1	**Name of Course**	**Professional Diploma in Railway Signaling and Telecommunication**
2	**Max no.of Students**	30
3	**Duration**	1 Year
4	**Course Type**	Full Time
5	**No. of Days per week**	6 days
6	**No. of hours per day**	6 Hrs
7	**Space require**	66 m^2 classroom and 66 m^2 Laboratory
8	**Entry qualification**	Diploma / SE in Electronics & Telecommunication / Electronics / Electrical / Instrumentation / Mechatronics / Allied branches
9	**Objective of syllabus**	To develop industry-ready E&TC professionals with strong foundations in communication systems, signaling, embedded electronics, control, safety, and digital railway technologies aligned with modern software-driven railway infrastructure.
10	**Employment opportunities**	Student will get jobs in Government as well as Private railway companies
11	**Teachers Qualification**	ME/ M.Tech/Ph.D

12 Teaching Scheme :

Sr. No	Subject	Subject Code	Theory (Hr)	Credit	Practical(Hr)	Credit	Total
1	Railway Signaling and System Engineering	RSTPCC-01	60	4	90	3	7
2	Railway Communication Systems	RSTPCC-02	45	3	90	3	6
3	Embedded Systems, Sensors & Predictive Maintenance	RSTMDM-03	45	3	90	3	6
4	Application Engineering	RSTPP-04	45	3	90	3	6
5	Modern, Emerging Telecommunication Technologies	RSTSEC-05	45	3	90	3	6
6	Capstone Project (Industry-Oriented)	RSTCC-06	-	-	390	13	13
		Total	**240**	**16**	**840**	**28**	**44**

Sr. No	Subject	Subject Code	Sem I (Hour/Week)		Sem II (Hour/Week)	
			TH	PR	TH	PR
1	Railway Signaling and System Engineering	RSTPCC-01	2	4	2	2
2	Railway Communication Systems	RSTPCC-02	2	4	1	2
3	Embedded Systems, Sensors & Predictive Maintenance	RSTMDM-03	2	4	1	2
4	Application Engineering	RSTPP-04	2	4	1	2
5	Modern, Emerging Telecommunication Technologies	RSTSEC005	2	4	1	2
6	Capstone Project (Industry-Oriented)	RSTCC-06	-	6	-	20

Sr. No	Subject	Subject Code	Theory				Practical			Total	
			Duration (Hr.)	Max	Min	Int	Duration (Hr.)	Max	Min	Min	Max
1	**Railway IT Systems & Enterprise Software**	RCSPCC-01	3	80	32	20	-	-	-	40	100
2	**Cyber security for Railway Digital Infrastructure**	RCSPCC-02	3	80	32	20	-	-	-	40	100
3	**IoT, Embedded Systems & Predictive Maintenance**	RCSMDM-03	3	80	32	20	-	-	-	40	100
4	**Simulation, Digital Twin & Cloud Computing for Railways**	RCSPP-04	-	-	-		3	100	40	40	100
5	**Data Science, AI & Computer Vision for Railways**	RCSSEC05	-	-	-		3	100	40	40	100
6	**Capstone Project (Industry-Oriented)**	RCSCC-06	-	-	-		-	100	40	40	100
Total											600

Note:

For Paper I,II,III

Sr. No	Subject	Subject Code	Theory				Practical			Total	
			Duration (Hr.)	Max	Min	Int	Duration (Hr.)	Max	Min	Min	Max
1	**Railway IT Systems & Enterprise Software**	RCSPCC-01	3	80	32	20	-	-	-	40	100
2	**Cyber security for Railway Digital Infrastructure**	RCSPCC-02	3	80	32	20	-	-	-	40	100
3	**IoT, Embedded Systems & Predictive Maintenance**	RCSMDM-03	3	80	32	20	-	-	-	40	100
4	**Simulation, Digital Twin & Cloud Computing for Railways**	RCSPP-04	-	-	-		3	100	40	40	100
5	**Data Science, AI & Computer Vision for Railways**	RCSSEC-05	-	-	-		3	100	40	40	100
6	**Capstone Project (Industry-Oriented)**	RCSCC-06	-	-	-		-	100	40	40	100
Total											600

Internal Examinations of Total Marks: 20

Pattern / Examination nature may be as follows (Any Two of Following): Written test/ Seminar/ PPT Presentation/ Open book examination / Field Work report / Project Report etc.

