



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)



COIMBATORE-35

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai**

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

**COURSE NAME: 23EET204/ ELECTRICAL MACHINES II
II YEAR / IV SEMESTER**

Unit 1 – SYNCHRONOUS GENERATOR

Topic 13: Slip Test





Determination of X_d and X_q Using Slip Test

The method used to determine X_q and X_d , the direct and quadrature axis reactance is called slip test.

Important caution for conducting slip test:-

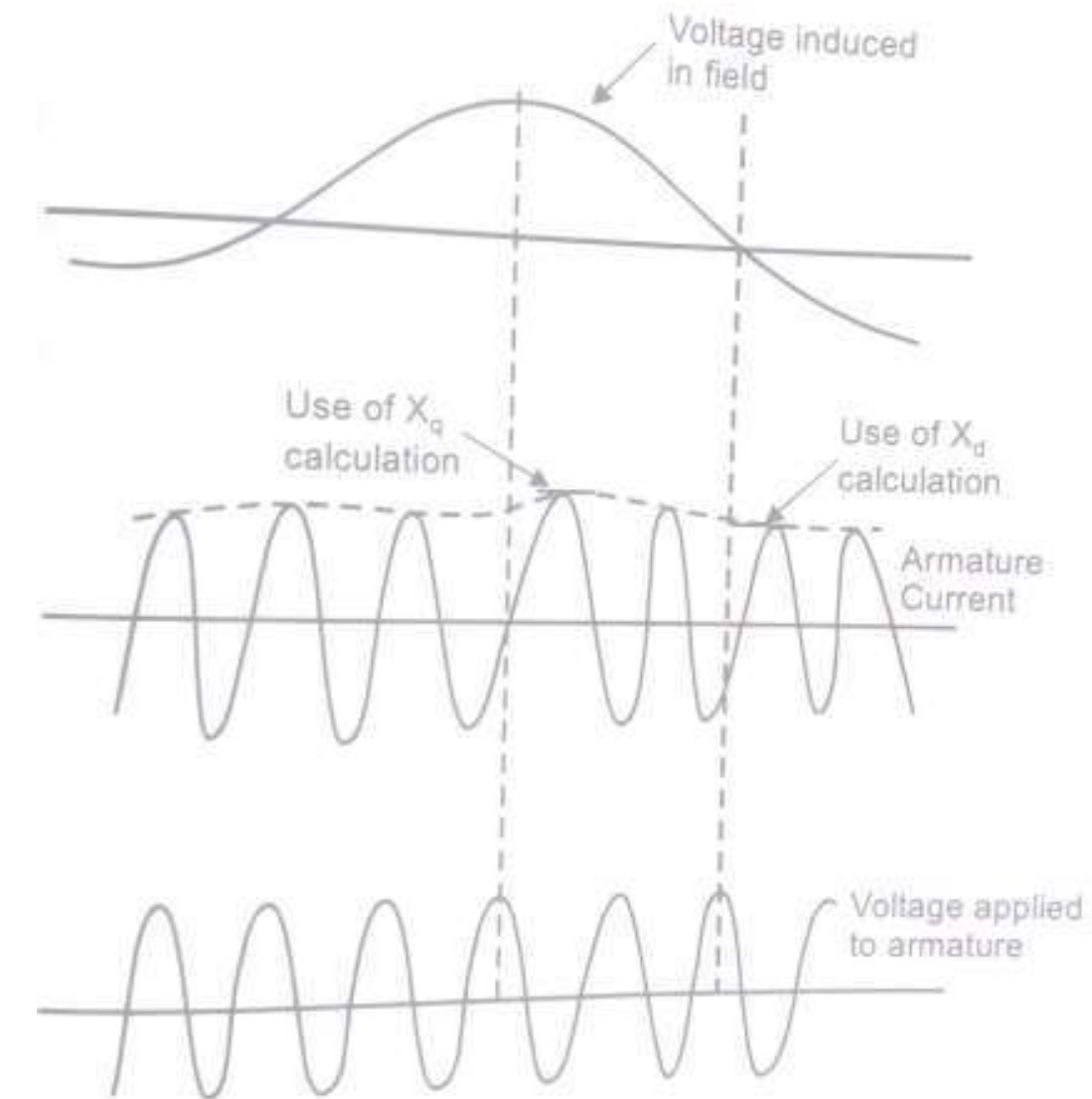
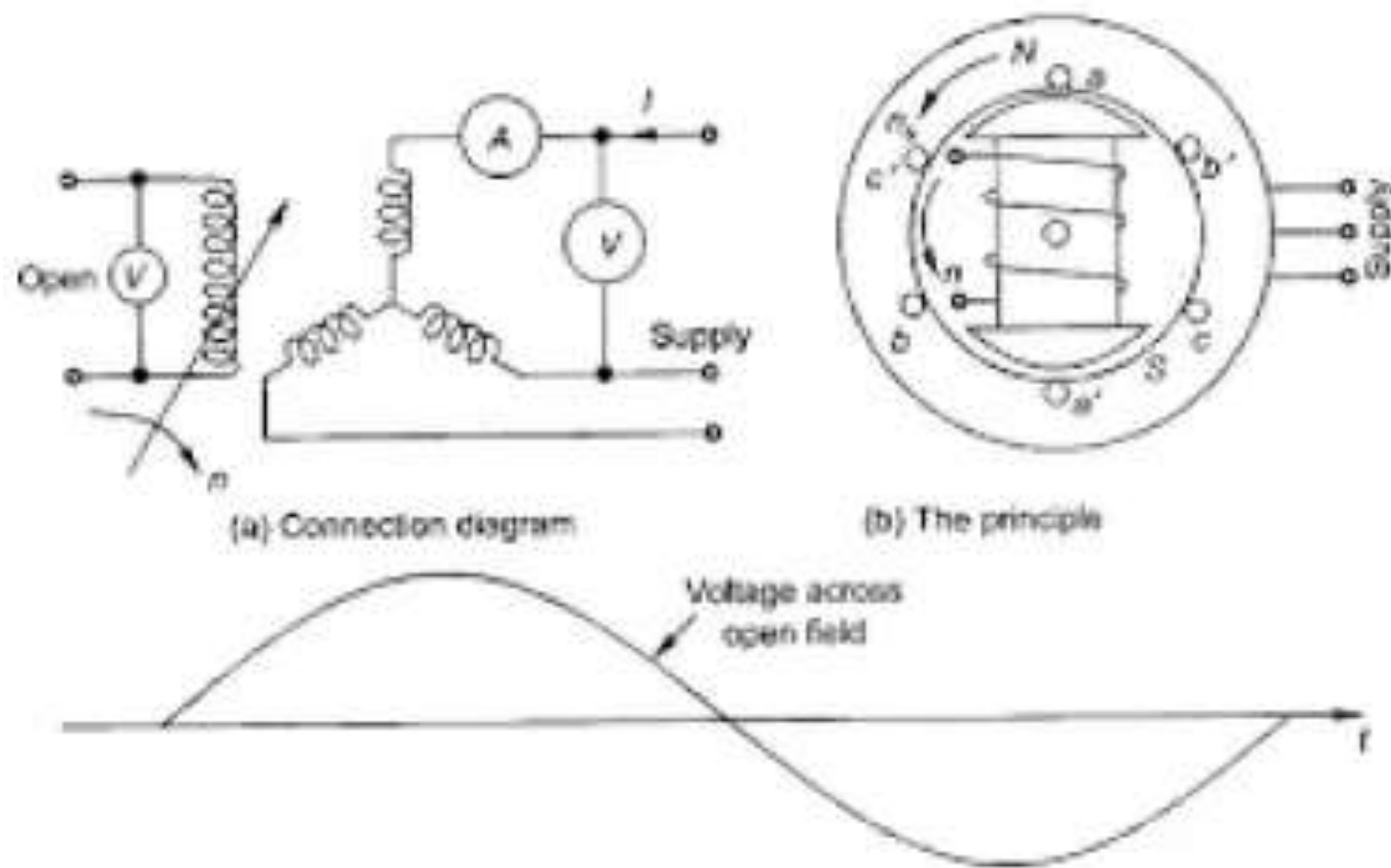
1) Slip should be extremely low during experimentation. In case of high slip (more than about 5%) following effects may be observed:-

