



NSCET E-LEARNING PRESENTATION

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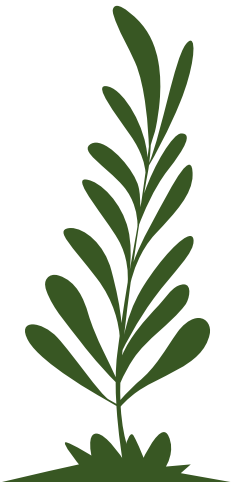
Electrical and Electronics engineering



IV YEAR/ VIIth Semester

EE8701 HIGH VOLTAGE ENGINEERING

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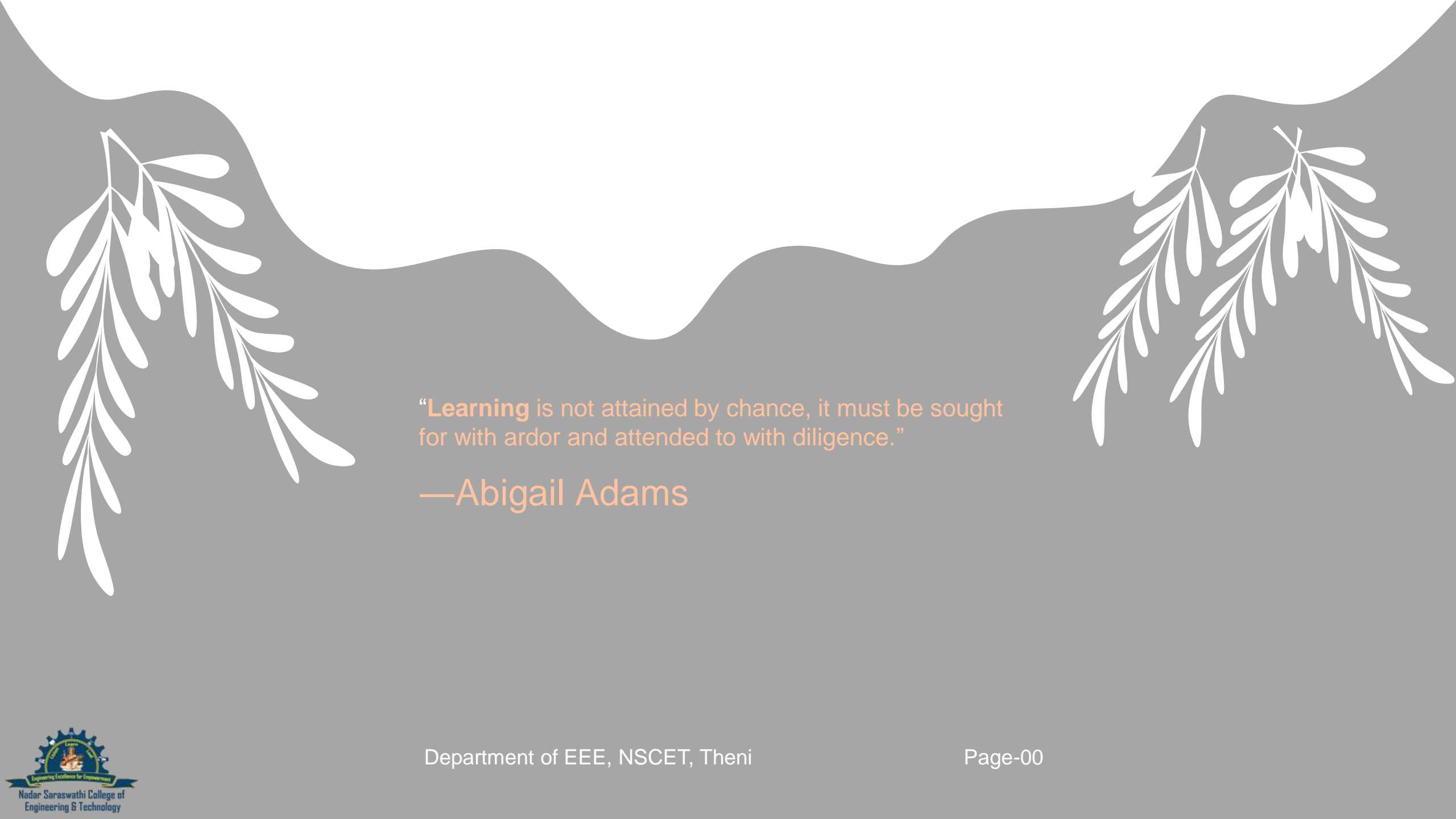




