EE540 Advance Electromagnetic Theory & Antennas

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Electromagnetic boundary conditions

- Six electromagnetic boundary conditions (2 each for electric field, magnetic field and electric current)
- Explains the behaviour of fields (electric and magnetic) and also current densities at a media interface
- Interface: boundary between two media (region 1 and region 2)
- Electric boundary conditions (two regions: dielectrics with different ε)
- Magnetic boundary conditions (two regions: magnetic materials with different μ)
- Current boundary conditions (two regions: conductors with different σ)
- Statements and equations in scalar form & vector form

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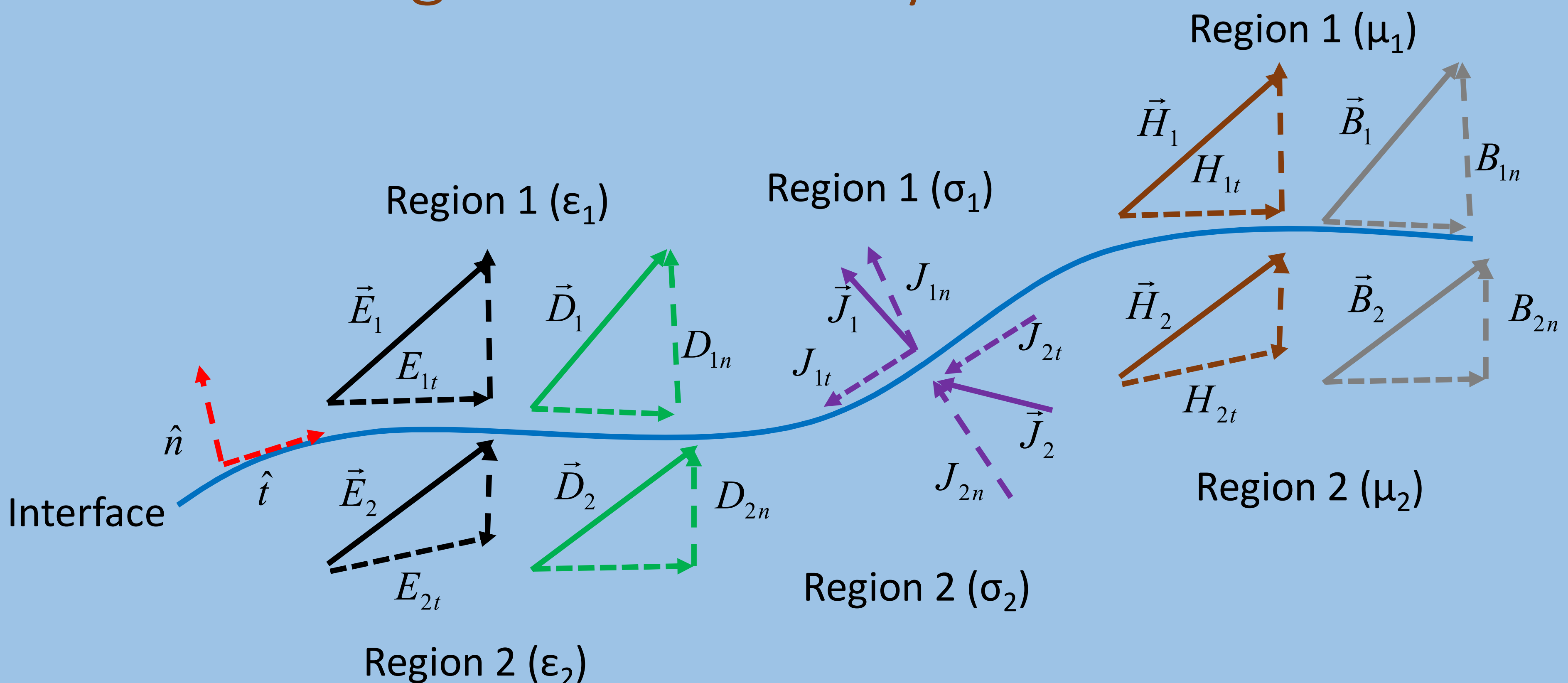
Electromagnetic boundary conditions



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Electromagnetic boundary conditions

- First electric boundary condition+
- Tangential component of electric fields
- Scalar form $E_{t1} = E_{t2}$
- Vector form
- Statement: $\hat{n} \times (\vec{E}_1 - \vec{E}_2) = 0$
  - the tangential component of the electric field is continuous across the boundary between two dielectrics
- ***+Boundary conditions are called as 1st & 2nd for convenience & easier understanding, there is no hard and fast rule in this ordering and it can be always altered***

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Electromagnetic boundary conditions

- Second electric boundary condition
- Normal component of electric flux density
- Scalar form $D_{n1} - D_{n2} = \rho_s$
- Vector form $\hat{n} \bullet (\vec{D}_1 - \vec{D}_2) = \rho_s$
- Statement:
- The normal component of the electric flux density is discontinuous across the boundary between two dielectrics by the surface charge density at the boundary

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Electromagnetic boundary conditions

- First current boundary condition
- Tangential component of current density
- Scalar form $\frac{J_{t1}}{J_{t2}} = \frac{\sigma_1}{\sigma_2}$
- Vector form $\hat{n} \times (\frac{\vec{J}_1}{\vec{J}_2}) = \frac{\sigma_1}{\sigma_2}$
- Statement:
- The ratio of the tangential components of the current densities at the interface is equal to the ratio of the conductivities

Electromagnetic boundary conditions

- Second current boundary condition
- Normal component of current density
- Scalar form $J_{n1}=J_{n2}$
- Vector form $\hat{n}\bullet(\vec{J}_1-\vec{J}_2)=0$
- Statement:
- It states that the normal component of electric current density is continuous across the boundary

Electromagnetic boundary conditions

- First magnetic boundary condition
- Tangential component of magnetic fields
- Scalar form $H_{t1}-H_{t2}=J_s$
- Vector form $\hat{n}\times(\vec{H}_1-\vec{H}_2)=\vec{J}_s$
- Statement:
- The tangential component of the magnetic field is discontinuous across the boundary between two magnetic materials by the surface current density flowing along the boundary

Electromagnetic boundary conditions

- Second magnetic boundary condition
- Normal component of magnetic flux density
- Scalar form $B_{n1}=B_{n2}$
- Vector form $\hat{n}\bullet(\vec{B}_1-\vec{B}_2)=0$
- Statement:
- The normal component of the magnetic flux density is continuous across the boundary between two magnetic materials

Electromagnetic boundary conditions