- Current induced in the damper winding of alternator will produce an appreciable error.
- Induced voltage in the open circuit field may reach dangerous values.

2) It should be assured that the induced voltage in the open circuit is less than the rating of the voltmeter connected in the circuit.



Determination of X_d and X_q Using Slip Test





Determination of X_d and X_q Using Slip Test



- In an alternator we apply excitation to the field winding and voltage gets induced in the armature. But in the slip test, a three phase supply is applied to the armature, having voltage must less than the rated voltage while the field winding circuit is kept open.
- The alternator is run at a speed close to synchronous but little less than synchronous value.
- The three phase currents drawn by the armature from a three phase supply produce a rotating flux. Thus the armature m.m.f. wave is rotating at synchronous speed
- Note that the armature is stationary, but the flux and hence m.m.f. wave produced by three phase armature currents is rotating. This is similar to the rotating magnetic field existing in an induction motor.



Determination of X_d and X_q Using Slip Test



- The rotor is made to rotate at a speed little less than the synchronous speed. Thus armature m.m.f. having synchronous speed, moves slowly past the field poles at a slip speed $(n_s - n)$ where n is actual speed of rotor. This causes an e.m.f. to be induced in the field circuit.
- When the stator m.m.f. is aligned with the d-axis of field poles then flux Φ_d per pole is set up and the effective reactance offered by the alternator is X_d .
- When the stator m.m.f. is aligned with the q-axis of field poles then flux Φ_q per pole is set up and the effective reactance offered by the alternator is X_q .
- As the air gap is nonuniform, the reactance offered also varies and hence current drawn the armature also varies cyclically at twice the slip frequency.
- The r.m.s. current is minimum when machine reactance is X_d and it is maximum when machine reactance is X_q . As the reactance offered varies due to nonuniform air gap, the voltage drops also varies cyclically. Hence the impedance of the alternator also varies cyclically.



