Lab 2

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Contents

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1 Equipment

- Dc Power Supply
- Model Transmission Line
- Multi-meters
- Synchronization unit

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1.1 Alternator

Table 1.1: *Alternator Nameplate Values*

Stator Voltage (V)	Stator Voltage +20% (V)	Rotor Voltage (VDC)	Power (W) @1500 rpm
41.5	49.8	24	50

2 Setup

- Load Switch Disabled
- 3-Phase power supply connected to load switch
- 3-Phase Wattmeter connected to the three phase supply
- Three Phase supply connected to the stator of the synchronous motor
- Dc power supply connected to synchronous machine rotor
- DC Power supply switched on
- DC Power to motor increased gradually
- DC Motor begins to turn Drive train at V ≈ `8-11Vdc`

3 Experiments

3.1 synchronisation

3.1.1 Procedure

- Dc voltage increased until DC motor is running at synchronous speed ≈ `1500rpm`
- Second DC Supply turned on to exit the rotor
- Excitation Current increased gradually
- Generator open circuit voltage noted as changing as excitation current to the rotor is increased?
- Machine is Disabled

3.2 Open circuit Test

3.2.1 Procedure

- Name Plate Rating of the Synchronous machine noted
- Additional `20%` margin added to stator voltage rating
- DC Motor restarted
- Synchronous motor spun up to `1500rpm`
- The Generator side of the synchronisation unit is disconnected
- The Rotor excitation current is set to `0A`
- The rotor excitation current is increased in steps of `0.5A` until the measured stator voltage reaches `49.8V` (calculated according to: $1.2 \times V_{\text{stator Name-Plate}}$).
  - for each `0.5A` step the synchronous speed was controlled to `1500rpm` by adjusting the supply to the DC Motor
  - for each step of `0.5A` the open circuit generator voltage was recorded

3.2.2 Results

Table 3.1: *Stator Line voltage Vs rotor Excitation current for open circuit test*

I_{rot} (A)	V_{Line} (V)
0.050	6.71
0.100	12.10
0.150	17.10
0.201	23.10
0.251	28.90
0.302	34.60
0.350	39.60
0.402	44.70
0.451	49.00
0.501	52.90

3.3 Short Circuit Test

3.3.1 Procedure

- The leads leaving the 3 Phase wattmeter which were disconnected Last experiment are now connected together effectively short-circuiting the Generator
- The rotor field supply is set to zero and the supply is switched on
- The DC Motor is turned on and the DC voltage supply is adjusted until the speed of the drive train is at 1500 rpm
- Rotor field excitation current gradually increased in steps of `0.05A`
  - rotor speed is kept constant at `1500rpm` for each step
  - for each step the current flowing out of the generator terminals is noted

3.3.2 Results

Table 3.2: *Stator Current Vs rotor excitation current for short circuit test*

I_{rot} (mA)	I_{stat} (mA)
0	0
52	0
101	350
150	496
200	639
250	786
299	930
325	1010

3.4 Load Tests

3.4.1 Setup (Steps 1-2)

1. Synchronisation - (Step 1)
   - Synchronous machine used as a generator into an infinite bus
   - A 3-Phase Power supply is used to simulate the grid

- Load switch is set to `Off` on the synchronisation unit
- The Synchronisation unit is set to `Intensity`
- The leads between the Synchronisation unit and the 3-Phase Wattmeter are reconnected
- The DC supply to the DC motor is switched on and the supply voltage is adjusted until the speed of the generator reaches `1500rpm`
- The DC Rotor supply is now turned on and the current is adjusted until the generator line voltage is `45V` which is the same amplitude of the 3-Phase supply
- The thee phase supply is now turned on
  - It is noted that the three lights on the synchronisation unit now begin to flash at `\approx0.5Hz`
- The motor speed is then adjusted by varying the DC motor current until the lights cease to flash.
- The Load switch is now set to `On`
  - it is noted that the lights now Cease to flash meaning the synchronous machine is now synchronised with the 3-Phase supply

2. Zero Apparent power flow - (Step 2)
   - The Rotor field excitation current and the DC Motor Current (its torque) is adjusted to minimise the AC stator current
     - the generator is neither motoring or generating with losses supplied by the DC motor (no real power is flowing between the grid and the synchronous machine)

3.4.2 Test 1 - Generating with unity power factor (Zero Q)- (Step 3)

1. Procedure
   - The Current to the DC motor is increased until the stator current is roughly 2/3 I_{nom} which is calculated as `464mA`
     - I Guess this will be primarily real power
   - the rotor excitation current is then adjusted until the stator current is minimised
     - cancelling out the reactive power by altering the magnitude of the EMF?
   - Once the stator current is minimised, the following are recorded
     - Final stator current
     - Prime mover input power
     - rotor excitation current
     - Terminal voltage
     - Power factor
     - rotor angle
   - the synchronous speed of the rotor is then measured with the lamp thing
2. Results

