtain the rated speed.
4. At no load the speed, current, voltage and power are noted.
5. By applying the load, for various values of current the above-mentioned readings are noted.
6. The load is later released and the motor is switched off and the graph is drawn.

Tabulation for load test on single phase squirrel cage induction motor

<table>
<thead>
<tr>
<th>S. no</th>
<th>Load current ((I_L))</th>
<th>Load voltage ((V_L))</th>
<th>Input power ((W))</th>
<th>Speed of the motor ((N))</th>
<th>Spring balance reading (T) ((s_1\sim s_2)) (R+\frac{v}{2}) ((9.81))</th>
<th>Torque ((T)) ((s_1\sim s_2)) (R+\frac{v}{2}) ((9.81))</th>
<th>Output power (2\pi NT/60)</th>
<th>Efficiency (\eta) (\text{o/p} / \text{i/p} \times 100)</th>
<th>Slip (S) ((N_s-N) / N_s \times 100)</th>
<th>Power factor ((\cos\phi)) (\text{i/p} / V_L I_L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Watts</td>
<td>Watts</td>
<td>rpm</td>
<td>Kg</td>
<td>Kg</td>
<td>Kg</td>
<td>N-m</td>
<td>Watts</td>
</tr>
</tbody>
</table>
Observation:
Circumference of the brake drum = Thickness of the belt =

Model graph:
The graph drawn for
i. Output power Vs speed
ii. Output power Vs line current
iii. Output power Vs Torque
iv. Output power Vs power factor
v. Output power Vs Efficiency
vi. Output power Vs %slip.

- Mechanical Characteristics

- Electrical Characteristics

MODEL CALCULATION:

RESULT:

INFERRENCE:
The maximum efficiency of the induction motor
EQUIVALENT CIRCUIT OF SINGLE PHASE SQUIRREL CAGE INDUCTION MOTOR

AIM:
To conduct the No load test and blocked Rotor test on Single Phase Induction Motor and to draw the equivalent circuit

Name plate Details:

1 Φ Induction Motor Auto transformer

Fuse Rating:

No load: 10% of rated current (Full load current)
Load: 125% of rated current (Full load current)

Apparatus Required:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Name of the apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-20)A</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-150)V</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-300)V</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Voltmeter</td>
<td>MC</td>
<td>(0-50)V</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>Wattmeter</td>
<td>LPF</td>
<td>(300V,10A)</td>
<td>1</td>
</tr>
<tr>
<td>8.</td>
<td>Wattmeter</td>
<td>UPF</td>
<td>(150V,10A)</td>
<td>1</td>
</tr>
<tr>
<td>9.</td>
<td>Capacitor</td>
<td>Electrolytic</td>
<td>440V/20Mfd</td>
<td>1</td>
</tr>
<tr>
<td>10.</td>
<td>Tachometer</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Formulae Used:

Open Circuit Test

1. No load power factor \((\cos \phi_o) = \frac{W_{oc}}{V_o I_o}\)
   Where \(V_o = \text{No load voltage in volts}\)
   \(I_o = \text{Load current in Amps}\)
   \(W_{oc} = \text{No Load power in watts}\)

2. Working component current \((I_W) = I_o \times \cos \phi_o\)
3. Magnetizing current \((I_M) = I_o \times \sin \phi_o\)
4. No load resistance \(R_o = \frac{V_o}{I_o \times \cos \phi_o} \text{ in } \Omega\)
5. No load reactance \(X_o = \frac{V_o}{I_o \times \sin \phi_o} \text{ in } \Omega\)
Short Circuit Test

1. Motor equivalent impedance referred to stator (Zsc) = Vsc / Isc in Ω
2. Motor equivalent resistance referred to stator (Rsc) = Wsc / I²sc in Ω
3. Motor equivalent reactance referred to stator (Xsc) = √(Zsc² – Rsc²) in Ω
4. Rotor resistance referred to stator (R2’) = Rsc – R1 in Ω
5. Rotor reactance referred to stator (X2’) = Xsc / 2 = X1 in Ω

   Where
   
   R1 = R (ac) = 1.6 x R (dc)

6. Magnetizing reactance (Xm) = 2(Xo – X1 – X2’ / 2)
7. Slip (S) = (Ns-N) / Ns

Where:

Ns – Synchronous speed in rpm
N – Speed of the motor in rpm.

PRECAUTION:
The autotransformer should be kept at minimum voltage position

PROCEDURE:

Note down the name plate details of motor.

