

Postgraduate Taught Programmes in Railway Systems Engineering and Integration



Railways have a key role in sustaining and enhancing the economic and social fabric of cities, regions and whole countries, at minimal cost to our environment.

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- Master of Science Degree (12 months full-time or 24 months part-time)
- Postgraduate Diploma (8 months full-time or 20 months part-time)
- Postgraduate Certificate (4 months full-time or 8 months part-time)
- Continuing Professional Development Options (1 week modules)

Postgraduate Taught Programmes in Railway Systems Engineering and Integration

Railway Systems Engineering and Integration has been taught at the University of Birmingham since 2005, building on the success of the MSc in Railway Systems Engineering, sponsored by British Rail at the University of Sheffield from 1995. To date, some 250 graduates from 25 countries have been awarded a qualification which is greatly valued by the railway industry. Many graduates now occupy senior positions in progressive railway organisations.

Who should attend

This postgraduate programme for the railway industry is intended for practicing railway engineers and engineering managers from all disciplines and functional specialisations. The part-time version is structured in such a way as to allow attendance by students from Britain, continental Europe and Overseas, without affecting their ability to play a full role at their place of work. The full-time programme suits numerate graduates who wish to enter the railway industry and professionals working in the industry who wish to upskill in the shortest possible time.

Programme content

The taught programme consists of lectures, workshops and tutorials, combined with directed reading, multimedia based research and the preparation of essays based on the analysis of the material studied. The following topics are covered in depth during the programme:

- Strategic Management of Railway Operations
- Railway Rolling Stock Systems Design
- Railway Traction Systems Design
- Systems Engineering and Integration for Dependability
- Railway Infrastructure and Track Systems
- Train Control Systems Engineering
- Railway Economics and Technology Management
- Ergonomics and Human Factors for Railways

Railway engineering specialists and senior managers active in the railway industry contribute the most recent discoveries and knowhow in lectures that represent about 50% of the contact time on this course. Many of the contributors are employed by sponsors of the programme, such as Atkins, Bechtel, Bombardier, Deltarail, Halcrow, London Underground, Network Rail, Swiss Federal Railways, Tubelines and Virgin Trains. Companies such as Irish Rail and Renaissance Trains regularly support the programme in this way.

Each module includes a team based activity that allows participants to reinforce their understanding of the major issues presented in lectures and to learn from the experience of the other members of the group. Some modules also include industrial visits.

An individual research project allows students on the MSc pathway to engage in the in-depth study of a railway related systems engineering and integration topic, either as part of an industry-related or university-based project.



Pathways

- MSc: Involves taught modules worth 120 credits and a major project which is worth 60 credits.
- Diploma: Involves taught modules worth 120 credits. Students may upgrade to MSc status if they perform well.
- Certificate: Requires successful completion of 60 credits.

Programme overview

Globalisation of economic activity, in terms of both production and consumption, relies on the presence of effective and efficient freight transport systems. Urbanisation and increasing distances between home and workplace require passenger transport operating at short intervals and elevated commercial speeds.

Towards the end of the 20th century it became apparent that this ever increasing demand for mobility could no longer be satisfied by road transport without creating significant environmental impact through noise,



atmospheric pollution and land take. This has been recognised by local, regional and national governments, as well as international stakeholders. Railways represent ideal solutions to transport problems where traffic volumes and service intensity are high. However, railways had been neglected in many countries between 1960 and the early 1980s. When they re-emerged as a sustainable solution to transport needs in the 1990s, many systems required substantial upgrading before they could offer the expected benefits in terms of speed, reduced congestion and greater safety.

In 1991, the European Commission issued its Directive 91/440, aimed at enhancing the competitiveness of the European railways by ensuring transparency of costs and revenues. The UK government chose to implement the directive by privatising Britain's railway into infrastructure and train operations separately, thereby fragmenting the vertically integrated railway into some 100 contractually linked businesses. Many people in the industry felt that this development would lead to conflicts and, ultimately, reduced performance, due to a lack of joined-up thinking.

