Question 1

Please read these notes carefully if you choose to answer question 1:

You can choose to answer question 1 based on either lineside signalling (Layout 3) or cab signalling (Layout 4).

If you have brought your own blank control tables to use for question 1 then these must be checked by the invigilator prior to use.

If your control table entries include numbered ‘standard’ notes, then you must show the examiner that you know the meaning of the numbers you have used, a reference to where you found them is not sufficient.

Control table entries involving time are more likely to get marks if the value is reasonably close than if it is entered as just ‘t’. You won’t lose marks for a difference of a few seconds but you should show that you know the difference between 5 seconds and 30.

You are not required to include a drawn/checked/issued and date box.

If your interlocking is part electric/electronic and part mechanical, the locking for both should be shown.

Using EITHER layout 3 OR layout 4;

a) Give the full interlocking and controls for the following signalled routes: B12A and 109A

b) Give the full interlocking and controls for the following points: 503

[22 marks]

c) State which layout you have used, which railway’s practice you have followed and any assumptions you have made.

[3 marks]

Paper continues on next page.
Question 2  

a) Cab signalling systems are often used to deliver increased capacity compared to lineside signalling systems. Briefly describe a system you are familiar with and how it can be configured to meet this goal. [8 marks]

b) Identify typical locations where it is not desirable for the signalling system to bring a train to a stand for safety or operational reasons. [5 marks]

c) Discuss how a system using very short or moving block sections could be modified to minimise the risk of trains being brought to a stand at undesirable locations. [6 marks]

d) Describe the impact on capacity of introducing constraints on stopping locations. [6 marks]

Question 3  

a) Briefly describe at least five safety incidents or events which require all trains on a line or in an area to be stopped. [5 marks]

b) For the items you have identified, which can the signalling or other systems identify and how effective are those systems? [6 marks]

c) For a signalling system you are familiar with, what measures can the signaller or system to take to respond to a safety incident or event? For each measure give a brief description of any limitations and your assessment of effectiveness. [14 marks]

Question 4  

a) The automation of train operations is normally described in terms of four grades. Briefly describe your understanding of these. [4 marks]

b) For Automatic Train Operation (ATO) operation where a member of staff is based in the leading cab, describe the potential advantages and disadvantages of the system driving the train rather than a person. [7 marks]

c) Discuss whether the advantages are equal for metro, high speed and freight operations. Include analysis of whether all the advantages can be delivered or whether they may be mutually exclusive. [7 marks]

d) For ATO operation where there is no member of staff on the train (known as GoA4), list the issues to be considered for passenger operation and propose the measures to manage those issues. [7 marks]

Paper continues on next page.
Question 5

a) Stating the signalling system in use, list reasons why fixed trackside signs could be used to supplement the signalling and support the overall driving task. [6 marks]

b) Describe 3 signs which address the reasons you have listed and indicate whether they fulfil safety-critical, safety related or advisory functions. For each sign, provide a brief description of the meaning of the sign and explain what are the potential risks if these signs are misinterpreted? [7 marks]

c) How can the signalling system be arranged to advise or impose the information given by safety-critical signs? Explain any limitations of such systems. [12 marks]

Question 6

All signalling systems prove moveable infrastructure for the sections of line that the train is to pass over and also check for the presence of trains or other obstructions.

a) Many systems also check infrastructure status not in the route. List three checks frequently made by the signalling system. [3 marks]

b) For each check describe the safety risk the check is designed to manage and how the check is implemented within the system. [6 marks]

c) Discuss, for each check, whether the need for the check is affected by the introduction of:
   i. Automatic Train Protection,
   ii. Automatic Train Operation. [12 marks]

d) Providing checks not on the route to be taken by the train can make the system more susceptible to failure, briefly describe the potential impact and how it could be reduced. [4 marks]

Question 7

A railway uses train detection to establish the position and progress of trains.

a) Describe, with reasons, controls or monitoring systems which should be put in place to detect failures in the correct detection of the presence and movement of trains. [8 marks]

b) Discuss whether the controls or systems you have described are affected by the type of train detection – track circuits, axle counters, train based position reports. [12 marks]

c) In the event that a problem is detected relating to the monitoring of train positions, what action should the signaller take when they identify an issue or are alerted by an alarm? [5 marks]

Paper continues on next page.
Question 8

Capacity is often described in terms of headway time which can apply to trains of the same capability following each other non-stop or stopping at the same stations. This is used when constructing the timetable.

a) Describe the means of calculating the headway time, including factors to be included, for a railway using:

   i. Lineside signals,
   ii. A cab signalling system.

   In each case describe the signalling system you are considering. [8 marks]

b) For the lineside signalling system selected, describe how the signalling can be adjusted to improve the headway of trains which are stopping at stations. [6 marks]

c) For the cab signalling system selected, describe how the system provides for capacity for both non-stopping and stopping trains. Include worked examples, based on a typical suburban service, of the maximum number of trains that could use a route where none stop, all stop and 50% stop. Your answer should include calculations, graphical or other explanations and you should state any assumptions. [11 marks]

Question 9

a) List at least four reasons for an Infrastructure Manager to impose a restricted speed, for each identify the immediate safety hazard, if any. [4 marks]

b) For a railway you are familiar with, describe how the driver is advised of permanent, temporary and emergency speed restrictions. Discuss, briefly, how effective the process/information is. [5 marks]

c) Including a description of a system you are familiar with:

   i. Describe how it supervises the speed of trains on approach to, and within, a speed restriction (permanent, temporary or in emergency);

   ii. Discuss the effectiveness of the supervision identifying any risks which are not managed; and

   iii. Identify the potential overspeed at the start of the restriction allowed by the system describing the reasons this overspeed is possible. [12 marks]

d) Describe any opportunities to improve the system or identify and describe a more effective system for managing the risks. [4 marks]

Paper continues on next page.
Question 10

Level Crossings are considered a significant risk to railway operations.

a) For a railway you are familiar with, briefly describe the major types of level crossings in use describing the types of road/pedestrian usage they are suitable for and any limitations on rail traffic. [8 marks]

b) Discuss the risks to rail operations and crossing users at level crossings and factors which may affect the risk. [6 marks]

c) Describe the safety and performance objectives for a level crossing on a busy line crossing a public highway which is close to, but not within a residential area. [5 marks]

d) Selecting an appropriate type of level crossing, describe how effective it is in meeting the identified safety and performance objectives providing reasons. [6 marks]

End of paper
# Institution of Railway Signal Engineers

**2019 Examination. Layout 4. For use with Module 3.**

## Diagram

![Railway Signal Diagram](attachment:image.png)

## Table: Route Setting

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<thead>
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<th>Notes</th>
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<td>Loop</td>
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<td>Down</td>
<td>Main</td>
</tr>
<tr>
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<td>200</td>
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## Table: Route Setting

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(c) IRSE 2019  

*Not to Scale*