1. For no-load or open circuit test by adjusting autotransformer, apply rated voltage and note down the ammeter and wattmeter readings. In this test rotor is free to rotate.
2. For short circuit or blocked rotor test by adjusting autotransformer, apply rated current and note down the voltmeter and wattmeter readings. In this test rotor is blocked.
3. After that make the connection to measure the stator resistance as per the circuit diagram
4. By adding the load through the loading rheostat note down the ammeter, voltmeter reading for various values of load

Tabulation for no load test on single phase squirrel cage induction motor

Speed of the induction motor: .........................
Multiplication factor: .........................

<table>
<thead>
<tr>
<th>S no</th>
<th>Open circuit Voltage (Vo)</th>
<th>Open circuit Current (Io)</th>
<th>Open circuit power (Woc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volts</td>
<td>Amps</td>
<td>Watts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tabulation for short circuit test on single phase squirrel Cage induction motor

Multiplication factor: …………………….

<table>
<thead>
<tr>
<th>S no</th>
<th>Short circuit Voltage (Vsc)</th>
<th>Short circuit Current (Isc)</th>
<th>Short circuit power (Wsc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volts</td>
<td>Amps</td>
<td>Watts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Actual</td>
</tr>
</tbody>
</table>

Measurement of armature resistance

![Diagram of armature resistance measurement](image.png)

Tabulation to find out the stator resistance (r₁)

<table>
<thead>
<tr>
<th>S no</th>
<th>Stator current (I)</th>
<th>Stator Voltage (V)</th>
<th>Stator Resistance R₁= V/I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Ohms</td>
</tr>
</tbody>
</table>
MODEL CALCULATION;

RESULT;
Equivalent Circuit of Three Phase Squirrel Cage Induction Motor

Aim: To conduct the No Load test and Blocked rotor on three phase squirrel cage induction Motor

Name plate details:

3 φ INDUTION MOTOR

AUTOTRANSFORMER

Fuse Rating calculation:

No Load: 10% of rated current (Full load current)

Load: 125% of rated current (Full load current)

Apparatus required:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the Apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-100)A</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-150)V</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-600)V</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Voltmeter</td>
<td>MC</td>
<td>(0-50)V</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Wattmeter</td>
<td>LPF</td>
<td>(600V,10A)</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Wattmeter</td>
<td>UPF</td>
<td>(150V,10A)</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Formulae used:

Open circuit test:
No load power factor \((\cos \phi_o)\) \(= \frac{P_o}{V_o I_o}\)
Working component current \((I_W)\) \(= I_o(\text{ph}) \times \cos \phi_o\)
Magnetizing current \((I_M)\) \(= I_o (\text{ph}) \times \sin \phi_o\)
No Load resistance \((R_o)\) \(= \frac{V_o}{I_o (\text{ph}) \cos \phi_o}\) in \(\Omega\)
No load reactance \((X_o)\) \(= \frac{V_o}{I_o (\text{ph}) \sin \phi_o}\) in \(\Omega\)

Where:
\(V_o\) – No load voltage per phase in volts
\(I_o\) – no load current per phase in amps
\(P_o\) – no load power per phase in watts
**Short circuit test:**

Motor equivalent impedance referred to stator \( (Z_{sc} \text{ (ph)}) \) = \( \frac{V_{sc} \text{ (ph)}}{I_{sc} \text{ (ph)}} \) in \( \Omega \)

Motor equivalent resistance referred to stator \( (R_{sc}(\text{ph})) \) = \( \frac{P_{sc}(\text{ph})}{I_{sc}^2} \) in \( \Omega \)

Motor equivalent reactance referred to stator \( (X_{sc}(\text{ph})) \) = \( \sqrt{(Z_{sc}(\text{ph})^2 / R_{sc} \text{ (ph)}^2)} \) in \( \Omega \)

ROTOR resistance referred to stator \( (R'_2 \text{ (ph)}) \) = \( R_{sc}(\text{ph}) - R_1 \) in \( \Omega \)

Rotor reactance referred to stator \( (X'_2 \text{ (ph)}) \) = \( \frac{X_{sc}(\text{ph})}{2} = X_1 \) in \( \Omega \)

Equivalent load resistance \( (R'_L) \) = \( R'_2 \left( \frac{1}{s-1} \right) \) in \( \Omega \)

Where:
- \( R_1 \) – stator resistance per phase
- \( X_1 \) – stator reactance per phase
- \( R_1 = R \text{ (ac)} = 1.6 \times R \text{ (dc)} = R'_2 \left( \frac{1}{s-1} \right) \) in \( \Omega \)
- Slip \( (S) = \frac{(N_s - N)}{N_s} \)
- \( N_s \) – Synchronous speed in rpm
- \( N \) – Speed of the motor in rpm

**Precaution:**

The autotransformer should be kept at minimum voltage position.