TOPIC NAME

**UNIT 05 –HIGH VOLTAGE TESTING &
INSULATION COORDINATION**





“**Learning** is not attained by chance, it must be sought for with ardor and attended to with diligence.”

—Abigail Adams

HIGH VOLTAGE TESTING & INSULATION COORDINATION

High voltage testing of electrical power apparatus as per International and Indian standards—Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers- Insulation Coordination. .

HIGH VOLTAGE TESTING & INSULATION COORDINATION

INTRODUCTION

- Purpose of the testing: To ensure that the electrical equipments are capable of withstanding the overvoltage's that are met with in service.
- Covers basic requirements procedures for testing on several electrical apparatus. Normally, high voltage (HV) testing is to investigate the insulation performance.
- International/national specifications for testing are outlined (details of test, specific equipment, procedure and acceptable limits) to meet the users' and manufacturers' requirements.

CLASSIFICATION OF HIGH VOLTAGE TESTS

Destructive Test

- Normally the equipment underwent destructive test cannot be used in the service.
- Test voltage is higher than its normal working voltage.
- Breakdown test.

Non-Destructive Test

Mainly done to assess the electrical properties, eg. Resistivity, dielectric constant and loss factor.

The apparatus is not destroyed during the test and can be used again

TYPES OF TESTS

Routine Tests

- Made by the manufacturer on every finished piece of product.
- To fulfill the specifications.

