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Guest lecture on "Finite Element Methods"

The Department of **Aeronautical and Aerospace Engineering** organised a **Guest lecture** titled **Finite Element Methods** to provide students with fundamental insights into numerical techniques used for solving complex engineering problems. The session focused on the principles of FEM, including discretization, element formulation, and its applications in structural analysis, thermal analysis, and fluid mechanics, enabling students to understand its significance in modern engineering design and analysis.

Schedule of the Event

- **Date:** March 27, 2026.
- **Time:** 10:00 AM – 13:00 PM.
- **Venue** Rajalakshmi Seminar Hall, M V J College of Engineering
- **OrganiSed by:** Department of Aeronautical and Aerospace Engineering.
- **Speaker:** Dr. Rajeev Jain,
  Retired Scientist, Stress Department, GTRE-DRDO.

Dr. Rajeev Jain delivered an insightful session by sharing his extensive experience in structural analysis and advanced engineering applications. He began by emphasising the importance of stress analysis in aerospace components, particularly in ensuring safety, reliability, and performance under various loading conditions. He explained how Finite Element Methods (FEM) play a crucial role in predicting stress distribution, deformation, and failure in complex structures.

Introduction:

Finite Element Method (FEM) is a powerful numerical technique used to analyse complex engineering problems that cannot be solved easily using analytical methods. In aerospace and aeronautical engineering, FEM is widely applied to study the behavior of structures such as wings, fuselage, turbine blades, and other components under various loading conditions.

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Figure 1: The Guest Speaker was honored by Dr. R. K. Mishra

The basic concept of FEM involves dividing a complex structure into smaller, simpler elements (called finite elements) connected at nodes. By applying governing equations and boundary conditions to these elements, the overall behavior of the structure—such as stress, strain, deformation, and temperature distribution—can be accurately predicted. This process is known as discretization.

For 4th-semester students, FEM provides a foundation to understand how real-world aerospace structures are analysed and designed for safety and efficiency. It is extensively used in structural analysis, vibration analysis, thermal analysis, and fluid-structure interaction problems. Learning FEM helps students gain skills in modern simulation tools like ANSYS and prepares them for advanced topics and industry applications in aircraft and engine design.

The guest lecture on Finite Element Methods (FEM) provided a technical overview of its role in solving complex aerospace problems using numerical modeling. The speaker explained key steps, including the discretization of the domain into ele-

Figure 2: Speaker delivering lecture on Gas Jet Engine Analysis

ments, the selection of element types (1D, 2D, and 3D elements), and the formulation of stiffness matrices based on the governing equations. The importance of boundary conditions, mesh quality, and convergence criteria was also discussed to ensure accurate and reliable simulation results.

In the context of gas turbine blade analysis, FEM is used to evaluate thermo-mechanical behavior under combined loading conditions. The speaker highlighted analysis involving centrifugal forces due to high rotational speeds, thermal gradients caused by hot gases, and creep and fatigue effects. Techniques such as steady-state and transient thermal analysis, modal analysis for vibration characteristics, and stress-life (S-N) and strain-life approaches for fatigue prediction were discussed. The use of high-temperature material models and nonlinear analysis was emphasised for realistic results.

For bird strike analysis, the lecture focused on explicit dynamic FEM techniques used to simulate high-velocity impacts. The bird is typically modeled using Smoothed Particle Hydrodynamics (SPH) or Lagrangian formulations to capture fluid-like behavior during impact. The aircraft structure is analysed for large deformation, material nonlinearity, and contact-impact conditions. Key parameters such as impact velocity, energy absorption, and stress wave propagation were explained. The speaker also mentioned the use of failure criteria (e.g., plastic deformation, fracture models) to predict damage and ensure structural safety under such extreme loading scenarios.

Figure 3: The Speaker interacting with students during the session

Outcome of the event:

The guest lecture on "UAV Systems – An Overview" successfully achieved its objectives of enhancing students' understanding of Unmanned Aerial Vehicle technologies.

- Students gained a clear understanding of the fundamental concepts of Finite Element Methods (FEM) and their role in engineering analysis.
- Students learned the process of discretization, element formulation, and the importance of boundary conditions in simulation accuracy.

- Students were exposed to real-world aerospace applications such as gas turbine blade analysis and bird strike impact analysis.
- Students developed awareness of advanced analysis techniques, including thermal, structural, and dynamic simulations.
- Students understood the importance of FEM tools (e.g., ANSYS) in modern aerospace design, enhancing their readiness for industry and research applications.

Conclusion:

The guest lecture on Finite Element Methods (FEM) provided valuable insights into both the theoretical fundamentals and practical applications in aerospace engineering. It helped students understand how complex engineering problems can be solved efficiently using numerical techniques. Through real-world examples such as gas turbine blade analysis and bird strike simulation, the session effectively demonstrated the significance of FEM in ensuring structural safety, performance, and reliability.

Report by: Prof. Gooty Rohan and Prof. Nandana

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