**Procedure:**

Note down the name plate details of motor.

1. For no-load or open circuit test by adjusting autotransformer, apply rated voltage and note down the ammeter and wattmeter readings. In this test rotor is free to rotate.
2. For short circuit or blocked rotor test by adjusting autotransformer, apply rated current and note down the voltmeter and wattmeter readings. In this test rotor is blocked.
3. After that make the connection to measure the stator resistance as per the circuit diagram
4. By adding the load through the loading rheostat note down the ammeter, voltmeter reading for various values of load

**Tabulation for No load test on three phase squirrel cage induction**

<table>
<thead>
<tr>
<th>S. No</th>
<th>No load Current ((I_0))</th>
<th>No Load Voltage ((V_0))</th>
<th>No load power</th>
<th>Total No Load Power (P_o)</th>
<th>No load Power / Phase (P_o) [(Po/3)]</th>
<th>No load Current / Phase (I_0) ((ph))</th>
<th>No load Voltage / Phase (V_0) ((ph))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amps</td>
<td>Volts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Amps</td>
<td>Volts</td>
</tr>
<tr>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tabulation for blocked rotor test on three phase squirrel cage induction

Type of the stator connection: …………… Multiplication factor: …………

<table>
<thead>
<tr>
<th>S. No</th>
<th>Short Circuit Current (I_sc)</th>
<th>Short Circuit Voltage (V_sc)</th>
<th>Short Circuit power</th>
<th>Total Short Circuit power / phase P_sc (ph) = (W1+W2)</th>
<th>Short Circuit Current / phase I_sc (ph)</th>
<th>Short Circuit Voltage / phase V_sc (ph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
</tr>
</tbody>
</table>

Measurement of armature resistance

220V, DC Supply

Variable resistive load

Tabulation to find out the stator resistance (r_s)

<table>
<thead>
<tr>
<th>S No</th>
<th>Stator current (I)</th>
<th>Stator Voltage (V)</th>
<th>Stator Resistance R_s = V/I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Ohms</td>
</tr>
</tbody>
</table>
MODEL CALCULATION:
Equivalent circuit of 1φ induction motor

RESULT:
V and Inverted V Curves of Three Phase Synchronous Motor

**AIM:** To draw the V and inverted V curves of three phase Synchronous Motor.

**Name plate details:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>3φ Synchronous motor</td>
<td>DC Excitation</td>
</tr>
</tbody>
</table>

**Fuse rating calculation:**

125 % of rated current (full load current)

For DC Excitation:

For Synchronous motor:

**Apparatus required:**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of the Apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-2)A</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-600)V</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Power factor meter</td>
<td>Double Element</td>
<td>(500V,10A)</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Rheostat</td>
<td>Wire Wound</td>
<td>(500Ω,1.2A)</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>
Circuit diagram of V and Inverted V Curves for Three Phase Synchronous Motor

Tabulation for V-curve and inverted V-curve of three phase synchronous motor

<table>
<thead>
<tr>
<th>S. No</th>
<th>Without Load</th>
<th>With Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excitation Current (Ir)</td>
<td>Armature Factor (Ia)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Precaution:
1. The potential divider should be in the maximum position.
2. The motor should be started without any load.
3. Initially TPST switch is open position.
Procedure:
1. Note down the name plate details of motor.
2. Connections are made as per the circuit diagram.
3. Close the TPST switch.
4. By adjusting the autotransformer from minimum position to maximum position the rated supply is given to the motor. The motor starts as an induction motor.
5. In order to give the excitation to the field for making it to run as the synchronous motor close the DPST switch.
6. By varying the field rheostat note down the excitation current, armature current and the power factor for various values of excitation.
7. The same process has to be repeated for loaded condition.
8. Later the motor is switched off and graph is drawn.

Graph:
The drawn for
i. Armature current Vs Excitation current
ii. Power factor Vs Excitation current.

Model Graph
1. Excitation current Vs Armature current

2. Excitation current Vs Power factor
Model calculation:

Result:
Predetermination of Regulation of Three Phase Alternator by EMF and MMF Methods

AIM:
To predetermine the regulation of three phase alternator by EMF and MMF method and also to draw the vector diagrams.

Name plate details:

<table>
<thead>
<tr>
<th>3φ Alternator</th>
<th>DC Shunt Motor</th>
</tr>
</thead>
</table>

Fuse rating:

125 % of current (Full load current)

For dc shunt motor.