RSTPCC-01 Railway Signaling and System Engineering

Duration: 60 hrs Theory + 90 hrs Practical

Course Objectives

1. To make student realize different types of signals and signaling
2. To make students understand preparation of signaling plans for single line and double line.
3. To introduce to students concept of block systems used on Indian Railways.
4. To Analyze various types of signaling technologies
5. To Design and evaluate railway signaling layouts

Course Outcomes

After completing this course, the learner will be able to:

CO1: Student can describe different types of signals.
CO2: Student can plan signaling in railway signaling.
CO3:Student can describe signaling plan for single line.
CO4: Student can describe about block system used in Indian Railways.

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Module	Module Title & Topics	Hours
Module 1	**Introduction to Railway Signaling** 1. Role of signaling in safe and efficient railway operations 2. Objectives and functions of railway signaling systems 3. Basic signaling concepts and terminology 4. Historical evolution of railway signaling 5. Overview of signaling in Indian Railways	**7**
Module 2	**Fixed Signals – Types and Characteristics** 1. Fixed signals and their importance 2. Kinds of fixed signals 3. Signal aspects and indications 4. Designation and numbering of signals 5. Location of signals on railway tracks	**7**
Module 3	**Signal Types and Signaling Plans** 1. Classification of signals based on function 2. Engineering plan and its significance 3. Signaling plan and layout principles 4. Standard signaling symbols and conventions 5. Interpretation of signaling drawings	**8**

Module 4	**Subsidiary Signals and Visibility Aspects** 1. Subsidiary signals and their applications 2. Repeaters, indicators, markers, and back lights 3. Breaking distance and its importance 4. Sighting distance and visibility of signals 5. Isolation and overlaps in signaling	**7**
Module 5	**CAD Tools and Train Reception Operations** 1. AutoCAD basics for signaling drawings 2. Preparation of signaling layouts using CAD tools 3. Simultaneous reception of trains 4. Simultaneous despatch of trains 5. Operational safety during reception and despatch	**7**
Module 6	**Systems of Working in Railways** 1. Concept of systems of working 2. Absolute Block System – principles and operation 3. Automatic Block System – features and advantages 4. Comparison between absolute and automatic block systems 5. Applications in single and double line sections	**8**
Module 7	**Classification of Stations** 1. Need for station classification 2. Class A, B, and C stations – features 3. Comparison of Class A, B, and C stations 4. MAUQ and MLQ operations 5. Operational constraints and safety aspects	**8**
Module 8	**Signaling Planning and Safety Standards** 1. Preparation of signaling plans for single-line sections 2. Preparation of signaling plans for double-line sections 3. Introduction to railway safety standards 4. EN 50126, EN 50128, and EN 50129 standards 5. Safety Integrity Levels (SIL) and their applications	**8**

Practical List

1. Study of Role of Signaling in Railway Operations
   Understand how signaling ensures safety, punctuality, and efficient train movement.
2. Identification of Railway Signaling Terminology and Concepts
   Study basic signaling terms, definitions, and operational concepts.
3. Study of Fixed Signals Used in Railways
   Identify types, kinds, aspects, and indications of fixed signals.

