**University of Management and Technology**

**Course Outline**

Course code: **EE426** Course title: **High Voltage Engineering**

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| **Program** | BSEE |
| **Credit Hours** | 3 |
| **Duration** | One Semester |
| **Prerequisites** | -- |
| **Resource Person** |  Muhammad Haris |
| **Counseling Timing****(Office # 7, Hall # 510, SEN Building )** | Monday, Wednesday (11:00-1:00) |
| **Contact** | Ext: 3663muhammad.haris@umt.edu.pk |

**Chairman/Director signature………………………………….**

**Dean’s signature…………………………… Date………………………………………….**

**Introduction:**

The course is an advanced course on high-voltage technology and electrical insulating materials.

**Learning Objective:**

The course contains the basic theories and the most important experimental methods of high voltage engineering.

Generation of high voltages. Cockroft-Walton cascade rectifier. Transformer cascade. Impulse voltages. High voltage dividers. High voltage test technique. Electrical breakdown strength of gaseous, liquid and solid insulation. Dielectric properties of electrical insulation. Complex permittivity and dielectric response functions. Insulation diagnostics. Dielectric spectroscopy. Partial discharges.

**Learning Outcomes:**

When the students have passed the course, they shall be able to

* Describe the principles behind generating high DC-, AC- and impulse voltages
* Develop equivalent circuit models of the different high voltage generators
* Perform a dynamic response analysis of high voltage measurement systems
* Approximately judge the breakdown strength of contaminated gases, liquids and solids.
* Describe the principles for measurement of capacitance and dielectric loss
* Discuss ageing of electrical insulation from measurements of complex permittivity
* Compute the complex permittivity from the dielectric response function and vice versa.
* Discuss the measurement principles behind partial discharges
* Compute phase resolved partial discharge patterns from simple models

**Teaching Methodology:**

Lectures will be used to describe and develop the concepts stated above.

Group tasks will be given to enhance interactive learning.

Industrial visits will be arranged to further strengthen the basic concepts and to increase practical exposure.

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in the semester.

**Marks Evaluation Marks in percentage**

Sessional (Quizzes + Assignments) 25%

Mid Term 25%

Final exam 50%

Total 100%

**Recommended Text Book:**

1. High Voltage Engineering, 2nd edition. By C.L. Wadhwa
2. High Voltage Engineering, 2nd edition. By E. Kuffel, W.S. Zaengl, amd J. Kuffel

**Reference Book:**

1. High voltage Engineering, 2nd edition, By M. S. Naidu, and V. Kamaraju

**Calendar of Course contents to be covered during semester**

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| **Lecture Plan (Week wise)** | **Topics** | **Textbook (TB) /****Reference Readings(RB)** |
| **1** | **Introduction** Generation of transmission of electric energy, Voltage stresses, Testing voltages | Ch # 1 of TB2 |
| **2-3** | **Breakdown Mechanism of Gases, Liquid and Solid Materials**Introduction, Mechanism of Breakdown of Gases, Townsend’s First ionization coefficient, Cathode processes, Townsend’s second ionization coefficient, breakdown mechanism, streamer and kanal mechanism of spark, sparking potential-Paschen’s law, Penning effect, corona discharge, time lag  | Ch # 1 of TB1 |
| **4-5** | **Breakdown Mechanism of Gases, Liquid and Solid Materials**Breakdown in liquid dielectrics, treatment of transformer oil, testing of transformer oil, Breakdown in solid dielectrics, breakdown in vacuum | Ch # 1 of TB1 |
| **6** | **Generation of High D.C. and A.C. Voltages**Half wave rectifier circuit, Cockroft-Walton voltage multiplier circuit, Electrostatic generator, Generation of high A.C. voltages, series resonant circuit | Ch # 2 of TB1 |
| **7** | **Generation of Impulse Voltages and Currents**Definitions, Impulse generator circuits, Analysis of circuits, Multistage impulse generator circuit, construction of impulse generator, triggering and synchronization of impulse generator, impulse current generation | Ch # 3 of TB1 |
|  | **Mid Term Exam in 8th week** |  |
| **9-10** | **Measurement of High Voltages and Currents**Introduction, Sphere gap, Uniform field spark gap, rod gap, electrostatic voltmeter, generating voltmeter, Chubb-Fortscue method, Impulse voltage measurements using voltage dividers, measurement of high DC and Impulse currents | Chap # 4 of TB1 |
| **11** | **High voltage testing of electrical equipment**Testing of overhead line insulators, cables, bushings, capacitors, transformers, circuit breakers, test voltage  | Chap # 5 of TB1 |
| **12-13** | **Non-destructive insulation test techniques**Loss in dielectric, Measurement of resistivity, dielectric constant and loss factor, high voltage scherring bridge, measurement of large capacitance, grounded test specimen, high loss factor, transformer ratio arm bridge, Partial discharges, bridge circuit, oscilloscope as PD measuring device, recurrent surge generator  | Chap # 6 of TB1 |
| **14-15** | **Transients in power system and insulation coordination**Transient in simple circuits, traveling waves, capacitance switching, over voltage due to arcing grounds, lightning phenomenon, line design based on lightning, switching surge test voltage characteristics, insulation coordination and overvoltage protection, overvoltage protection, ground wires, surge protection of rotating machine | Chap # 7 of TB1 |
| **End Term Exam (Comprehensive)** |