For alternator

Apparatus required:

<table>
<thead>
<tr>
<th>s. no</th>
<th>Name of the apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-2)A</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-5)A</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-600)V</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Voltmeter</td>
<td>MC</td>
<td>(0-150)V</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>Rheostat</td>
<td>Wire Wound</td>
<td>(500Ω,1.2A)</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>Rheostat</td>
<td>Wire Wound</td>
<td>(300Ω,1.7A)</td>
<td>1</td>
</tr>
<tr>
<td>9.</td>
<td>Tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Formulæ used:

Emf method:

Armature resistance Ra = 1.6 Rdc where - Rdc is the resistance in DC supply.
Synchronous impedance Zs = Open circuit voltage (E1 (ph))/short circuit current (Isc)
Synchronous impedance Xs = √(Zs²-Ra²)
Open circuit voltage Eo = √((Vrated cosφ + Ia Ra)² + (Vrated sinφ + Ia Xs)²)(For lagging power factor)

Open circuit voltage Eo = √((Vrated cosφ + Ia Ra)²+(Vrated sinφ - Ia Xs)²) (For leading power factor)
Open circuit voltage Eo = √((Vrated cosφ + Ia Ra)²+( Ia Xs)²) (For unity power factor)
Percentage regulation  \[= \left(\frac{E_o - V_{\text{rated}}}{V_{\text{rated}}}\right) \times 100\] (For both EMF and MMF methods)

**Precaution:**

i. The motor field rheostat should be kept in the minimum resistance position.
ii. The alternator field potential divider should be in the maximum voltage position.
iii. Initially all switches are in open position.

**Procedure for both emf and MMF method:**

1. Note down the nameplate details of motor and alternator.
2. Connections are made as per the circuit diagram.
3. Give the supply by closing the dust switch.
4. Using the three point starter, start the motor to run at the synchronous speed by varying the motor field rheostat.
5. Conduct an open circuit test by varying the potential divider for various values of field current and tabulate the corresponding open circuit voltage readings.
6. Conduct a short circuit test by closing the TPST switch and adjust the potential divider to set the rated armature current, tabulate the corresponding field current.
7. Conduct a stator resistance test by giving connection as per the circuit diagram and tabulate the voltage and current readings for various resistive loads.

**Procedure to draw the graph for EMF method:**

1. Draw the open circuit characteristics curve (generator voltage per phase Vs field current)
2. Draw the short circuit characteristics curve (short circuit current Vs field current)
3. From the graph find the open circuit voltage per phase \(E_1 \text{ (ph)}\) for the rated short circuit current \(I_{sc}\).
4. By using respective formulae find the \(Z_s, X_s, E_o\) and percentage regulation.

**Open circuit test:**

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Field current (I_f)</th>
<th>Open circuit line voltage (V_{OL})</th>
<th>Open circuit phase voltage (V_{O(ph)})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Volts</td>
</tr>
</tbody>
</table>
Circuit diagram – Regulation of Alternator by EMF method
Short circuit test:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Field current(I_f)</th>
<th>Short Circuit Current (120 to 150 % of rated current ) (Isc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Amps</td>
</tr>
</tbody>
</table>

Tabulation to find out the armature resistance (ra):

<table>
<thead>
<tr>
<th>S.No</th>
<th>Armature current (I)</th>
<th>Armature voltage (V)</th>
<th>Armature Resistance Ra=V/I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Ohms</td>
</tr>
</tbody>
</table>

Procedure to draw the graph for MMF method:

1. Draw the open circuit characteristics curve (generator voltage per phase Vs field current)
2. Draw the short circuit characteristics curve (short circuit current Vs field current)
3. Draw the line OL to represent I_f’ which gives the rated generated voltage (V).
4. Draw the line LA at an angle (90±Φ) to represent I_f” which gives the rated full load current (Isc) on short circuit [(90±Φ) for lagging power factor and (90- Φ) for leading power factor].
5. Join the points O and A and find the field current (I_f) measuring the distance OA that gives the open circuit voltage (E_o) from the open circuit characteristics.
6. Find the percentage regulation by using suitable formula.

Procedure to draw the vector diagram:

1. Draw the line OA that represents the rated voltage V.
2. Draw the line OB to represent the rated current Ia, which makes an angle Φ (it may lags/leads in phase) with the voltage.
3. Draw the line AC to represent IRa drop, which is parallel to current axis (OB)
4. Draw the perpendicular line CD with the line AC (IRa drop) to represent IXs drop.
5. Join the points D and A to represent the IZs drop.
6. Join the points O and D and measure the length OD by voltage scale to find open circuit voltage E_o.
7. Find the percentage regulation by using suitable using formulae.