4. Analysis of Signal Aspects and Indications
   Interpret different signal aspects and their corresponding train movements.
5. Study of Designation and Numbering of Signals
   Understand standard practices for signal designation and numbering.
6. Study of Location of Signals in Railway Track Layouts
   Analyze correct placement of signals in yards and station sections.
7. Preparation of Engineering Plan for a Railway Station
   Draw and interpret an engineering plan showing tracks and signaling assets.
8. Preparation of Signaling Plan Using Standard Symbols
   Develop a signaling plan using approved railway signaling symbols.
9. Study of Subsidiary Signals and Their Applications
   Identify calling-on, shunt, and other subsidiary signals.
10. Study of Repeaters, Indicators, Markers, and Back Lights
    Understand their function in improving visibility and safety.
11. Calculation of Breaking Distance in Railway Signaling
    Perform calculations related to braking distance under given conditions.
12. Calculation of Sighting Distance and Signal Visibility
    Evaluate signal visibility based on sighting distance requirements.
13. Study of Isolation and Overlaps in Signaling
    Analyze the importance of overlaps and isolation for safe train operation.
14. Introduction to AutoCAD for Signaling Drawings
    Learn basic AutoCAD commands relevant to signaling layouts.
15. Preparation of Signaling Plan Using AutoCAD
    Draw a simple signaling plan for a station using CAD tools.
16. Study of Simultaneous Reception of Trains
    Analyze signaling requirements for simultaneous reception.
17. Study of Simultaneous Despatch of Trains
    Understand signaling and interlocking conditions for despatch operations.
18. Study of Absolute Block System
    Observe block working principles through diagrams and case studies.
19. Study of Automatic Block System
    Analyze automatic signaling operation and compare with absolute block system.
20. Study of Railway Safety Standards and SIL Levels
    Understand EN 50126 / EN 50128 / EN 50129 standards and Safety Integrity Levels.

Teaching & Learning Methodology

- Classroom lectures with diagrams and real railway layouts
- Chalk-and-talk explanation of signaling concepts
- Demonstration of signaling plans and CAD drawings
- Case studies from Indian Railways signaling practices
- Assignments and tutorials on station signaling layouts

Reference Books & Resources

Books:

- Railway Signaling – M. Rangaraj, Tata McGraw-Hill
- Indian Railway Signaling – S. K. Khanna, Katson Publishing
- Railway Engineering – Satish Chandra & M. M. Agarwal, Oxford University Press
- Signaling Principles and Practice – Institution of Railway Signal Engineers (IRSE)

Online Resources:

- IRSE Technical Papers
- RDSO official website and publications
- Indian Railways Institute of Signal Engineering & Telecommunications (IRISET) training materials

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RSTPCC-02 Railway Communication Systems

Duration: 45 hrs Theory + 90 hrs Practical

Course Objectives

1. To make Students realize concepts of points.
2. To make Students understand level crossing gates and classification.
3. To make students understand the principles of interlocking.
4. To introduce to students advantages, disadvantages and application of principles of signal engineering.

Course Outcomes (COs)

After completing this course, the learner will be able to:

CO1: Student can describe concepts of points.

CO2: Student can describes level crossing gates and classification.

CO3: Student can describe the principles of interlocking.

CO4: Student can describe about advantages, disadvantages and application of principles of signal engineering.

Module	Module Title & Topics	Hours
Module 1	**Points and Their Operational Concepts** 1. Definition and purpose of points in railway signaling 2. Types of points and their construction 3. Location of points in station layouts 4. Range and limits of point operation 5. Safety considerations in point operation	**7**
Module 2	**Level Crossing Gates – Classification and Location** 1. Classification of level crossing gates 2. Location of level crossing gates on railway sections 3. Protection of level crossings inside station limits 4. Level crossings at Class 'A' stations 5. Level crossings at Class 'C' stations	**7**
Module 3	**Control of Level Crossings in Signaling Systems** 1. Level crossings located within station limits 2. Level crossing control in MAS signaling 3. Interlocking of level crossing gates with signals 4. Control of level crossings in automatic signaling sections 5. Safety and operational procedures at level crossings	**8**

Module 4	**Standards and Essentials of Interlocking** 1. Need for interlocking in railway signaling 2. Standards of interlocking 3. Essentials of interlocking systems 4. Minimum equipment for previous interlocking standards 5. Evolution of interlocking practices	**5**
Module 5	**Interlocking Parameters and Route Holding** 1. Parameters for setting of switches 2. Speed of trains over points (standard-wise) 3. Route setting and route locking 4. Route holding principles 5. Application of interlocking principles in yards	**5**
Module 6	**Railway Communication Systems** 1. GSM-R fundamentals and applications 2. LTE-R and 5G-R overview 3. MPLS and IP-based railway communication networks 4. TETRA radio and train-to-ground communication 5. Reliability and safety in railway communication	**7**
Module 7	**Passenger Information and Surveillance Systems** 1. Passenger information systems (PIS) 2. Real-time train information display systems 3. CCTV systems in stations and coaches 4. Integration of PIS and CCTV with control centers **5.** Cybersecurity and data privacy in passenger systems	**7**

