

**Course Name:** Dielectrics and Related Materials  
**Course Code:** ME 616  
**Credits:** 3-0-0-3  
**Pre-requisites:** Nil

**Objective:**

To provide an advanced understanding of dielectric based materials. It is intended to give the students an understanding of the physics and electrical engineering behind the important dielectric materials. State-of-the-art problems and challenges will be discussed to give students a better appreciation of a fast moving field. The course is complemented with a critical assessment of classical papers and review articles to provide an in depth perspective.

**Course contents:**

Students will be introduced to dielectric theory. Various dielectric related concepts such as relaxation phenomena will be discussed. Non-linear dielectrics, ferroelectrics, and antiferroelectrics will also be described. Soft mode theory will be used to link dynamic vibrational modes to static dielectric permittivity. Temperature coefficient of capacitance will be discussed for a wide group of materials using Clausius-Mossotti theory. Capacitor and microwave material design is described for a variety of applications: X7R, Y5V, and NPO capacitors, and microwave resonators and filters. Importance of crystal structures, defect chemistry will be emphasized in relation to the final performance of the devices. Performance will be considered in terms of temperature dependence, dielectric loss, defect chemistry, dielectric breakdown, and degradation. Piezoelectric materials will be considered in terms of properties, domain switching, and compositional design. Important piezoelectric applications are reviewed in terms of properties. Conduction mechanisms of dielectric materials will be discussed in terms of Mott insulators, semiconductors, and superconductors. Solid-state electronic theory will be discussed in relation to structure-property relationship to give the students an understanding of processes that control these unique properties.