Model calculation:
Result:
Inference:
RESULTANT TABULATION FOR REGULATION OF THREE PHASE ALTERNATOR
BY EMF AND MMF METHODS

<table>
<thead>
<tr>
<th>S.N o</th>
<th>Power factor</th>
<th>Percentage of Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EMF method</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lagging</td>
</tr>
<tr>
<td>1.</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MMF method</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lagging</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vector diagram</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lagging</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Predetermination of Regulation of Three Phase Alternator by ASA and ZPF Methods

Aim:
To predetermine the regulation of three phase alternator by Potier and ASA methods and also to draw the vector diagrams.

Name plate details:

<table>
<thead>
<tr>
<th>3 Φ Alternator</th>
<th>DC Shunt Motor</th>
</tr>
</thead>
</table>

Fuse rating:
125% of rated current
For DC shunt Motor:

For Alternator:

Apparatus required:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name Of The Apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-2)A</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-5)A</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-600)V</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Voltmeter</td>
<td>MC</td>
<td>(0-150)V</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Rheostat</td>
<td>Wire wound</td>
<td>500Ω,1.2A</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Rheostat</td>
<td>Wire wound</td>
<td>300Ω,1.7A</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Wattmeter</td>
<td>LPF</td>
<td>600V,10A</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Formulae used:

Precaution:

i. The motor field rheostat should be kept in the minimum resistance position.
ii. The alternator field potential divider should be in the maximum position.
iii. Initially all switches are in open position.
Procedure for both POTIER and ASA method:

1. Note down the name plate details of motor and alternator.
2. Connections are made as per the circuit diagram.
3. Give the supply by closing the DPST switch.
4. Using the Three Point Starter, start the motor to run at the synchronous speed by varying the motor field rheostat.
5. Conduct an Open Circuit Test by varying the Potential Divider for various values of Field Current and tabulate the corresponding Open Circuit Voltage readings.
6. Conduct a Short Circuit Test by closing the TPST switch and adjust the potential divider to set the rated Armature Current, tabulate the corresponding Field Current.
7. Conduct a ZPF test by adjusting the potential divider for full Load Current passing through either inductive or capacitive load with zero power and tabulate the readings.
8. Conduct a Stator Resistance Test by giving connection as per the circuit diagram and tabulate the Voltage and Current readings for various resistive loads.

Procedure to draw the POTIER triangle (ZPF method):

(All the quantities are in per phase value)

1. Draw the Open Circuit Characteristics curve (Generated Voltage per phase Vs Field Current) 
2. Mark the point A at X- axis, which is obtained from short circuit test with full load armature current.
3. From the ZPF test, mark the point B for the field current to the corresponding rated armature current and the rated voltage.
4. Draw the ZPF curve which passing through the point A and B in such a way parallel to the open circuit characteristics curve.
5. Draw the tangent for the OCC from origin (i.e.,) air gap line.
6. Draw the line BC from B towards Y-Axis, which is parallel and equal to OA.
7. Draw the parallel line for the tangent from C to the OCC curve.
8. Join the point B and D also drops a perpendicular line DE to BC.
9. Where the line DE represent armature leakage reactance (Ixl)
   a. Be represent armature reaction excitation (Ifa)

Procedure to draw the vector diagram (ZPF method):

1. Select suitable voltage current scale.
2. For the corresponding power angle (Lag, Lead, Unity) draw the voltage vector OA and current vector OB.
3. Draw the vector AC with the magnitude of IRA drop, which should be parallel to the vector OB.
4. Draw the perpendicular CD to AC from the point C with the magnitude of IXL drop.
5. Join the points O and D, which will be equal to the air gap voltage (Eair).
6. Find out the field current (IFE) for corresponding air gap voltage (Eair) from the OCC curve.
7. Draw the vector OF with the magnitude of IFE, which should be per perpendicular to the vector OD.
8. Draw the vector FG from with magnitude IFA in such away it is parallel to the current vector ob.
9. Join the points O and G, which will be equal to the field excitation current (IF)
10. Draw the perpendicular line to the vector OG from the point O and extend vector CD in such a manner to intersect the perpendicular line at the point H.

