UNIVERSITY OF GAZİANTEP
ELECTRICAL AND ELECTRONICS ENGINEERING DEPARTMENT

EEE322
EXPERIMENT 2

OPEN-CIRCUIT, SHORT-CIRCUIT AND ZERO POWER FACTOR TESTS ON AN ALTERNATOR

A. Object of the experiment:

The object of the experiment is to perform open-circuit, short-circuit and zero power factor tests on an alternator (synchronous generator) and from the result of these tests to determine the various parameters of the alternator.

B. Theory:

Three basic sets of characteristic curves for a synchronous machine (m/c) are involved in the inclusion of saturation effects and determination of the appropriate m/c constants.

a) Open circuit characteristic (O.C.C)

O.C.C is a plot of terminal voltage against field excitation, with m/c driven at synchronous speed. Choosing rated terminal voltage and corresponding field current as base values, the curve may be plotted in per unit terms (Fig.1).

b) Short circuit characteristic (S.C.C)

S.C.C is a plot of armature current as a function of field excitation obtained with a symmetrical three-phase short circuit applied across the armature terminals when the m/c is driven at synchronous speed. The S.C.C is plotted in per unit with rated armature current being the base value (Fig.1).

c) Zero power factor characteristic (Z.P.F.C)

Z.P.F.C., is a plot of terminal voltage as function of field excitation, with the m/c supplying a recommended value of armature current at zero power factor and driven at rated speed (Fig.2)

From the O.C.C and S.C.C. curves, the so called saturated and unsaturated synchronous reactance of m/c can be determined respectively.

Unsaturated synchronous reactance Xs(ag), is found from the air-gap line of the O.C.C. together with S.C.C neglecting saturation. If Vt is open circuit terminal voltage on the air-gap line and Ia is the short circuit current on the S.C.C curve at the corresponding excitation, then the unsaturated synchronous reactance is given as (assuming negligible armature resistance),

$$X_s(ag)=V_t/I_a \quad \text{ohms/phase}$$

Referring to Fig.1

$$X_s(ag)=O_a/O_c \ \text{pu}; \ O_c=1 \ \text{pu of armature current.}$$

Saturated synchronous reactance is found from the O.C.C and S.C.C and therefore takes into account the effect of saturation. If Vt is rated terminal voltage on the O.C.C and Ia is the corresponding short circuit current on the S.C.C. then,

$X_s(sat)=V_t/I_a$ ohms/phase : assuming negligible armature resistance.

Or in per unit, from Fig.1

$X_s(sat)=O_b/O_d$ pu ;$O_b=1$ pu of terminal voltage.

C. Procedure:

1. Connect the machine as shown in Fig.2 (a) with the armature winding open-circuited. Start dc driving motor and adjust the speed until it is equal to the synchronous speed of the alternator. Increase the field current in steps until the armature voltage exceeds the rated value by 25% recording at each step the values of armature voltage and field current.

2. Connect the circuit shown in Fig.2 (b) with the armature winding short-circuited true an ammeter. Increase the field current in steps until the armature current exceeds the rated value by 25%, recording at each step the values of armature current and field current.

3. Connect the circuit as shown in Fig.2(c) with the armature winding connected to a variable inductance. Adjust the inductance to the minimum value and increase the field current until the armature current reaches recommended value (5A) record the value of the field current and armature voltage .Increase the value of the inductance in steps and at each step again increase the field current until the armature current reaches the recommended value, record corresponding values of field current and armature voltage. Proceed in this way until the armature voltage exceeds the rated value by 10%.

4. Measure the resistance of one phase of the armature winding using a digital ohmmeter.

Result and Conclusion:

1. Convert all measured quantities to per unit values and values and plot open-circuit, short-circuit and zero-power factor characteristics on the same graph.
2. From the O.C.C. and S.C.C. determine the saturated and unsaturated values of the synchronous reactance at rated voltage.
3. Draw the Potier-triangle and hence estimate the value of armature leakage reactance for two type's synchronous m/c.
4. Comment on the shape of all curves and on the values obtained for all parameters.