Practical List

1. Study of points and their role in railway signaling
2. Identification of point locations in a station layout
3. Study of range and operation of railway points
4. Study of classification of level crossing gates
5. Analysis of location of level crossing gates on railway sections
6. Study of protection of level crossings inside station limits
7. Case study of level crossings at Class ‘A’ stations
8. Case study of level crossings at Class ‘C’ stations
9. Study of level crossing control in MAS signaling
10. Study of level crossing control in automatic signaling sections
11. Study of standards of interlocking
12. Identification of essentials of interlocking systems
13. Study of parameters for setting of switches
14. Analysis of train speed over points as per standards

15. Study of route setting, locking, and route holding
16. Study of GSM-R communication system architecture
17. Study of LTE-R / 5G-R railway communication systems
18. Study of MPLS and IP-based railway communication networks
19. Study of passenger information and CCTV systems
20. Study of signal aspect control and indication circuits

Teaching & Learning Methodology

- Classroom lectures with diagrams and real railway layouts
- Chalk-and-talk explanation of signaling concepts
- Demonstration of signaling plans and CAD drawings
- Case studies from Indian Railways signaling practices
- Assignments and tutorials on station signaling layouts

Reference Books & Resources

Books:

- Railway Signaling – M. Rangaraj, Tata McGraw-Hill
- Indian Railway Signaling – S. K. Khanna, Katson Publishing
- Railway Engineering – Satish Chandra & M. M. Agarwal, Oxford University Press
- Signaling Principles and Practice – Institution of Railway Signal Engineers (IRSE)

Standards & Guidelines:

- Indian Railways Signal Engineering Manual (SEM)
- EN 50126 / EN 50128 / EN 50129 Railway Safety Standards
- RDSO Signaling Documentation

Online Resources:

- IRSE Technical Papers
- RDSO official website and publications
- Indian Railways Institute of Signal Engineering & Telecommunications (IRISET) training materials

RSTMDM-03: Embedded Systems, Sensors & Predictive Maintenance

Duration: 45 hrs Theory + 90 hrs Practical

Course Objectives

1. Understand embedded systems and controllers used in railway applications
2. Identify and interface sensors used for railway monitoring
3. Acquire and process field data using standard interfaces and protocols
4. Apply wireless sensor networks for track and coach monitoring
5. Implement predictive maintenance concepts using sensor data
6. Understand safety standards applicable to railway embedded systems

Course Outcomes (COs)

After completing this course, students will be able to:

CO1: Explain embedded system architecture used in railway signaling and monitoring
CO2: Interface railway sensors for speed, vibration, and axle counting
CO3: Acquire and transmit sensor data using appropriate interfaces and protocols
CO4: Apply wireless sensor networks for railway asset monitoring
CO5: Implement basic predictive maintenance techniques
CO6: Apply safety standards such as EN 50128 and IEC 61508 in embedded applications

Module	Module Title & Topics	Hours
Module 1	**Introduction to Embedded Systems in Railways** 1. Overview of embedded systems in railway applications 2. Role of controllers in signaling and monitoring systems 3. PLCs and their applications in railway control 4. RTUs and remote monitoring systems 5. Reliability and safety requirements of railway embedded systems	**7**
Module 2	**Controllers, PLCs and RTUs** 1. Microcontrollers used in railway electronics 2. PLC architecture and working principle 3. Input/output modules of PLCs 4. RTU architecture and communication 5. Comparison of PLCs and RTUs in railways	**7**
Module 3	**Railway Sensors and Instrumentation** 1. Classification of sensors used in railways 2. Speed sensors and their applications 3. Vibration sensors for condition monitoring 4. Axle counters and train detection	**8**

	5. Sensor selection criteria for railway use	
Module 4	**Data Acquisition and Field Interfaces** 1. Data acquisition systems in railways 2. Analog-to-Digital Converters (ADCs) 3. Field interfaces and signal conditioning 4. Communication protocols for sensor data 5. Reliability and accuracy in data acquisition	**8**
Module 5	**Wireless Sensor Networks for Railways** 1. Concept of wireless sensor networks (WSN) 2. WSN architecture for railway applications 3. Track monitoring using wireless sensors 4. Coach health monitoring systems 5. Challenges and limitations of WSN in railways	**7**
Module 6	**Predictive Maintenance Concepts** 1. Maintenance strategies in railways 2. Condition-based maintenance concepts 3. Sensor-based fault detection 4. Data analysis for predictive maintenance 5. Benefits of predictive maintenance in railways	**8**