Table 3.3: *Mesurements while operating at zero reactive power*

Measurand	Value
Field Excitation Current	478 mA
Line Current	417 mA
Line Voltage	47.2 V
Active Power	33.4 W
Power Factor	1
Prime Mover Input Power	105.67 W
Rotor (load) Angle	330°

3.4.3 Test 2 - Generating at rated current (Positive Q) - (Step 4)

1. Procedure
   - The rotor excitation current is increased until the stator current reaches its nominal value.
     - the Prime-mover torque is kept constant
   - The following are recorded:
     - Final stator current
     - Prime mover input power
     - rotor excitation current
     - Terminal voltage
     - Power factor
     - rotor angle
2. Results

Table 3.4: *Mesurements while operating at rated current with negative reactive power*

Measurand	Value
Field Excitation Current	638 mA
Line Current	689 mA
Line Voltage	47.5 V
Active Power	36.0 W
Power Factor	0.63
Prime Mover Input Power	104.48 W
Rotor (load) Angle	150°

3.4.4 Test 3 Generating at rated current (Negative Q) - (Step 5)

1. Procedure
   - 24:29
   - DC Motor Power is kept constant
   - Rotor excitation current is reduced to the value measured in step 3: `478mA`
   - Rotor excitation current is continually reduced until the stator current reaches its nominal value
   - The following are recorded at this point:
     - Final stator current
     - Prime mover input power
     - rotor excitation current
     - Terminal voltage
     - Power factor
     - rotor angle
   - the synchronising switch is opened and all power supplies are turned off
2. Results

Table 3.5: *Mesurements while operating at rated current and positive negative power*

Measurand	Value
Field Excitation Current	334 mA
Line Current	692 mA
Line Voltage	47.6 V
Active Power	42.8 W
Power Factor	–0.75
Prime Mover Input Power	110.2 W
Rotor (load) Angle	150°

4 Deductions

4.1 Synchronous Impedance Plot

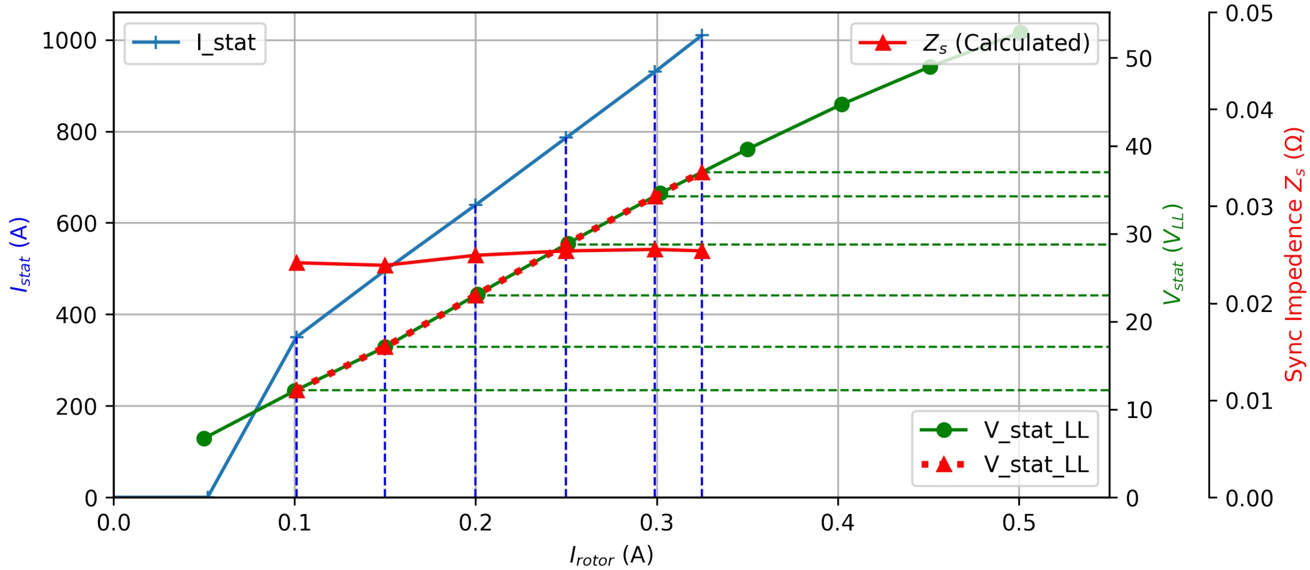

Figure 4.1: *Synchronous Impedance Calculated according to Equation ref:equation.*