Introduction to ANSYS Electromagnetic Tools
Presentation Overview

- Introduction to ANSYS Electromagnetics
- Low Frequency Electromagnetics - Maxwell
- High Frequency Electromagnetics - HFSS
- Conclusions
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**Electromagnetics** simulate electromagnetic fields and compute electrical parameters that govern electronic device behavior — enabling to optimize product’s performance.
Differentiation

$DC \ldots \ldots \ldots \text{to} \ldots \ldots \ldots \text{Antennas}$

Low Frequency

High Frequency
Low Frequency Applications

Pantograph

Traction Supply

Traction Motor

AM

3~
High Frequency Applications

Platform Integration and RCS

Phased Array Antenna and Antenna Design

Integrated Mobile Devices

Biomedical

Commercial Platform Integration
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4. Conclusions
About ANSYS Low Frequency Electromagnetics

- ANSYS Maxwell is a high-performance interactive software package that uses finite element analysis (FEA) to solve electric or magnetic problems.
- Maxwell solves the electromagnetic field problems by solving Maxwell's equations in a finite region of space

\[ \nabla \times H = J + \frac{\partial D}{\partial t} \]

\[ \nabla \times E = -\frac{\partial B}{\partial t} \]

\[ \nabla \cdot D = \rho \]

\[ \nabla \cdot B = 0 \]

- Appropriate set of equations and its terms are used based on the solver selected such as Electrostatic, Magnetostatic, Eddy Current and Magnetic Transient.
Sensors
**Electrical Machines**

\[
P_{\text{mech}} = \text{torque} \times \text{speed}
\]

\[
P_{\text{elect}} = \text{voltage} \times \text{current}
\]

**Mechanical Power**

- **Generator**

- **Motor**
Objective: Electrical Machine Cosimulation Design with Power Electronics and Control

- To validate the designed electric machine works with the electric drive and digital control system.

ANSYS Solution

- ANSYS Maxwell can be directly coupled with ANSYS Simplorer and cosimulate during transient analyses.
Objective: Wireless Power Transfer

- To design electromagnetic power transfer from a coil to another coil based on inductive coupling and/or resonant (wireless) coupling

ANSYS Solution

- Using ANSYS Maxwell to calculate the inductive coupling to design the coil topologies
**Objective:** Fault-Tolerant Electrical Machine Design

- To design the electrical machine to sustain normal load operation after occurrence of a particular fault condition

**ANSYS Solution**

- ANSYS Maxwell to compute motor performance when a fault condition occurs:
  - Stator to rotor eccentricity
  - Magnet damage and demagnetization
  - Winding abnormalities and faults
  - Unbalanced magnetic pull
Objective: Noise-Vibration Analysis

- To eliminate vibration problem early in the design process and optimize the electrical machine design for low acoustic noise

ANSYS Solution

- ANSYS Maxwell to compute the transient electromagnetic forces and transfer DFT on spatial force distribution to ANSYS Mechanical to perform harmonic and acoustic analysis
Maxwell ANSYS CFD

\[ F = f(P(\vec{x}, t), S) \]

\[ B = \mu H \]

\[ F = kx \]

\[ F = ma \]

Solenoid Valve: Fuel Injector

Spray Tip

Plunger

Fuel Filter

Injector Casing

Pressurised Fuel

Electrical Attachment

Solenoid Off

Battery

ANSYS Mechanical
Objective: Motor Design and Thermal Management

• To predict electrical machine design performance based on thermal feedback. For large machines, the cooling system plays a significant role in the overall performance of the entire drive.

ANSYS Solution

• ANSYS Maxwell for electromagnetic analysis, ANSYS Mechanical for thermal analysis and ANSYS Fluent for heat transfer coefficients
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ANSYS HFSS: Finite Element Method

- High Frequency Structure Simulator
- Full-wave 3D electromagnetic field solver
- Industry leading EM simulation tool
  - Simulation driven product development
  - Shorten design cycle
  - First-pass design success
- Finite element method with adaptive mesh refinement
  - Provides an Automatic, Accurate and Efficient solution
  - Removes requirement for manual meshing expertise
• Use ANSYS HFSS to design antenna element and integrate into phone platform
• Analyze impact of user interaction with phone on antenna’s performance
• Systematically study impact of component manufacturing tolerances on device yield
Integrated Antenna Design Tool and Library with Electromagnetics Field Solver

50+ Topologies

Design Synthesis

Ready to Solve
The real situation: Installed Antenna Performance

- Antennas often designed in isolation or under ideal conditions
- Mounting the antenna on a realistic platform changes its performance
- Can impact overall RF system performance
- Customers want to know installed performance early in the design cycle
Effect of Different Antenna Positions

Position #1

Position #2

Position #3
Reliable Antenna Performance

- Proliferation of antennas in complex industrial environment create reliability issues.
- Shooting and Bouncing Ray simulation techniques can identify and help prevent these antenna ‘co-site’ issues.
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Electromagnetic fields are frequently employed in advanced medical applications like **MRI**. As these devices become more complex, design simulation can maintain advanced functionality while addressing safety concerns.

**Applications:**

- Magnetic Resonance Imaging (MRI)
- RF ablation
- Specific Absorption Rate (SAR)
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A summary of ANSYS EM Strengths

• Ease of Use

• Multiphysics advantages
  – Deep electromagnetics, fluid, and structural solver technology and capabilities
  – Drag-n-drop multiphysics couplings
  – Flexible coupling methods
  – Fast, accurate data mapping
  – Automated solver coordination

• Speed
  – Electronics HPC
  – Advanced meshing and solver technologies

• A world-class team of technical support experts