Practical List

1. Study of embedded systems used in railway applications
2. Identification of railway controllers, PLCs, and RTUs
3. Introduction to microcontroller programming
4. PLC programming basics for railway applications
5. Interfacing speed sensor with embedded controller
6. Interfacing vibration sensor for condition monitoring
7. Study of axle counter operation and applications
8. Data acquisition using ADC
9. Signal conditioning for railway sensors
10. Study of field communication protocols
11. Wireless sensor network architecture study
12. Track monitoring using wireless sensor nodes (simulation)
13. Coach health monitoring using sensor data
14. Data logging and visualization for railway sensors

15. Fault detection using sensor thresholds
16. Embedded fault monitoring system design
17. Condition-based maintenance case study
18. Predictive maintenance logic implementation
19. Study of EN 50128 compliance requirements
20. Study of IEC 61508 and SIL levels

Teaching & Learning Methodology

Classroom lectures with case studies from Indian Railways & global operators.

1. Hardware demonstrations of IoT-enabled railway systems.
2. Lab-based experiments for embedded programming & IoT data analysis.
3. Mini-projects integrating sensors and cloud platforms.

Reference Books & Resources

Books:

- Embedded Systems: Introduction to ARM Cortex-M Microcontrollers – Jonathan W. Valvano
- Programmable Logic Controllers – Frank D. Petruzella
- Internet of Things: Principles and Paradigms – Rajkumar Buyya
- Predictive Maintenance in Smart Factories – Jan Holler
- Railway Safety, Reliability and Security – Xing Liu

Standards & Technical References:

- EN 50128 – Railway Applications: Software for Railway Control and Protection Systems
- IEC 61508 – Functional Safety of Electrical/Electronic Systems
- Indian Railways RDSO signaling and safety documents

Online Resources:

- IRISET training materials
- Arduino and PLC manufacturer documentation
- RDSO and Indian Railways technical publications

RSTPP-04 Application Engineering

Duration: 45 hrs Theory + 90 hrs Practical

Course Objectives

1. Understand relay concepts and their applications in railway signalling.
2. Identify and analyze different types of signaling relays and circuits.
3. Explain track detection methods and relay interlocking principles.
4. Design and interpret signaling plans and tables of control.
5. Understand power supply, cabling, and layouts for railway signalling.
6. Analyze the impact of electrification on signaling systems

Course Outcomes (COs)

After completing this course, the learner will be able to:

CO1: Explain relay principles and types used in railway signaling
CO2: Interpret signaling circuits, symbols, and track detection devices
CO3: Apply relay interlocking and signal locking concepts
CO4: Prepare and analyze signaling plans and tables of control
CO5: Understand power supply, cabling, and relay room layouts
CO6: Evaluate signaling arrangements in electrified railway areas

Module	Module Title & Topics	Hours
Module 1	**Relay Concepts and Signaling Fundamentals** 1. Basic concepts of electrical relays 2. Types of relays used in railway signaling 3. Symbols used in signaling circuits 4. Introduction to signaling circuit concepts 5. Applications of relays in railway safety systems	**7**
Module 2	**Track Detection and Relay Interlocking** 1. Track detecting devices and their principles 2. Track circuits and axle counter basics 3. Introduction to relay interlocking systems 4. Sequence of operations on control panels 5. Overview of signaling plans and control tables	**8**
Module 3	**Signaling Plans and Control Tables** 1. Components of a signaling plan 2. Preparation of signaling plan diagrams 3. Concept and structure of control tables 4. Interpretation of signaling plans with control tables 5. Practical significance in station operations	**7**

