**20EE41E2-BASICS OF POWER SYSTEM HARMONICS & ELECTRICAL INSULATION**

**(EEE)**

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| **Course Category:** | Professional Elective | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture-Tutorial-Practical:** | 3-0-0 |
| **Pre-requisite:** | Basic power system components. | **Sessional Evaluation:**  **External Exam Evaluation:**  **Total Marks:** | 40  60  100 |

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| **Course Objectives:** | To make the student learn about: | |
| 1.The terms associated with harmonics and the causes for harmonic  producing loads.  2. The various effects of harmonics.  3.The concepts of harmonic instrumentation with computer simulation.  4.To select the appropriate insulation material, insulation failures and  vacuum insulation.  5. The different types of insulation testing.  6. The advanced measuring and testing techniques. | |
| **Course Outcomes:** | At the end of the course, student will be able to: | |
| **CO1** | Understand the terms associated with harmonics and the causes for harmonic producing loads. |
| **CO2** | Demonstrate the various effects of harmonics. |
| **CO3** | Assess the concepts of harmonic instrumentation with computer simulation |
| **CO4** | Choose appropriate insulation material for the different applications. |
| **CO5** | Enumerate different types of insulation testing. |
| **CO6** | Distinguish among advanced measuring and testing techniques. |
| **Course Content:** | **UNIT I**  **Sources and generation of harmonics:** Transformer magnetization- machines- fluorescent lamps with magnetic ballasts- power electronics loads such as line, commutated converters- typical current waveforms and THD-switched mode power supplies- typical current waveforms and THD- uncharacteristic and inter harmonics**.**  **UNIT II**  **Effects of harmonics:** Resonance- nuisance tripping- blown capacitor fuses and capacitor cells degradation of internal capacitance- digital clocks- motor overheating overloading neutrals-telephone interference.  **UNIT III**  **Investigation of harmonics:** Field measurements-requirements- harmonic symmetrical components-transducers-harmonic instrumentation computer simulation with an example.  **UNIT IV**  **Insulation materials and failures:** Insulation materials properties- application- causes of insulation degradation- failure modes- recent insulation testing and diagnostic techniques.  **Vacuum insulation:** Breakdown electron emission-pre-breakdown conduction- effective condition of electrodes- breakdown mechanism in vacuum- factors affecting breakdown voltage- vacuum circuit breaker-space application.  **UNIT V**  **Insulation testing:** Classification of testing- procedures and standards- testing automation- partial discharge test-dielectric loss test- insulation testing of equipments- testing of transformer and cable accessories- testing of electrical switchgear and circuit breakers-testing of motor and generators.  **UNIT VI**  **Advanced measurement and diagnostic technologies**: Digital impulse recorders-digital techniques in testing, testing automation- electric field measurements-electro optic sensors- magneto optic sensors-space charge measurement techniques- electro optical imaging techniques- insulation resistance measuring instruments. | |
| **Text books**  **&**  **Reference books:** | **Text books:**  1. “Power system harmonics”, by Arrillaga J. and Watson N. R., Wiley,  2nd Edition, U.S.A, Nov2003.  2.“Understanding power system harmonics”, by Prof. Mack Grady,  Dept. of electrical & computer engineering university of Texas at  Austin, U.S.A, 2012.  3.“High voltage and electrical insulation engineering”, by Ravindra  Arora, Wolfgang Mosch, IEEEpress series on power Engineering,  2011.  4. “Electrical power equipment maintenance and testing”, by Paul Gill,  2nd Edition, CRC Press, Taylor & Francis group, 2009.  **Reference books:**  1.“Electrical insulation in power systems”, by N.H.Malik, A.A.Al-  Arainy, M.I.Qureshi, CRC Press, Taylor & Francis group, 1998. | |
| **e-Resources:** | <http://nptel.ac.in/courses>  <http://iete-elan.ac.in>  <http://freevideolectures.com/university/iitm>  [www.ece.utexas.edu/~grady](http://www.ece.utexas.edu/~grady) | |