11. Find out the open circuit voltage (EO) for the corresponding field excitation current (if) from the OCC curve.

12. Find out the regulation from the suitable formula.

Procedure to draw the POTIER triangle (ASA method):
(All the quantities are in per phase value)

1. Draw the Open Circuit Characteristics curve (Generated Voltage per phase Vs Field Current).
2. Mark the point A at X-axis, which is obtained from short circuit test with full load armature current.
3. From the ZPF test, mark the point B for the field current to the corresponding rated armature current and the rated voltage.
4. Draw the ZPF curve which passing through the point A and B in such a way parallel to the open circuit characteristics curve.
5. Draw the tangent for the OCC from origin (i.e.,) air gap line.
6. Draw the line BC from B towards Y-axis, which is parallel and equal to OA.
7. Draw the parallel line for the tangent from C to the OCC curve.
8. Join the point B and D also drops a perpendicular line DE to BC.
9. Where the line DE represent armature leakage reactance (IXL)
   a. Be represent armature reaction excitation (IFA)
10. Extend the line BC towards the Y-Axis up to the point O. the same line intersects the air gap line at point G.
11. Mark the point I an Y-axis with the magnitude of Eair and draw the line from I towards OCC curve which should be parallel to X-axis. Let this line cut the air gap line at point h and the OCC curve at point F.
12. Measure the length of O G, HF and OA.

Procedure to draw the vector diagram (ASA method):
To find the field Excitation current (IF)

1. Draw the vector with the magnitude of O, G.
2. From G draw a vector with the magnitude of GH (OA) in such a way to make an angle of (90± Φ) from the line O, G (90+Φ) for lagging power factor and (90-Φ) for leading power factor.
3. Join the points O and H. also extend the vector O F with the magnitude of Hf.
   a. Where O f be the field excitation current (IF).
4. Find out the open circuit voltage (EO) for the corresponding field excitation current IF from the OCC curve.
5. Find out the regulation from the suitable formula.

RESULT:
Load Test on Three - Phase Squirrel Cage Induction Motor

Aim:
To conduct the load test on three phase squirrel cage induction motor and to draw the performance characteristics curves.

Name plate details:

<table>
<thead>
<tr>
<th>3φ Induction Motor</th>
<th>Auto Transformer</th>
</tr>
</thead>
</table>

Fuse rating:

125% of rated current (Full load current)

Apparatus required:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the Apparatus</th>
<th>Type</th>
<th>Range</th>
<th>qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ammeter</td>
<td>MI</td>
<td>(O-10)A</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-600)v</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Wattmeter</td>
<td>UPF</td>
<td>(500V,10A)</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Formulae used:

1. Torque \(= (S_1 \approx S_2)(R+t/2) \times 9, 81 \text{ N-m.}\)
   \(S_1, S_2 – \text{spring balance readings in Kg.}\)
   \(R – \text{Radius of the brake drum in m.}\)
   \(T – \text{Thickness of the belt in m.}\)

2. Output power \(= 2\pi NT/60 \text{ Watts}\)
   \(N – \text{Rotor speed in rpm.}\)
   \(T – \text{Torque in N-m.}\)

3. Input power \(= (W_1+W_2) \text{ Watts}\)
   \(W_1, W_2 – \text{Wattmeter readings in watts.}\)

4. Percentage of efficiency \(= (\text{Output power/Input power}) \times 100\%\)

5. Percentage of slip \(= (N_s - N)/N_s \times 100\%\)
   \(N_s – \text{Synchronous speed in rpm.}\)
   \(N – \text{Speed of the motor in rpm.}\)

6. Power factor \((\cos \phi)\) \(= (W_1+W_2)/\sqrt{3} V_L I_L\).

PRECAUTION:

i. The motor should be started without any load

PROCEDURE:

1. Note down the name plate details of motor.
2. Connections are made as per the circuit diagram.
3. The TPSTS is closed and the motor is started using On Line starter to run at rated speed.
4. At no load the speed, current, voltage and power are noted.
5. By applying the load, for various values of current the above-mentioned readings are noted.
6. The load is later released and the motor is switched off and the graph is drawn.

**OBSERVATION:**

Circumference of the brake drum =
Thickness of the belt =

**MODELGRAPH:**

The graph drawn for
vii. Output power Vs speed
viii. Output power Vs line current
ix. Output power vs. Torque
x. Output power Vs power factor
xi. Output power Vs Efficiency
xii. Output power Vs %slip.

**MODEL CALCULATION:**

**RESULT:**

**INFERRENCE:**

The maximum efficiency of the induction motor.

**TABULATION FOR LOAD TEST ON SINGLE PHASE SQUIRREL CAGE INDUCTION MOTOR**

<table>
<thead>
<tr>
<th>S.no</th>
<th>Load current(IL)</th>
<th>Load voltage(VL)</th>
<th>Input power(W)</th>
<th>Speed of the motor(N)</th>
<th>Spring balance reading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>amps</td>
<td>volts</td>
<td>watts</td>
<td>watts</td>
<td>rpm</td>
</tr>
</tbody>
</table>
Separation of No Load Losses in Three Phase Squirrel Cage Induction Motor