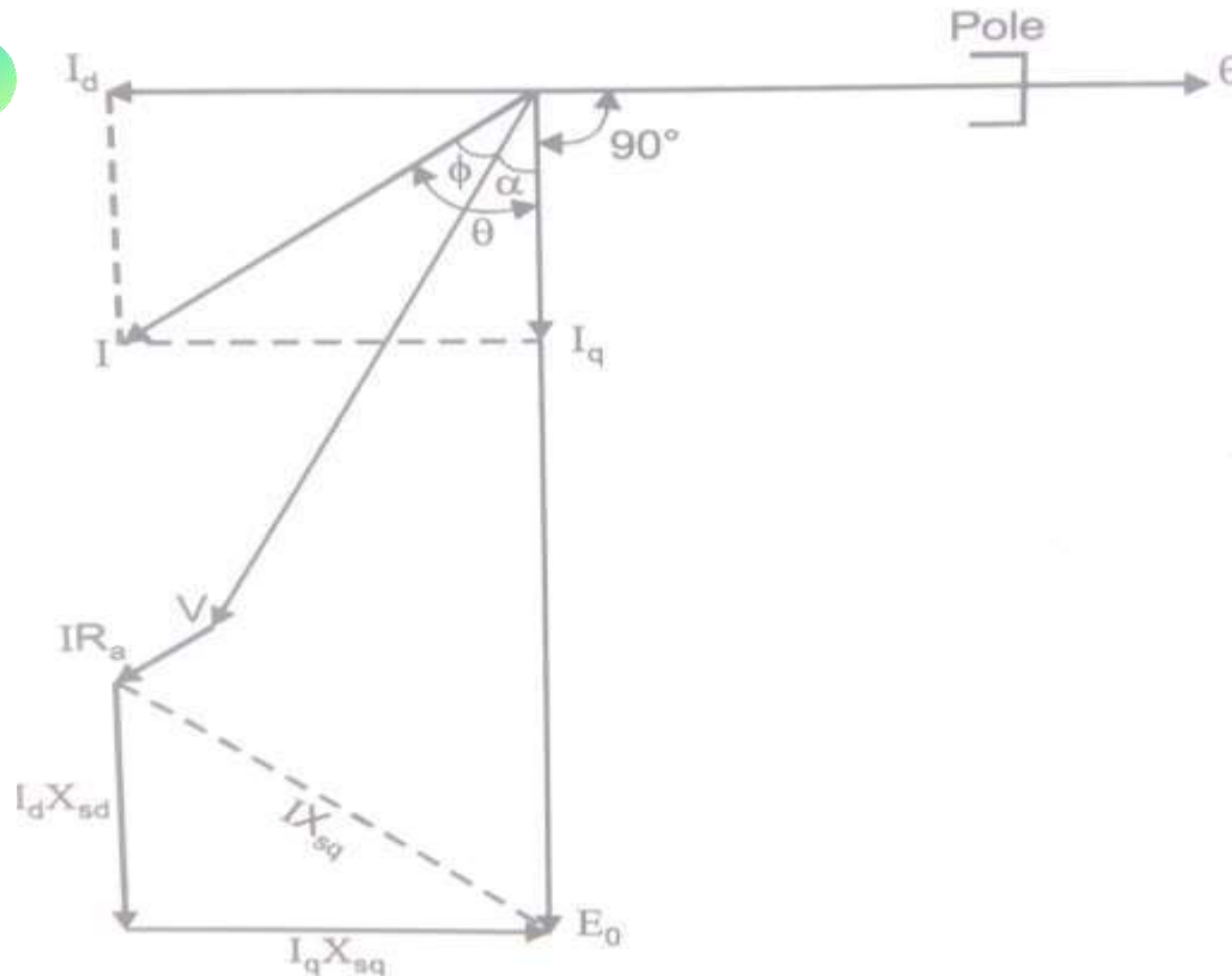
Determination of X_d and X_q Using Slip Test



- The terminal voltage also varies cyclically. The voltage at terminals is maximum when current and various drops are minimum while voltage at terminals is minimum when current and various drops are maximum.
- The waveforms of voltage induced in rotor, terminal voltage and current drawn by armature are shown
- it can observed that rotor field is aligned with the armature m.m.f., its flux linkage are maximum, but the rate of change of flux is zero. Hence voltage induced in field goes through zero at this instant. This is the position where alternator offers reactance X_d .
- While when rate of change of flux associated with rotor is maximum, voltage induced in field goes through its maximum. This is the position where alternator offers reactance X_q .



Phasor Diagram



$$X_{sd} = X_{ad} + X_l$$

$$X_{qd} = X_{ad} + X_l$$

$$V = E_0 - IR_a - I_d X_{sd} - I_q X_{sq}$$



KEEP
LEARNING..
Thank u

SEE YOU IN NEXT CLASS