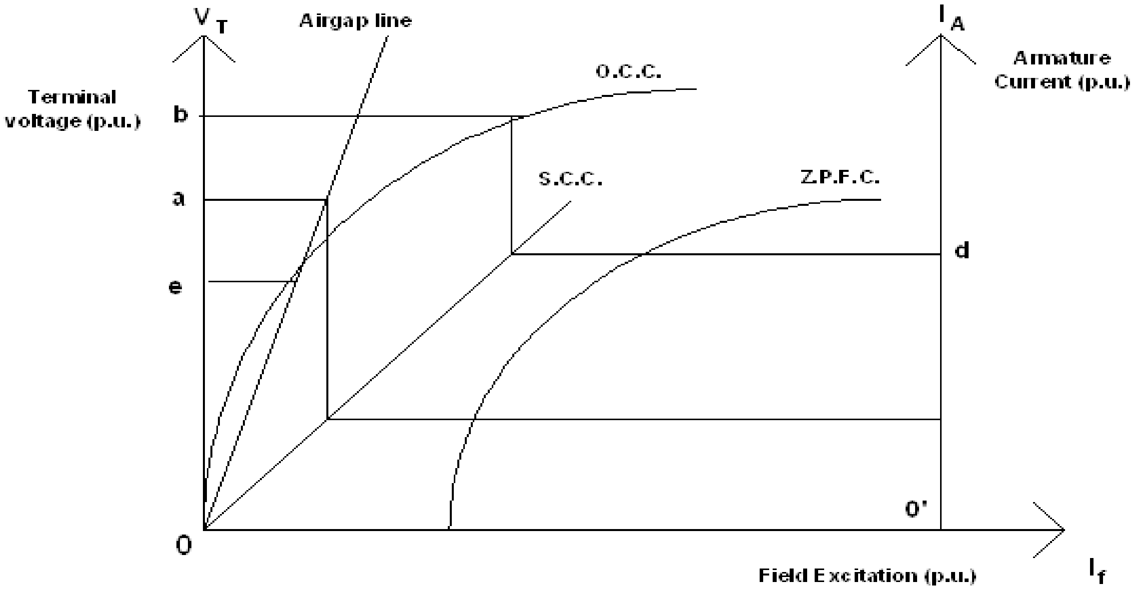
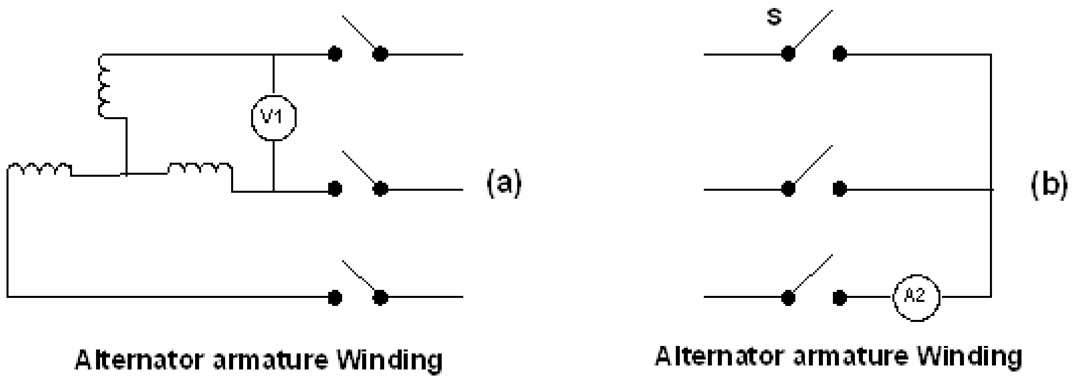
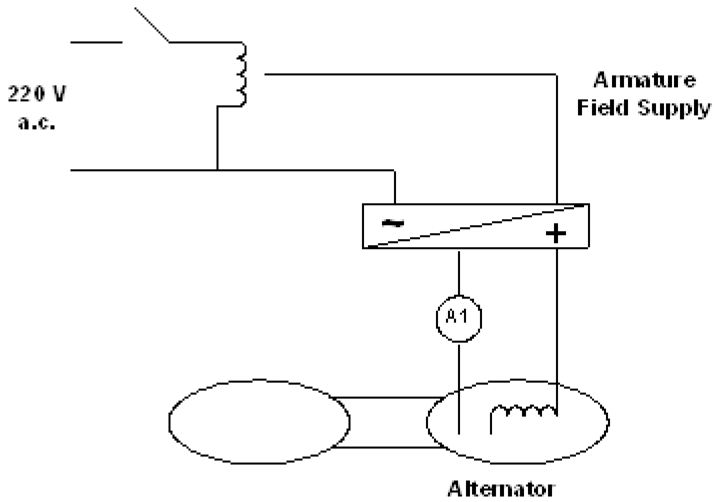


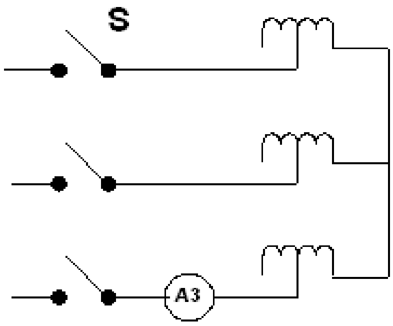
Fig.1 Open-circuit, short-circuit and zero-power factor characteristics



(a)



(b)



Inductive Load

(c)

Fig.2 Alternator (a) Armature connection (b) Field winding connection (c) Inductive load connecton.

EQUIPMENT
For d.c. driving motor
1 Ammeter (0-30 A)
1 Voltmeter (0-200 V)
1Ammeter(0-1.2 A)
1Rheostat (1320 ohms 0,6A)
1Ammeter 0-1.2 A (A1)
1 Voltmeter 0-520 V (V1)
1Ammeter 0-12 a (A2)

E 1. Table of Results for C 1.

V_T	I_F

E 2. Table of Results for C 2.

I_A	I_F

E 3. Table of Results for C 3.

I_F	I_A

Table of Results for C 4.

R_a	