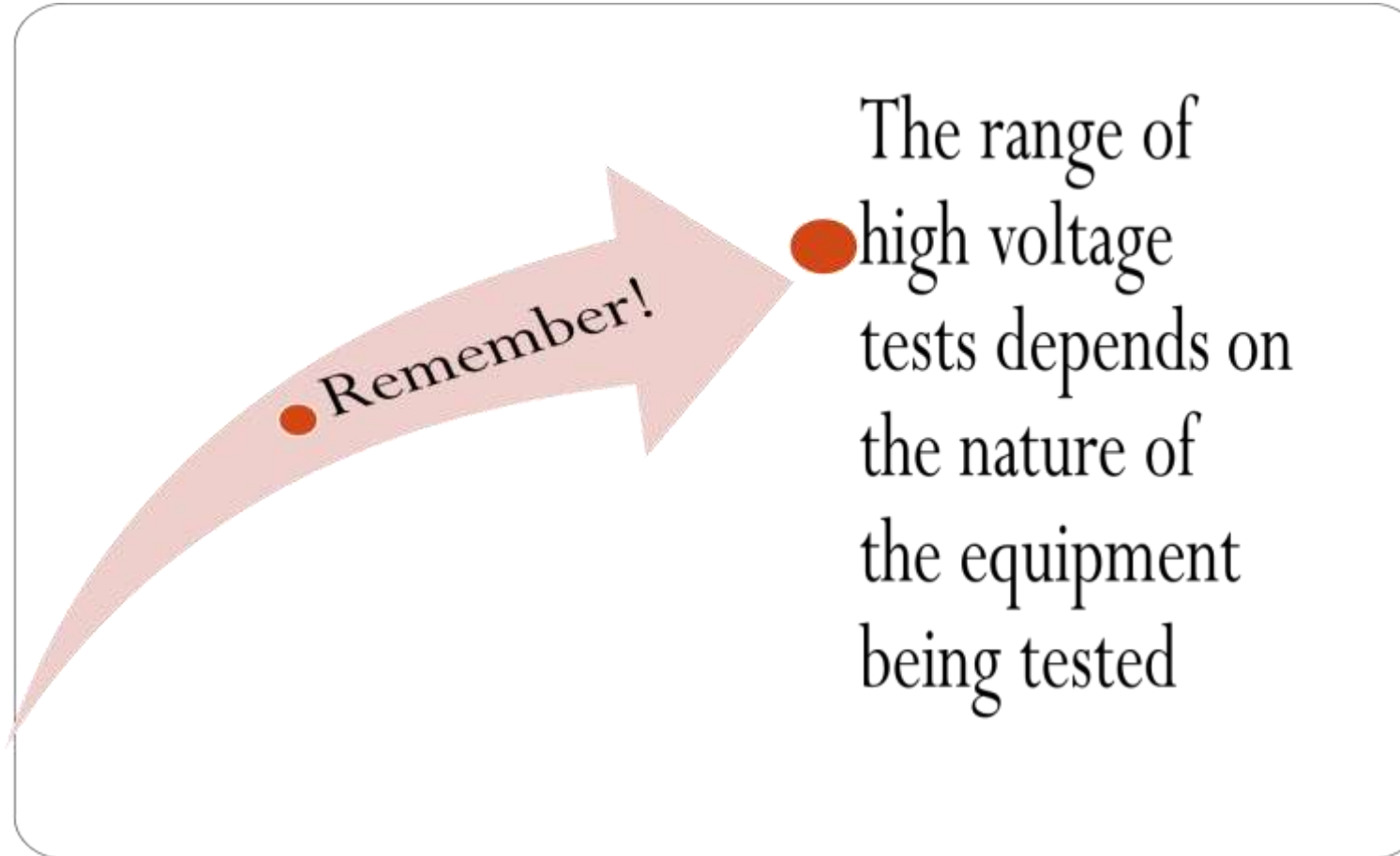
Type Tests

- Performed on each type of equipment before their supply on a general commercial scale – demonstrate performance characteristics.
- No need to repeat the test unless changes are made in the design of the product

Maintenance Tests

- Usually carried out after maintenance/repair of the equipment.
- Conducted according to schedule provided.
- Purpose of the test : To ensure the equipment lifetime is achieved.

TYPES OF TESTS



Remember!

- The range of high voltage tests depends on the nature of the equipment being tested

POWER FREQUENCY TESTS

(a) Dry and wet flashover tests:

- A.C voltage of power frequency is applied across the insulator and increased at a uniform rate of 2% per second of 75% of their estimated test voltage.
- If the test is conducted under normal conditions without any rain –dry flashover test.
- If the test is conducted under normal conditions of rain –wet flashover test

(b) Dry and wet withstand tests(one minute)

The test piece should withstand the specified voltage which is applied under dry or wet conditions.

IMPULSE TESTS ON INSULATORS

- **Impulse withstand voltage test**

If the test object has withstood the subsequent applications of standard impulse voltage then it is passed the test

- **Impulse flashover test**

The average value between 40% and 60% failure is taken, then the insulator surface should not be damaged.

- **Pollution Testing**

Pollution causes corrosion, deterioration of the material, partial discharges and radio interference. Salt fog test is done.

TESTING OF BUSHINGS

Power frequency tests

(a) Power Factor-Voltage Test

Voltage is applied up to the line value in increasing steps and then reduced. The capacitance and power factor are recorded in each step.

(b) Internal or Partial discharge Test

This is done by using internal or partial discharge arrangement.

(c) Momentary Withstand Test at Power frequency

The bushing has to withstand the applied test voltage without flashover or puncture for 30 sec.

