

St. Francis Institute of Technology
Department of Electronics and Telecommunication Engineering
Report on “Research & Development Lecture”

Topic: Railway Signal Engineering & Automatic Train Protection (KAVACH)

Date: 8 January 2026

Venue: 618

Time: 2:45 PM

A Research & Development lecture was organized by the department of EXTC to share the knowledge and insights gained by the faculty, in the Faculty Development Programme (FDP) for Engineering college teachers organized by the Indian Railways Institute of Signal Engineering and Telecommunications (IRISET), Secunderabad in a hybrid mode from 28 April 2025 to 2 May 2025. The FDP was attended by Dr Jayasudha Koti, Ms Monika Cheema and Ms Valentina Rani Basker. All three participants actively attended the sessions and gained valuable insights from the presentations delivered during the programme and shared their experiences during the R&D lecture held on 8 January 2026.

The lecture focused on modern railway signalling systems and Automatic Train Protection technology, addressing the critical transition from traditional safety mechanisms to advanced automated systems. This session aimed to share expertise on the indigenous KAVACH ATP system and its significance in enhancing railway safety standards across Indian Railways.

Details of the Presentation:

The following topics were discussed during the presentation

Core Components of Railway Safety Systems

- **Station Layout & Signalling:** The foundation of railway operations includes strategic arrangement of running lines, loop lines, sidings, points, crossings, and signals. Train signalling systems convey instructions to locomotive pilots through visual indications, ensuring safe separation between trains and preventing collisions. However, traditional line-side signalling faces limitations at high speeds and poor visibility conditions.
- **Interlocking Systems:** Interlocking represents the core safety mechanism that interconnects signals, points, and track circuits to physically prevent unsafe train movements. Relay Interlocking (RI) uses electromagnetic relays implementing fail-safe logic, where any failure automatically results in signals displaying danger. This proven technology continues to serve as the backbone of safety in Indian Railways.
- **Network & Key Management:** Modern systems require robust cybersecurity and monitoring. The Key Management System (KMS) ensures secure, authenticated wireless communication between locomotives and trackside equipment through cryptographic keys and random number generation. The Network Management System (NMS) provides centralized monitoring, diagnostics, and logging capabilities, enabling predictive maintenance and post-incident analysis.

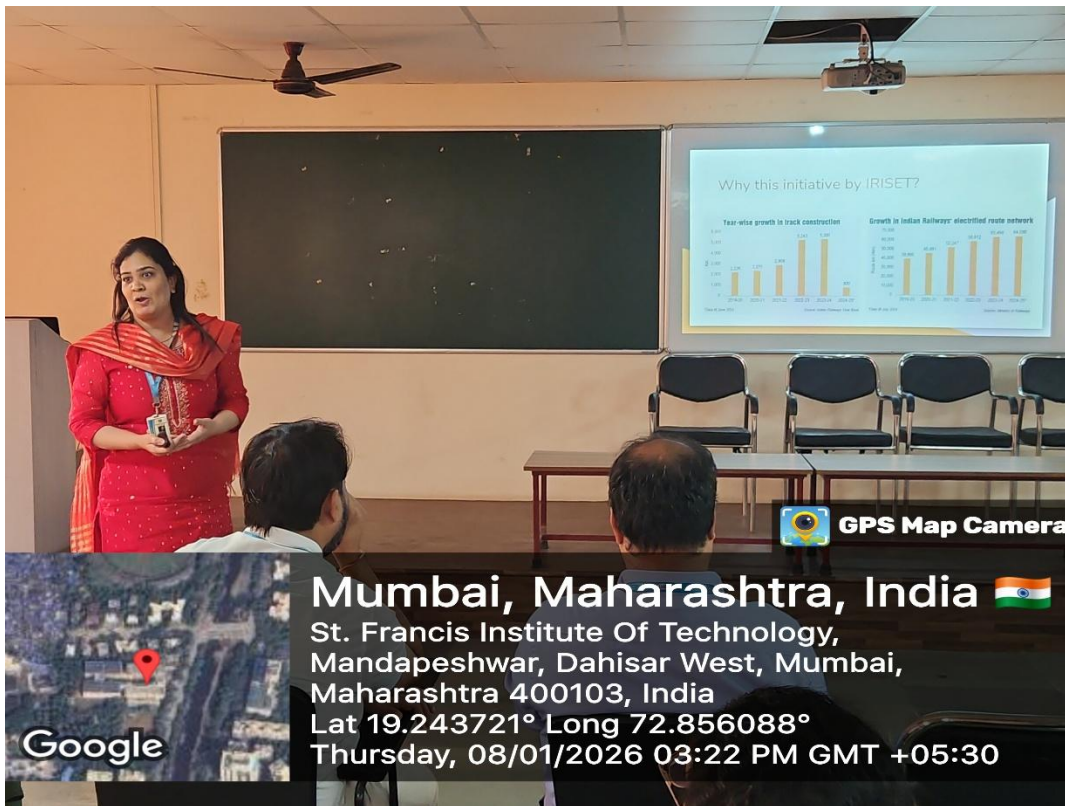
Indian Railways faces critical safety concerns including Signal Passing at Danger (SPAD), reduced visibility during fog, inadequate signal visibility at high speeds, and human error factors. With minimum stop signal visibility standards of 200 meters proving insufficient at speeds above 140 km/h, the transition

to automated protection systems becomes essential. High-speed operations exponentially increase braking distances while reducing driver reaction time, making traditional signalling alone inadequate.

KAVACH: Indigenous Automatic Train Protection System

- **System Architecture:** KAVACH is India's indigenous ATP system, mandatory for train speeds exceeding 140 km/h. It provides continuous safety supervision through real-time monitoring of train speed and signal compliance, automatically applying brakes if limits are violated regardless of driver action. The system prevents SPAD incidents, enforces overspeed protection, and enables collision avoidance.
- **Loco KAVACH:** The onboard component installed in locomotives continuously receives signalling data via wireless communication. It compares actual train speed against permitted limits derived from signal aspects and track conditions. When violations are detected, Loco KAVACH automatically intervenes by applying emergency brakes, providing both visual and audible warnings to the driver. The system maintains constant communication with stationary units and logs all operational data for analysis.
- **Stationary KAVACH:** Trackside equipment transmits real-time signalling information, track conditions, and speed restrictions to approaching trains. These units are integrated with existing interlocking systems and continuously broadcast authenticated data. Stationary KAVACH monitors track occupancy, verifies signal aspects, and coordinates with multiple trains simultaneously. The bidirectional communication enables dynamic speed profile updates and ensures situational awareness for all equipped locomotives in the section.
- **Integration & Benefits:** KAVACH seamlessly integrates signalling, interlocking, communication networks, cybersecurity protocols, and monitoring systems. Being indigenous, it is cost-effective, scalable, and adaptable to diverse Indian railway environments. The system represents a paradigm shift from reactive to preventive safety, ensuring accidents are avoided before occurrence rather than merely mitigating consequences.

Thus, the lecture discussed the evolving landscape of railway safety and the need to transition from conventional signalling practices to advanced automated protection systems. Key aspects of modern signalling, interlocking mechanisms, secure communication networks, and the indigenous KAVACH Automatic Train Protection system were covered.



Dr Jayasudha Koti
 Ms Monika Cheema
 Ms Valentina Baskar

Dr. Kevin Noronha
 HOD (EXTC Dept)