**Aim:** separation of no load losses in three phase squirrel cage induction motor as core loss and mechanical loss.

**Name plate details:**

<table>
<thead>
<tr>
<th>Name apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>3Φ induction motor</td>
<td>auto transformer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fuse rating:**

No load: 10 % of rated current (full load current)

**Apparatus required:**

<table>
<thead>
<tr>
<th>S.no</th>
<th>Name apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-10)A</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Voltmeter</td>
<td>MC</td>
<td>(0-50)V</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-600)V</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Wattmeter</td>
<td>LPF</td>
<td>(600V,10A)</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

**Formulae used:**

1. Input Power (W) = (W1+W2) in Watts
2. Stator copper loss = 3 I_o^2 in watts
3. Constant loss/phase (Wc) = (W – 3 I_o^2 R_S) / 3 in Watts
4. Core loss/phase (Wi) = (constant loss / phase) – Mechanical loss

<table>
<thead>
<tr>
<th>S. No</th>
<th>No load current (Io)</th>
<th>No load voltage (Vo)</th>
<th>No load power</th>
<th>Total no load power</th>
<th>No load power / phase (Po(ph))</th>
<th>No load current / phase (Io (ph))</th>
<th>No load voltage / phase (Vo (ph))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
<td>Watts</td>
</tr>
</tbody>
</table>

**Precaution:**

The autotransformer should be kept at minimum voltage position. The motor should not be loaded throughout the experiment.
Separation of No Load Losses on Three Phase Squirrel Cage Induction Motor

Procedure:
1. Note down the name plate details of motor.
2. Connections should be made as per the circuit diagram.
3. By giving the three phase supply through the autotransformer, start the motor.
4. The autotransformer should be varied till the motor attains its rated speed and note the input power, voltage and current.
5. Repeat the same procedure for some more low values of the voltage tabulate the readings.
6. Find the stator copper loss and constant loss by respective formula.
7. Draw the suitable graph to find the mechanical loss.
8. Obtain the core loss by separating the mechanical loss from the constant loss.

Measurement of armature resistance

Graph:
The graph drawn between constant losses (watts) and input voltage (volts).
Tabulation to find out the stator resistance ($r_1$)

<table>
<thead>
<tr>
<th>S No</th>
<th>Stator current (I)</th>
<th>Stator Voltage (V)</th>
<th>Stator Resistance $R_s$ = $V/I$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Ohms</td>
</tr>
</tbody>
</table>

Model calculation:

Model graph:

![Graph showing voltage on the x-axis and constant loss per phase in Watts on the y-axis.]

Result:

Inference:
1. The stator copper loss of the motor at rated voltage:
2. The constant loss of the motor at rated voltage:
3. The mechanical loss of the motor:
4. The core loss of the motor at rated voltage:
Load Characteristics of Alternator with Infinite Bus bar Loading

Aim:
To synchronize and operate the two electric sources in parallel with bus bar arrangement and draw the performance characteristics curves.

Name plate details:

<table>
<thead>
<tr>
<th>3 φ Alternator</th>
<th>DC Shunt Motor</th>
<th>3 φ Load</th>
</tr>
</thead>
</table>

Fuse rating:
125% of rated current (full load current)

For DC shunt motor:

For AC Alternator:

Apparatus required:

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Name of the apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-2)A</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-10)A</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-600)V</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Frequency meter</td>
<td>Reed</td>
<td>(0-60)Hz</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Rheostat</td>
<td>Wire wound</td>
<td>(500Ω,1.2A)</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Rheostat</td>
<td>Wire wound</td>
<td>(300Ω,1.7A)</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Precaution:

i. The motor field rheostat should be in the minimum position.
ii. The Alternator field Potential divider should be in the maximum voltage position.
iii. Initially all Switches are open position.

Procedure:

**Synchronization:**
1. Note the name plate details of motor and alternator.
2. Connections are made as per the circuit diagram.
3. Give the supply by closing DPST Switch.
4. Using the Three Point Starter, start the motor to run at the synchronous speed by varying the motor field rheostat.
5. By varying the potential divider, the generated voltage is built to the rated voltage.
6. Now close the TPST switch.
7. TPSTS (source) alone is closed and the corresponding voltage is marked by voltmeter.
8. TPSTS is opened (source) and in the alternator (source) side, by adjusting the potential divider the field current is varied so that the voltmeter reads the same voltage as measured above.
9. When the TPSTS is closed (now Synchronization Switch should be opened) then the lamps might flicker uniformly.
10. If the lamps are not flicker or not flicker uniformly then the phase sequence of any two lines are changed.
11. After ensuring the correct phase sequence Synchronization switch when the lamps are dark period. If the frequency of flickering is so fast, the motor field rheostat is adjusted very slightly so that the frequency of flickering is convenient.
12. Now the two sources are synchronized.