In 1995, the University of Sheffield launched its MSc programme in Railway Systems Engineering, with sponsorship from the then British Railways Board and with the support of the UK engineering institutions, in particular, the Institution of Mechanical Engineers. The

stimulus for this initiative was the realisation that modern railways require multidisciplinary approaches to ensure success in engineering and operations. The programme flourished at Sheffield, producing more than 200 graduates of 21 nationalities, including 150 from the UK. In summer 2005, the MSc team moved to the Rail Research and Education Centre at the University of Birmingham, the home of Rail Research UK (RRUK).

The MSc programme in Railway Systems Engineering and Integration (RSEI) at Birmingham offers truly interdisciplinary postgraduate study. The objective of the course team is to encourage a thorough understanding of the principles involved in developing, designing and operating modern railway systems, as well as to develop in postgraduates a robust understanding of the issues involved in interface management for both existing and new railway systems. The programme has a strong focus on developing individuals' railway engineering knowledge and management know-how, their systems integration skills and their ability to work in focused project teams.

Many participants are experienced railway engineers and managers, sponsored by their employers, but the programme also allows new entrants to the railway industry to familiarise themselves with the specialist disciplines involved in railway systems while

gaining a strong understanding of the complex interactions between the subsystems. The taught part of the programme in RSEI is built around eight class taught modules of 10 credits each, two research modules of 20 credits, four supplementary modules and an integrating dissertation attracting 60 credits, all at Masters level. An assessed module involves about 30 hours of teaching, 20 hours of tutorials, a major team exercise and some 50 hours of independent study. The assessment of learning is based on class tests, assignments and end of year examinations. All modules are assessed separately, to allow flexible study.

Qualifications and modes of attendance

Successful completion of four taught modules and one research module (60 credits) leads to the award of a Certificate in RSEI, that of eight taught modules and two research modules (120 credits) results in the award of the Diploma in RSEI, completion of 120 taught credits, combined with the dissertation (60 credits), entitle a participant to receive the degree of MSc in RSEI.

Full-time study requires attendance at the University for eight months (October to May) for the taught modules, followed by the dissertation, occupying four months. Part-time students from Britain, Ireland and mainland Europe complete modules LMR31, LMR33, LMR35 and LMR37 in year one and LMR32, LMR34, LMR36 and LMR38 in year two. Part-time students from overseas complete LMR31, LMR32, LMR35 and LMR36 in year one and LMR33, LMR34, LMR37 and LMR38 in year two, thus requiring two three week periods in Birmingham in each academic year.





Overseas students may elect to take the exams in their home country. Most students undertake their dissertation projects as part of their work in the sponsor's company or during a placement with a sponsor. In the case of part-time study, the dissertation project is often completed in the third year of study with only very limited attendance, if any, at University.

Entry requirements, admissions process and fees

The normal entry requirement for the programme in RSEI is a good honours degree in a numerate discipline, such as engineering, physics or economics. Most candidates will have some experience of working in the railway industry, although pre-course placements can be arranged for recent graduates. All applicants for study on the programme are interviewed by a member of the programme team, either face to face or by telephone. Candidates with non-standard qualifications but substantial industrial experience in a relevant field and working at graduate engineer level can be admitted to the Diploma programme with later transfer to the MSc, subject to performance.

Applications can be made via the University website or a paper form at any time. The fees for the programme (available on request from: j.whitehouse@bham.ac.uk) reflect the value added through the close co-operation between companies and university.

Most candidates are successful in obtaining sponsorship from their employer. Over the past 14 years, programme sponsors have included Deltarail, Atkins, Network Rail, Balfour Beatty, Halcrow, London Underground, Metronet, Queensland Rail, Pakistan Railways, Singapore LTA, Tubelines, Virgin Trains and many others.

Sponsorship may also be available from the British Council for overseas applicants working at senior level (Chevening Scholarships). There are also up to two University central bursaries which cover part-time fees only. Fuller details can be obtained by contacting the admissions administrator.

Module descriptions

Mathematics as an Engineering Tool LMR20 (September)

This module allows students to re-acquaint themselves with the mathematical tools needed to undertake the MSc programme in RSEI. It includes a review of GCSE and A-level mathematics, the derivation of differential equations from the physical characteristics of systems, the use of specialist engineering software and the application of standard software tools to engineering tasks. The module is optional for students with a first degree in a numerate subject. An additional fee is payable.