Module 4	**Electromagnetic Signaling Relays** 1. Characteristics of electromagnetic relays 2. Classification of signaling relays 3. Marking of track circuits 4. Applications of electromagnetic relays 5. Reliability and fail-safe operation of relays	**8**
Module 5	**Point Control and Point Machines** 1. Point control circuits and functions 2. Types of point machines 3. Working principle of point machines 4. Detection and locking of points 5. Safety aspects in point operation	**7**
Module 6	**Locking and Signal Logic Circuits** 1. Track locking concepts 2. Various locking arrangements on signals 3. Logic circuits used in signaling 4. Signal control circuits 5. Interlocking logic implementation	**8**

Practical List

1. Study of relay concepts used in railway signaling
2. Identification of types of signaling relays
3. Study of signaling symbols and circuit diagrams
4. Study of basic signaling circuits
5. Study of track detecting devices
6. Study of track circuits and axle counters
7. Study of relay interlocking system
8. Sequence of operations on signaling control panel
9. Preparation of a simple signaling plan
10. Preparation of control table from signaling plan
11. Study of electromagnetic relay characteristics
12. Classification and marking of signaling relays
13. Study of point control circuits
14. Study of point machines and their working
15. Study of track locking arrangements

16. Study of signal locking and logic circuits
17. Preparation and practice of table of control
18. Study of signaling power supply arrangements
19. Study of cables, relay room, and cable layouts
20. Study of signaling in electrified railway areas

Teaching & Learning Methodology

- **Lectures:** Theoretical foundation with tool demonstrations.
- **Labs:** Hands-on use of simulation software, cloud platforms, and GIS tools.
- **Case Study Analysis:** Evaluation of real-world railway digital twin deployments.
- **Mini Projects:** Application of simulation and cloud tools to railway problems.

Reference Books & Resources

Books:

- Railway Signaling **– M. Rangaraj, Tata McGraw-Hill**
- Indian Railway Signaling **– S. K. Khanna, Katson Publishing**
- Railway Engineering **– Satish Chandra & M. M. Agarwal**
- Signaling Principles and Practice **– IRSE**

Online Resources:

- IRISET signaling training materials
- RDSO official publications
- IRSE technical papers

RSTSEC-04: Modern, Emerging Telecommunication Technologies

Duration: 45 hrs Theory + 90 hrs Practical

Course Objectives

1. To make Students realize concepts of Electronic interlocking, software and Data preparation.
2. To make Students understand the Train control system and various communication systems.
3. To make students understand the auxiliary warning systems and axel counter block working.
4. To introduce to students the Train collision avoidance system.
5. To Apply knowledge of protocols and standards in telecom system design.

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Students can describe concepts of Electronic interlocking, software and Data preparation.
CO2: Students can describe the Train control system and various communication systems.
CO3: Students can describe the auxiliary warning systems and axel counter block working.
CO4: Students can describe train collision avoidance systems.
CO5: Explain SCADA architecture and IoT integration in railways
CO6: Describe advanced train control and collision avoidance systems

Module	Module Title & Topics	Hours
Module 1	**Introduction to Electronic Interlocking** 1. Definition and concept of electronic interlocking 2. Purpose and role of electronic interlocking in railways 3. Necessity of electronic interlocking systems 4. Safety and reliability aspects 5. Applications in Indian Railways and metros	**7**
Module 2	**Relay Interlocking vs Electronic Interlocking** 1. Limitations of relay interlocking 2. Advantages of electronic interlocking over relay interlocking 3. Comparative analysis of relay and electronic interlocking 4. Fail-safe principles in electronic interlocking 5. Evolution of interlocking technologies	**7**

Module 3	**Electronic Interlocking System Architecture** 1. Components of electronic interlocking system 2. Configuration of electronic interlocking system 3. Input–output interfaces and redundancy 4. Installation of electronic interlocking system 5. Maintenance practices for electronic interlocking	**8**
Module 4	**Hardware, Software and Data Preparation** 1. Hardware components of electronic interlocking 2. Software architecture and application programs 3. Concept of data preparation 4. Application programs for train control systems 5. Verification and validation of signaling software	**8**
Module 5	**Railway Communication Systems and Cables** 1. Communication systems used in railways 2. Radio communication and related software 3. Types of cables used in railways 4. Indoor, outdoor, and power cables 5. Telecom cables and their applications	**7**
Module 6	**Cable Types and Testing Practices** 1. Screened and unscreened cables 2. Difference between screened and unscreened cables 3. Cable laying practices in railways 4. Testing of cables before laying 5. Testing of cables after laying	**8**