**Load sharing:**
1. Connect the synchronized output with the variable load.
2. For various Synchronization switch loads, note all (source, source and load) the corresponding ammeters and voltmeters readings.
3. Draw the graph between respective voltages and currents ($V_1 V_S I_1$, $V_2 V_S I_2$ and $V_1 V_S I_1$).

**V-curve:**
1. After synchronization, the prime mover should be switched off and the potential divider should be brought to the original position (maximum position).
2. By adjusting the potential divider tabulate Synchronization switch the varies field current and corresponding armature current readings.
3. To obtain V curve drew the graph between armature current and field current.

**Graph:**
The graph drawn for
- Load Current Vs Load Voltage.
- Load Current Vs Excitation Current

**Result:**

**Inference:**

- Current drawn from the First Source ($I_1$) = 
- Current drawn from the Second Source ($I_2$) = 
- Current through the Load ($I_L$) =
Slip Test and Regulation of Alternator Using Two Reaction Theory

Aim: To conduct the slip test on three phase alternator and to predetermine the regulation through vector diagram.

Name plate details:

<table>
<thead>
<tr>
<th>3φ Alternator</th>
<th>DC Shunt Motor</th>
</tr>
</thead>
</table>

Fuse rating:

125 % of rated current (Full load current)

For DC shunt motor:

For Alternator:

Apparatus required:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the Apparatus</th>
<th>Type</th>
<th>Range</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ammeter</td>
<td>MC</td>
<td>(0-5)A</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Ammeter</td>
<td>MI</td>
<td>(0-5)A</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Voltmeter</td>
<td>MI</td>
<td>(0-150)V</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Voltmeter</td>
<td>MC</td>
<td>(0-150)V</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Rheostat Wire wound</td>
<td>-</td>
<td>(300 Ω, 1.7A)</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Tachometer</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Formulae used:

Precaution:

1. The motor field rheostat should be kept in the minimum position.
2. The alternator field should be kept open throughout the experiment.
3. The direction of rotation due to prime mover and due to the alternator run as the motor should be same.
4. Initially all the switches are kept open.

Procedure:

1. Note down the nameplate details of motor and alternator.
2. Connections are made as per the circuit diagram.
3. Give the supply by closing the DPST switch.
4. Using the three point starter, start the motor to run at the synchronous speed by varying the motor field rheostat at the same time check whether the alternator field has been opened or not.
5. Apply 20% to 30% of the rated voltage to the armature of the alternator by adjusting the autotransformer.
6. To obtain the slip and the maximum oscillation of pointers, the speed is reduced slightly lesser than the synchronous speed.
7. Maximum current, minimum current, maximum voltage and minimum voltage are noted.
8. Find out the direct and quadrature axis impedances.

Procedure to draw the vector diagram:
1. Draw the line OA vector that represents the rated voltage $V$.
2. Draw the line OB vector to represent the rated current $I$, which makes an angle (it may lag /lead/in phase) with the voltage.
3. Draw the line AC vector to represent $IR_a$ drop, which is parallel to OB vector.
4. Draw the perpendicular line CD vector to the line AC ($IR_a$ drop) that represent $IX_q$ drop.
5. Draw the line from the origin through the point D, which consist the no load voltage ($E_0$).
6. Draw the line Pole axis through the origin, which should be perpendicular to vector OD.
7. Draw the perpendicular line to the pole axis from the same point (point E), which should be passed through the point B. [where, vector $OE$ represents direct ($I_d$) and vector EB represents quadrature axis current ($I_q$)]
8. Find out the reactive voltage drops $I_d X_d$ AND $I_q X_q$.
9. Draw the parallel line (ie.perpendicular to $I_d$) to OD vector from the point C, with the magnitude of the drop $I_d X_d$ (line CF).
10. Draw the parallel line (ie.perpendicular to $I_q$) to OE vector from the point F, with the magnitude of the drop $I_q X_q$ (line FG).
11. let the point at where the $I_q X_q$ drop meets the OD line be G. here the vector $OG$ is representing the no load voltage ($E_0$).
12. Find out the voltage regulation by using the suitable formula.

Model calculation:

Result:

Inference:
LIST OF EXPERIMENTS

1. Regulation Of Three Phase Alternator By EMF Method
2. Regulation Of Three Phase Alternator By MMF Method
3. Regulation Of Three Phase Alternator By ZPF And ASA Method
4. Slip Test On Three Phase Alternator Using Two Reaction Theory
5. Synchronization Of Three Phase Alternator
6. V And Inverted V Cures Of Synchronous Motor
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