Induction Days LMR00 (September)

This weekend course prepares the new students for the challenges of postgraduate study. It consists of an introduction to railway systems engineering, a team activity, lectures on the history of railways, on the legislative and financial background of European railways and on the structure of the British and European rail industry. It also includes an introduction to human factors and safety issues. A thorough grounding in research techniques and in academic writing is also provided.

Strategic Management of Railway Operations LMR31 (October)

The contributors to this module cover railway management and operations activities, from demand based railway planning through to inter-modal freight transport operations, all in the context of the special characteristics of the rail mode of transport. Areas addressed include the management of complexity, marketing, freight and passenger train services, human resource management and environmental issues, as well as operations management and economics for the rail industry. The module is led by the Department of Civil Engineering, with many speakers from the railway industry. It includes a visit to a light rail system and a railway test site.

Railway Rolling Stock Systems Design LMR32 (October)

The wheel rail interface is the initial focus of this module, with particular attention being paid to rail vehicle dynamics, including the steering of wheelsets. Aerodynamics, body-shell design and crashworthiness issues, choice of materials, vehicle maintenance, the design and behaviour of active suspensions and tilting systems, as well as European standards, are covered in some detail. This module is led by a member of staff of the University of Birmingham. Lectures are delivered by experts from the University of Loughborough, from Manchester Metropolitan University as well as guest speakers from industry who can provide the most up to date information on rolling stock systems design and manufacture.

Rolling Stock and Traction Systems Laboratory Week LMR22 and LMR23 (October)

Two days each are allocated to laboratory activities associated with modules LMR32 and LMR33. Mechanical aspects are covered by experiments on the dynamics of systems, an introduction to CAD and FE work and an overview of modelling tools. A visit to a rolling

stock depot complements the laboratory work. Power electronic and electrical aspects are addressed in experiments on DC and AC machines and drives.

Railway Traction Systems Design LMR33 (November)

The traction systems module covers all aspects of motive power, from diesel-electric propulsion through to modern pulse width converter systems. Individual lectures deal with the basic physics of traction, friction braking and electric braking systems, DC and AC motor design, power converters, AC and DC traction supplies, as well as train detection. Also covered are infrastructure electrification systems and EMI issues. The module features a visit to a railway traction manufacturer and is run by the Department of Electronic, Electrical and Computer Engineering, with input from the railway industry.

Systems Engineering and Integration for Dependability LMR34 (November)

Dependability is defined as the combination of acceptable levels of reliability, availability and safety, often measured as service performance.

The module covers two broad areas: systems engineering and management of the engineering process, including project risk, risk control and reliability engineering. Lectures cover both hard and soft systems approaches, systems engineering tools, case studies and safety case issues. Human factors and organisational systems are also addressed in the lectures. The module is run by the Department of Electronic, Electrical and Computer Engineering of the University, with some 60% of the input provided by the railway industry.

Project and Programme Management for Linear Infrastructures* LMR39 (December)

This project management module has been developed jointly by the Universities of Birmingham and MWH, the specialist utilities programme managers and engineers. Lectures and practical activities cover the particular requirements related to the construction, maintenance and renewal of linear infrastructures, as well as the associated logistics. PERT diagrams, GANTT charts and network methods are covered, together with the related software tools. Project control, using tools such as earned value management, is an important focus for the module.



* This module is only available as an element of continuous professional development. An additional fee is payable for attendance.

Railway Infrastructure and Track Systems **LMR35 (January)**

The infrastructure module is designed to teach students about all aspects of the railway infrastructure, from bridges and tunnels through to conventional track forms and slab track. Railway alignment design issues are discussed in detail, as are issues relating to the rolling contact behaviour of the wheel-rail interface. Industry-based speakers address the topics of station design, station systems and infrastructure power supply components. Also included are issues such as environmental impact assessment, gauging and track maintenance. The module is managed by the Department of Civil Engineering of the University of Birmingham, with inputs from the railway industry.

Train Control Systems Engineering **LMR36 (January)**

The design of railway control and signalling systems requires a detailed understanding of the principles relating to braking performance, block operation, route setting, failsafe principles and the mathematical theories of safe software design. Interlocking design, automatic train control (ATP and ATO) and moving block are covered, together with the new European Train Control System (ERTMS). The special requirements of metro and light rail operations are considered alongside signalling maintenance and EMC issues. Modelling of signalling systems and the simulation of simple railway networks are introduced through lectures and practical activities. The Department of Civil Engineering and speakers from London Underground and the mainline railway industry contribute to this module.

