

An Indian-Australian research partnership

**Project Title:**

**Project Number**



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## Research Academy Themes:

**Highlight which of the Academy's Theme(s) this project will address?**

*(Feel free to nominate more than one. For more information, see [www.iitbmonash.org](http://www.iitbmonash.org))*

1. **Advanced computational engineering, simulation and manufacture**
2. **Infrastructure Engineering**
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

## The research problem

interest to us. This project can admit 2-3 PhD scholars working on various scheduling and optimisation facets of the problems listed below:

### **1. Scheduling freight trains on complex rail networks:**

Freight trains travel along complex paths, usually on lines they share with passenger trains, which have specified timetables. Freight trains do not have a specific timetable that needs to be adhered to. It is therefore of interest to schedule freight train movements optimally so that all freight traffic demand is met. This project involves developing mathematical programming models for freight train movement and scheduling that takes into account passenger train timetables and ensures that this is minimally disrupted.

### **2. Locomotive scheduling problems:**

Locomotives are one of the most important resources of railway companies. Depending on its class and the path it needs to travel on, each train requires locomotives of a certain power for different segments on its path. The problem therefore is to assign a set of locomotives to each train respecting both power and availability constraints such that locomotives are (a) at the right place at the right time, (b) the right locomotive is available and is used for the right trains, (c) the schedule is honoured, (d) locomotives are appropriately maintained and rotated.

### **3. Line planning problems:**

In a passenger rail network, a line is a path along which commuter trains run, a subset of all paths on the network. The line planning problem decides the lines along which trains run, the frequency of trains on each line, and the stations at which trains on each line stop, taking into account travel patterns of commuters. The objectives of this planning problem could be several: minimizing transit times, minimizing line changes, etc.

### **4. Integrated planning for a suburban railway network:**

A suburban rail network (like Mumbai) consists of tracks that are used by passenger trains, goods trains (sometimes) and 'local' trains. Given forecast 'demand' over a planning horizon, the problem is to define a schedule/timetable that satisfies this demand for every day of the week. The next problem then is to ensure that this schedule has rakes allocated to it optimally. This allocation must allow for individual rakes to be maintained at appropriate intervals. Further, the schedule should be drawn in such a manner that the track segments are appropriately utilised (allowing for fast trains, slow trains, long distance passenger trains) where, passing loops may sometimes be used. In a planning sense, the whole process may need to be repeated, especially if excess capacity is detected, until passenger demand is fully satisfied.

## **Project aims**

In an environment where

- (a) rail infrastructure is extremely expensive,
  - (b) space constraints prohibit the building of additional capacity,
  - (c) passenger/goods demand is always increasing,
  - (d) capital expenditure on infrastructure investments are high,
- it is important to ensure that schedules and allocations are optimised.

This project aims to develop models and solutions that improve capital utilisation in railway operations.

## **Expected outcomes**

Better models, better capital (rolling stock) utilisation and better schedules that satisfy passenger demands for services.

## **How will the project address the Goals of the above Themes?**

Infrastructure planning and utilisation is the key to achieving good outcomes in a growing economy that is already burdened by burgeoning demand for services. This project will address some of these issues.

## Capabilities and Degrees Required

*List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.*

High level courses in operations research

Knowledge of mathematical programming, scheduling, integer programming, heuristics.

Knowledge of scheduling, integer programming and simulation.

Interest in Railway scheduling or work experience in railway scheduling.

Knowledge of heuristics.