

**INSTITUTION OF RAILWAY SIGNAL ENGINEERS  
2018 EXAMINATION**

**MODULE 3 - SIGNALLING PRINCIPLES**

**TIME ALLOWED - 1 1/2 HOURS**

ANSWER **THREE** QUESTIONS, ALL QUESTIONS CARRY EQUAL MARKS

WRITE ON ONE SIDE OF THE PAPER ONLY, AND NUMBER EACH SHEET THAT  
YOU USE CONSECUTIVELY

COMMENCE YOUR ANSWER TO EACH QUESTION ON A NEW SHEET OF PAPER

ANSWER SHEETS WILL BE PHOTOCOPIED – PLEASE USE ONLY BLACK INK

**Question 1**

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

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.

Tell us which railway’s practice you have followed and state any assumptions you make.

Using the accompanying **layout 3**;

- a) Give the full interlocking and controls for the following signalled routes:  
**836C(M)** and **823G(C)**
- b) Give the full interlocking and controls for the following points:  
**941**

[25 marks]

Paper continued on next page.

## Question 2

A railway can choose to detect the presence or absence of rail vehicles using:

- i) Track circuits,
  - ii) Axle counters, or
  - iii) Train reported positions.
- a) For each of these systems, outline the advantages and disadvantages. [12 marks]
  - b) For each of these systems, describe a potential wrong side failure. [6 marks]
  - c) Describe how the overall signalling system can protect against, or mitigate the effects of, failures of the train detection system. [7 marks]

## Question 3

The issue of a movement authority is usually dependent on the infrastructure ahead and interlocking controls.

- a) For a practice you are familiar with, list ten items which need to be proved before a movement authority is issued. [5 marks]
- b) Briefly describe the impact of a short duration loss of proving on the Movement Authority where it is provided using:
  - i) Lineside signals,
  - ii) Cab signalling. [10 marks]
- c) For a cab signalled railway, identify which items in your list should be proved continuously and which could only be proved when the movement authority is first issued, giving brief reasons. [10 marks]

## Question 4

It is proposed that lightweight tram style vehicles share a track with heavy passenger or freight trains. The trams and trains use different train protection systems, communication systems and have different braking characteristics.

- a) Briefly describe the issues which need to be considered and how the proposed signalling system would be affected? [12 marks]
- b) Away from the shared track, the trams and trains would use different forms of lineside signalling as already used on each of their rail networks. Discuss the issues which need to be considered in this scenario. [8 marks]
- c) Outline any safety, technical or operational measures you consider necessary for this mixed operation. [5 marks]

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### Question 5

- a) For a practice you are familiar with, list four typical failures of the signalling system which can prevent movement authorities being issued. [4 marks]
- b) Describe operational procedures which can be used to overcome each of the failures of the system you have listed. [5 marks]
- c) Identify errors which can occur with the operational procedures described. [6 marks]
- d) What additional controls or features would reduce the likelihood of these errors, or the safety risk associated with them? [10 marks]

### Question 6

- a) List, with brief reasons, the information you consider a signaller needs to be shown continuously on a display system. [8 marks]
- b) List, with brief reasons, the additional information that a signaller should have available on request. [6 marks]
- c) Describe how the signaller will use all the available information during a partial failure of the signalling interlocking or control system to manage the train service safely. Your answer should describe any operational rules/processes you consider necessary. [6 marks]
- d) Discuss the reasons why display/control systems are typically of lower integrity than interlockings. [5 marks]

### Question 7

A railway authority wishes to provide more capacity by operating longer trains with extra carriages. As the signalling engineer you have been asked to provide input into the feasibility study.

- a) Describe what issues may typically arise at stations, giving consideration to a range of complex and simpler station layouts. [8 marks]
- b) List any additional issues that may arise elsewhere on the network away from stations. [5 marks]
- c) List the information you would want from other parties such as other engineering disciplines and operators to inform your thinking. [5 marks]
- d) How would you select a suitable solution for each site? [7 marks]

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### Question 8

An administration is introducing a system to continually monitor the delivery of the train service, manage potential conflicts by updating the train service in real time, and set and cancel signalling routes.

- a) Identify the information such a system would need to make these decisions. [4 marks]
- b) List the signalling operations, previously undertaken by a signaller, where the system could undertake the action automatically. [5 marks]
- c) For each of the operations you have listed, discuss whether the system should be autonomous or require signaller confirmation based on safety or operational needs. [10 marks]
- d) Describe any extra features you would consider for the interlocking functionality to manage any risks associated with an automated control system. [6 marks]

### Question 9

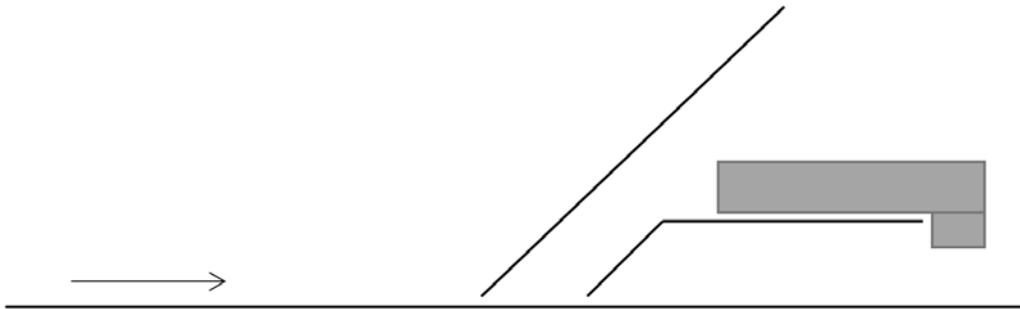
A lightly used line has a number of locations where road vehicles cross the line to access properties on private roads. The users are required to contact the signaller/dispatcher before crossing the line. The line is not equipped with train detection and the signaller/dispatcher only knows the train is somewhere on the line which takes 20 minutes to transit.

- a) Discuss why the road users may find contacting the signaller/dispatcher frustrating and stop doing so. [6 marks]
- b) A member of the public has seen the technology used on bus stops to indicate when a bus will arrive and has suggested to the railway authority that it provides a similar system for level crossings. Describe how such a system might work. [5 marks]
- c) List potential failure modes of such a system and describe the impact on the information available to the road user. [8 marks]
- d) It is decided to provide the information to the signaller/dispatcher instead of direct to the user, how may this affect the form and integrity of the required information? What other safeguards does this approach provide? [6 marks]

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### Question 10

As shown in the diagram below, an electrified line with a speed of 180km/h has a junction. One diverging route at the junction leads to an electrified terminal platform (speed limit 50km/h) and another divergence leads to a non-electrified line with a turnout speed limit of 110km/h.



- For a lineside signalling system you are familiar with, produce an aspect sequence chart to show the aspects and indications displayed to train drivers on the approach to the junction for each of the three routes through the junction. [10 marks]
- Explain how the information displayed to the driver is intended to convey route and speed information. [5 marks]
- Discuss the risks of overspeeding and misrouting at the junction and the effectiveness of the signalling in controlling the risks. [5 marks]
- It is proposed to replace the lineside signals with in-cab signalling, what risks will be reduced and what new risks will need to be considered? [5 marks]

End of paper