Railway Economics and Strategic Management of Technology **LMR37 (February)**

The module introduces participants to the fundamental principles of economics and develops their understanding of technology strategy issues. Macro- and micro-economics, supply and demand and marginal costing are important topics and are complemented by balance sheet analysis and project financing. Lectures cover the railway operations paradigm, the strategic cycle and develop the understanding of supply chains and logistics. The module is also intended to introduce the concepts of critical success functions and key performance indicators and to develop students' management skills. The module features a railway franchising case study and is taught jointly by staff from the University of Birmingham and the Railway Technology Strategy Centre at Imperial College.

Ergonomics and Human Factors for Railways **LMR38 (February/March)**

This module takes a holistic approach to the interaction between humans and systems, with the content ranging from anthropometry to organisational ergonomics. The needs of customers of railways and of the staff associated with their operations are covered, together with the design of work places and railway related environments. The philosophical frameworks of fitness for purpose, usability and acceptance by users are explored in lectures and exercises. The module is partly lecture based and partly taught through a practical group project where participants can apply and extend the taught elements. Typically, this project involves user requirements analysis, simulation of ageing and disability and the preparation and trialling of design mock-ups.

European Study Tour **LMR21 (April or May)**

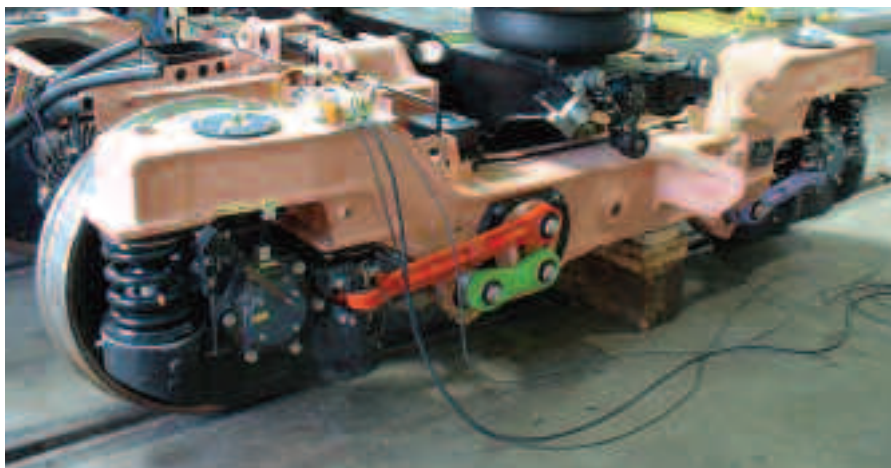
The European study tour is included in the programme to allow the participants to experience at first hand some of the most advanced railway systems and best practice available in Europe, before setting out on their dissertation project. It is an opportunity for comparison and benchmarking. Attendance stimulates thought and encourages the participants to learn from a wide range of approaches to railway operations and engineering. Destinations have included Austria, Belgium, France, Czech Republic, Denmark, Holland, Germany, Italy, Norway, Portugal, Spain, Sweden and Switzerland.

MSc Individual Investigative Research Project **LMR09 (January onwards)**

The main focus of the dissertation project is on systems integration. Most postgraduates undertake the dissertation while working for a rail industry sponsor. Project topics are agreed between the student, the University and the sponsor, whether or not the student is a permanent employee. A project workshop held before the main project activity allows the postgraduate to learn more about finding a topic, developing a hypothesis and about carrying out the necessary research.

Continuing Professional Development

Modules LMR31 to LMR38 and LMR39 are available for continuous professional development purposes. Participants commit themselves to completing the directed individual study associated with each module and participate fully in the team exercise activities. In order to be awarded full credits for attendance, CPD delegates also need to pass the end of year examination associated with the module.