Practical List

1. Study of electronic interlocking system components
2. Comparison study of relay and electronic interlocking
3. Study of EI system configuration
4. Study of EI installation practices
5. Study of EI maintenance procedures Identification of hardware components of EI
6. Study of EI software architecture
7. Data preparation exercise for electronic interlocking
8. Study of application program for train control
9. Study of railway communication systems
10. Study of radio communication used in railways
11. Identification of indoor, outdoor, and power cables
12. Comparison of screened and unscreened cables
13. Study of telecom cables used in railways

14. Cable testing before laying
15. Cable testing after laying
16. Study of SCADA system for station control
17. Study of traction SCADA system
18. Study of Train Collision Avoidance System (TCAS)
19. Study of ERTMS and CBTC systems

Teaching & Learning Methodology

- PPT with real-life railway communication systems
- Diagrams of OFC, radio, and cable networks
- Videos on GSM-R / LTE-R concepts
- Chart preparation on communication systems
- Cable identification activity
- Short notes on radio communication software

Reference Books & Resources

Books:

- Railway Signalling and Interlocking – J.S. Mundrey
- Modern Railway Signalling – G.R. Sinha
- Railway Engineering – Saxena & Arora
- Signalling Principles – Indian Railways Institute of Signal Engineering & Telecommunications (IRISET)
- Electronic Interlocking Systems – IRISET Training Manuals

Case Study References:

- Indian Railways accident enquiry reports related to signaling
- EI commissioning case studies from:
  IRISET Secunderabad
  DMRC signaling system
- Metro Rail EI installations
- Comparison studies of Relay Interlocking vs EI in IR stations

Online Resources:

- IRISET Official Website – Training notes & presentations
- Indian Railways Signal Engineering Manuals (SEM)
  DMRC Signaling System Documentation
  YouTube Channels:
  IRISET Official
- Railway Technical Videos (Signaling & Telecom)
- IEEE Xplore – Research papers on electronic interlocking & safety systems

RSTCC-06 Capstone Project (Industry-Oriented)

Duration: 390 Hrs (Theory + Practical combined)

Course Objective

1. To carry out a thematic design project in one of the specializations of Railway Signaling and telecommunication.
2. To carry out a project that will make the students aware of the different facets of Railway Signaling and telecommunication.
3. To explore the skill and abilities of student to work in team

Course Outcomes (COs)

Upon completion, students will be able to:

CO1:Design and develop a thematic project related to a selected specialization in Railway Signaling and Telecommunication, applying appropriate engineering concepts, tools, and standards.

CO2:Analyze and explain the various facets of Railway Signaling and Telecommunication systems, including signaling, interlocking, communication, safety, and maintenance aspects, through project implementation and documentation.

CO3: Demonstrate teamwork, coordination, and project management skills by effectively working in a group to plan, execute, and present a railway signaling or telecommunication project.

CO4:Communicate technical ideas, designs, and project outcomes clearly through project reports, presentations, and reviews, following professional and ethical practices.Project Work Components (Suggested Breakdown)

Sr. No.	Project Component	Description	Hours
1	**Problem Identification & Requirement Analysis**	Students identify a **realistic problem** related to **Railway Signaling and Telecommunication** (such as interlocking, communication reliability, safety enhancement, or automation). They analyze **operational needs, safety constraints, standards, and user requirements** through literature survey, case studies, and system manuals. Functional and non-functional requirements are clearly defined, considering **Indian Railways / Metro norms**, safety, reliability, and feasibility.	**50**
2	**Tool Familiarization & Skill Readiness**	Students gain hands-on exposure to **hardware, software, and simulation tools** relevant to railway signaling and telecom systems, such as signaling diagrams, data preparation formats, communication tools, and basic modeling/simulation platforms. Training focuses on **safe handling, configuration, testing, and documentation practices**. Team	**40**