(d) One Minute withstand Test at Power Frequency

The bushing has to withstand the applied test voltage without flashover or puncture for 1min.

(d) Visible Discharge Test at Power Frequency

No discharge should be visible when standard voltage is applied.

IMPULSE VOLTAGE TESTS ON BUSHING

Full wave Withstand Test

The bushing is tested for either polarity voltages, 5 consecutive full wave is applied, If the test object has withstood the subsequent applications of standard impulse voltage then it is passed the test.

Chopped Wave Withstand and Switching Surge Tests

It is same as full wave withstand test but it is done for high voltage bushings(220 kV and 400 kV)

TESTING OF ISOLATORS AND CIRCUIT BREAKERS

Short circuit tests

- (a) Direct tests
- (b) using a short circuit generator as the source
- (c) using the power utility system as the source

SYNTHETIC TESTS ON CIRCUIT BREAKER AND ISOLATOR

(a) Direct testing in the Networks or in the Fields

This is done during period of limited energy consumption or when the electrical energy is diverted to other sections of the network which are not connected to the circuit under the test.

(b) Direct Testing in short Circuit Test Laboratories

A make switch initiates the short circuit and the master c.b isolates the test device from the source at the end of predetermine time setnon a test controller

(c) Synthetic Testing of Circuit Breakers

In the initial period of the short circuit test, a.c current source supplies the heavy current at a low voltage, and recovery voltage is simulated by a source of high voltage of small current capacity.

(d) Composite Testing

The C.B is tested first for its rated breaking capacity at a reduced voltage and afterwards for rated voltage at a low current.

(e) Unit Testing

When large C.B of very high voltage rating (220 kV and above) are to be tested and where more than one break is provided per pole, the breaker is tested for one break at its rated current and the estimated voltage.

(f) Testing Procedure

The C.B are tested for their breaking capacity B and making capacity M and it is tested for following duty cycle

(1) B-3-B-3-B at 10% of the rated symmetrical breaking capacity

(2) B-3-B-3-B at 30% of the rated symmetrical breaking capacity

(3) B-3-B-3-B at 60% of the rated symmetrical breaking capacity

(4) B-3-MB-3MB-MB0 at 10% of breaking capacity with the recovery voltage not less 95% of the rated service voltage

(g) Asymmetrical Tests

One test cycle is repeated for the asymmetrical breaking capacity in which the d.c component at the instant of contact separation is not less than 50% of the a.c component

TESTING OF CABLES

Different tests on cables are

- (i) mechanical tests like bending test, dripping and drainage test, and fire resistance and corrosion tests
- (ii) Thermal duty tests
- (iii) Dielectric power factor tests
- (iv) Power frequency withstand voltage tests
- (v) impulse withstand voltage tests
- (vi) Partial discharge test
- (vii) Life expectancy tests

INSULATION CO-ORDINATION

- A gradation of system insulation and protective device operation is to be followed.
- Substations contain transformers and switchgear with non-self restoring insulation should be protected against flashover
- For other apparatus which contain self restoring insulation may be allowed to flashover.
- Lightning impulse withstand level known as Basic Insulation Level(BIL). Various equipment and their component parts should have their BIL above the system protective level by a margin which is determined with respect to air insulation.

INSULATION CO-ORDINATION

- For higher system voltages, switching surges are of higher magnitude compared to the lightning over voltages.
- The flashover voltage of a protective device is chosen such that it will not operate for switching overvoltage and other power frequency and its harmonic overvoltages. BIL has to be higher.
- For EHV systems, Switching Impulse Level (SIL) should be assigned to each protective device.



**High voltage AC withstand test on 11 kV XLPE single core cable
(TOPLINK SDN BHD)**



**High voltage lightning impulse test on cast resin transformer
(LKH POWER TRANSFORMER SDN BHD)**



**High voltage lightning impulse test on 11 kV switchgear
(MAHKOTA MANUFACTURING SDN BHD)**