Recommended Attendance Patterns

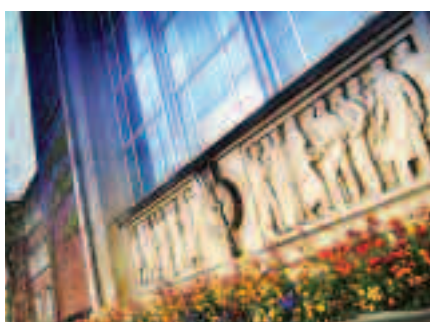
Unit code	Module title		Semester	FT	1E	2E	1O	2O
	Mathematics as an Engineering Tool	LMR20		(M)	(M)		(M)	
	Induction to Programme	LMR00	Autumn	M	M		M	
CE5SROa	Strategic Management of Railway Operations	LMR31	Autumn	M	M		M	
	Independent Study		Autumn	U	H	H	U	H
CE5RSDa	Railway Rolling Stock Systems Design	LMR32	Autumn	M		M	M	
	Independent Study		Autumn	U	H	H	H	H
	Dynamics Laboratory	LMR22	Autumn	M		(M)	(M)	
	Traction Laboratory	LMR23	Autumn	M	(M)			(M)
	Independent Study		Autumn	U	H	H	H	H
CE5RTSa	Railway Traction Systems Design	LRM33	Autumn	M	M			M
	Independent Study		Autumn	U	H	H	H	U
CE5SEDa	Systems Engineering and Integration for Dependability	LMR34	Autumn	M		M		M
	Independent Study		Autumn	U	H	H	H	H
	Project Management for Linear Infrastructures	LMR39	Autumn					
	Independent Study		Autumn					
CE5RITb	Railway Infrastructure and Track Systems	LMR35	Spring	M	M		M	
	Independent Study		Spring	U	H	H	U	H
CE5TCSb	Train Control Systems Engineering	LMR36	Spring	M		M	M	
	Independent Study		Spring	U	H	H	H	H
CE5RTMb	Railway Economics and Strategic Management of Technology	LMR37	Spring	M	M			M
	Independent Study		Spring	U	H	H	H	U
CE5EHFb	Ergonomics and Human Factors for Railways	LMR38	Spring	M		M		M
	Independent Study		Spring	U	H	H	H	H
	Examination Tutorials	ALL	Spring	U	U	U	H	H
	Independent Study		Spring	U	H	H	H	H
	Examinations	ALL	Summer	U	U	U	R	R
	European Study Tour	LMR21	Summer	M		M		M
CE5RSPb	Railway Systems Project	LMR09	Summer	S	S	S	S	S

Key

CE5AAAx	Module unit code for credit allocation (a=autumn semester, b=spring semester)
LMRNN	Programme internal code
M	Taught module requiring attendance at the University of Birmingham
U	Independent study using University facilities
S	Research studies at sponsor's premises or at the University
H	Independent study at home but with access to University resources
R	Examination arrangements may be made in the candidates' home region
FT	Full-time students based in Birmingham
1E	First year part-time for students based in Britain and continental Europe
2E	Second year part-time for students based in Britain and continental Europe
1O	First year part-time for students based Overseas
2O	Second year part-time for students based Overseas
M	Indicates attendance requirement at the University of Birmingham for overseas students

Research Modules LMR50, LMR51 and LMR52

A substantial essay type assignment is associated with each of the class-taught module. This allows students to develop their in-depth understanding of the module content and also encourages them to develop the research skills that are required for the dissertation project and their future roles in systems projects. The essays also develop students' analytical skills. Each of the research modules combines four assignments and results in the award of 20 credits at masters level.



From no railway experience, the course gave me a solid technical appreciation and confidence in the operations of the railway.

*Simon Banda
(Graduated 2005)*



'It was a tough but enjoyable and rewarding course, and now, after graduating in 2005, I find I've joined a select number of engineers who possess this specialist qualification.'

*Andrew Nunnery
(Graduated 2006)*



'Having had no railway experience, for me the MSc in RSE was a great grounding in the complexities of the rail industry.'

*Steve Johnson, Grant Rail
Project Leader, S&C Midlands Team
(Graduated 2003)*



'A comprehensive course that covers major themes and concerns of modern railway systems. I have no doubt that I benefited from it professionally.'

*Low Chen-Wah, Land Transport Authority
of Singapore
(Graduated January 2003)*



Learn more

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This brochure was written several months in advance of the start of the academic year. It is intended to provide prospective students with a general picture of the programmes and courses offered by the School. Please note that not all programmes or all courses are offered every year. Also, because our research is constantly exploring new areas and directions of study some courses may be dropped and new ones offered in their place.