		members allocate roles and develop the required technical and collaborative skills.	
3	**System Design & Architecture**	Based on analyzed requirements, students design the **overall system architecture**, including block diagrams, hardware–software integration, data flow, and communication interfaces. Emphasis is given to **fail-safe principles, redundancy, safety integrity, and standard compliance**.	**70**
4	**Development & Implementation**	Students implement the proposed **railway signaling or telecommunication system/project** as per the approved design and architecture. This includes **hardware assembly, software development, data configuration, and system integration** while following standard engineering and safety practices. Team members execute assigned roles, manage resources, and maintain proper documentation during implementation.	**150**
5	**Testing & Validation**	The developed system is tested using **structured test plans** to verify functional performance, safety requirements, and reliability. Students carry out **unit testing, integration testing, and system-level validation**, ensuring compliance with signaling principles and fail-safe behavior. Test results are analyzed, documented, and corrective actions are taken where required.	**45**
6	**Industry Practices, Safety & Professional Skills**	Students follow **industry-relevant practices** such as adherence to **railway standards, safety protocols, ethical conduct, and quality documentation**. Emphasis is placed on **safety-critical thinking, risk awareness, professional communication, teamwork, and time management**. Students present their work in a professional manner through reviews, reports, and demonstrations.	**20**
7	**Documentation & Presentation**	Preparation of final project report, technical documentation, user manuals, test reports, presentation slides, demo preparation, and viva voce readiness.	**15**
	Total		**390 Hours**

Example Project Ideas

A. Railway Signaling Project Ideas

1. **Mini Electronic Interlocking (EI) System Model**
   Design and implement a small-scale EI model for a station yard using relays / PLC / microcontroller with fail-safe logic.
2. **Computer-Based Interlocking (CBI) Simulation**
   Develop software to simulate route setting, locking, and releasing functions of an interlocking system.
3. **Automatic Signal Control Using Track Occupancy Detection**
   Implement signal aspects based on track occupancy using sensors and control logic.
4. **Point Machine Control and Monitoring System**
   Design a system to control and monitor turnout positions with indication and safety interlocks.
5. **Level Crossing Gate Control System**
   Automatic gate operation based on train detection with audio-visual warning and safety interlocking.

B. Railway Telecommunication Project Ideas

6. **Railway Communication Network Model Using OFC**
   Simulate data transmission between stations using optical fiber communication.
7. **Railway Station PA & Emergency Announcement System**
   Design a public address system integrated with emergency alerts.
8. **GSM-R / LTE-R Based Train–Station Communication Model**
   Study and simulate train-to-station communication for signaling or emergency messages.
9. **Wireless Sensor Network for Track Condition Monitoring**
   Use wireless sensors to monitor vibration, temperature, or rail cracks.
10. **Train Arrival Information Display System**
    Develop a real-time passenger information system using wired/wireless communication.

C. Safety, Monitoring & Smart Railway Projects

11. **Fail-Safe Signal Control System**
    Design a signaling system that defaults to safe conditions during failures.
12. **Track Intrusion Detection System**
    Use IR / camera / sensor-based system to detect unauthorized track entry.
13. **Remote Monitoring of Signaling Equipment**
    Monitor status of signals, point machines, and cables using IoT concepts.
14. **Cable Fault Detection and Localization System**
    Detect and locate faults in railway signaling cables.

Teaching & Learning Methodology

- Guided project mentorship by faculty and industry experts.
- Collaborative teamwork with defined roles (developer, tester, documentation, presentation).
- Agile/scrum style iterative development encouraged.

- Regular reviews and feedback sessions.

Assessment Scheme

Assessment Component	Weightage
Problem Definition & Requirement Analysis	10%
System Design & Architecture	15%
Implementation & Integration	40%
Testing & Validation	15%
Documentation & Presentation	20%

Reference Books & Resources

- **Railway Signalling and Interlocking** – J. S. Mundrey
  Comprehensive coverage of signaling principles, relay and electronic interlocking, safety concepts.
- **Modern Railway Signalling** – G. R. Sinha
  Detailed explanation of modern signaling systems, EI, and communication techniques.
  Railway Engineering – Saxena & Arora
- Useful for fundamentals of railway systems, signaling overview, and practical aspects.
  Indian Railways Signal Engineering Manual (SEM)
- Official manual covering standards, practices, and safety procedures.
  Electronic Interlocking Systems – IRISET Manuals
- Practical training material on EI architecture, data preparation, installation, and maintenance.