

**INSTITUTION OF RAILWAY SIGNAL ENGINEERS
2017 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:
719B(M) and 728C(M)
- b) Give the full interlocking and controls for the following points:
203

[25 marks]

Paper continued on next page.

Question 2

Most railways provide an overlap or safety margin beyond stop signals or limits of authority.

- a) Describe the factors that affect the likelihood and consequence of a train passing the limit of authorised movement. [8 marks]
- b) Discuss how one might establish rules for the length of the overlap or safety margin [8 marks]
- c) A train protection system is provided which supervises the train speed on approach to the limit of authorised movement. How does this affect the likelihood and consequences of an overrun and what risks might the protection system introduce? [9 marks]

Question 3

A railway plans to introduce fully automated freight trains on a route exclusively used by these trains with no staff on the train during normal operation.

- a) List two social/political issues and two safety issues that might need to be resolved. [4 marks]
- b) For each of the issues identified, briefly describe what actions you would take to address them. [6 marks]
- c) Describe the type of signalling and protection systems you would expect to be in place for such an operation. [8 marks]
- d) Describe the arrangements you would put in place to manage a train failure. [7 marks]

Question 4

A railway is introducing a moving block signalling system on a busy two-track railway which will not be based on trackside train detection.

- a) In the absence of trackside train detection, how will the system safely manage the trains? [5 marks]
- b) The railway has an intermediate station with several platforms. How would the issue of movement authorities be managed in this area? [8 marks]
- c) Describe three failures related to the loss of communications, trackside equipment or on-board systems and identify technical or operational measures to address each failure. [12 marks]

Paper continued on next page.

Question 5

A railway administration has a set of interlocking rules which have been developed over time. These state the controls which determine when signals may clear/movement authorities are issued and when locking may be released. Due to the complexity of the rules there have been errors in design and testing when amendments are made. The costs of designing the interlocking data/wiring to apply these rules, as well as rectifying the errors that have occurred, have led the administration to seek to simplify the principles. You have been asked to lead this task.

- a) What information would you require before proposing removal or amendment of a rule? [5 marks]
- b) Where you cannot find documentation describing the reason for a rule, how would you seek to understand its purpose? [7 marks]
- c) Where it is discovered that more than one rule addresses the same underlying risk, how would you deal with this potential duplication? [7 marks]
- d) Give an example of an interlocking principle/rule that is technology specific (e.g. related to a type of interlocking or trackside equipment) but is often applied to all technologies. [6 marks]

Question 6

A busy railway corridor has a total of six lines used by express, semi-fast and metro passenger trains. Several freight trains also pass through each day.

- a) Using a system of your choice, explain what factors would affect the signalling provided on each line. [8 marks]
- b) What constraints on the signalling arrangements could be caused by having six lines adjacent to each other? [7 marks]
- c) At a major station partway along the corridor, the six lines merge into a short four track section before splitting into numerous platforms. What additional constraints might this cause, and what compromises may be necessary? [10 marks]

Paper continued on next page.

Question 7

Refer to the accompanying Layout 4.

Layout 4 shows a section of railway with the position of the Down direction signals which are all capable of showing a stop aspect. There are both stopping and non-stopping trains which use the fast and the slow lines.

Using a signalling practice you are familiar with, decide on the signal profiles (aspects and indicators) for each marked signal together with any relevant lineside signs, including speed signs if applicable. Your proposed signalling should, where possible, allow trains to travel at the speeds shown on the layout.

- a) Using the information provided, state the aspects and indications to be provided at each signal. You may add these details to Layout 4 and submit it with your answer paper. [7 marks]
- b) List all the aspects, combinations of aspects, indicators and signs that you have used with their meaning to the train driver. [3 marks]
- c) Provide an aspect sequence chart for all the signals shown. [15 marks]

Your answer must clearly state which railway's signalling practice you have used.

Question 8

During a transitional phase between one type of signalling system and another, train drivers will experience changes in the information displayed to them.

- a) Briefly describe the features of a lineside signalling system and an in-cab signalling system you are familiar with. [6 marks]
- b) Describe the factors you would consider at a boundary between the two systems to ensure that the train driver has sufficient information to drive the train safely and efficiently. [6 marks]
- c) It is proposed that both systems shall be available over a section of route to enable driver training and the passage of trains without the on-board equipment. Information from both systems will be visible to drivers. Discuss how drivers should use information from the two systems and deal with any issues of inconsistency in that information. [8 marks]
- d) For the section of route fitted with both systems as explained in c), list the issues that the railway operator should consider for inclusion in operational rules or procedures to manage failures of only one of the two systems present. [5 marks]

Paper continued on next page.

Question 9

A railway network needs to improve the capacity to meet the increasing demand.

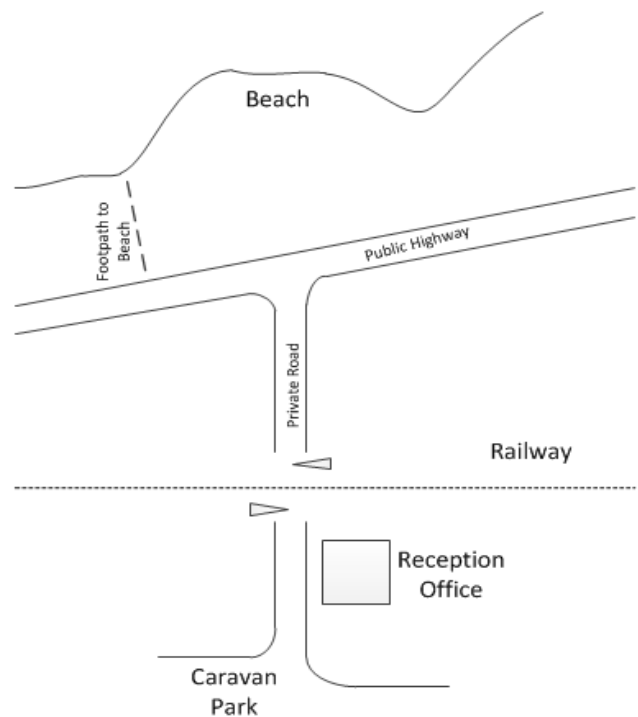
- a) List factors that determine the overall network capacity. [5 marks]
- b) Suggest three practical signalling features or systems for providing more capacity without modifying the existing track layout. Discuss the benefit and impact for each. [10 marks]
- c) What are the main challenges in achieving the full benefit of the features or systems you have suggested? [10 marks]

Question 10

As shown in the diagram to the right, a private road leading to a caravan park crosses a single track railway.

An automatic level crossing is provided which has flashing road traffic lights and barriers which close half of the roadway.

At certain times of the year large numbers of cars and caravans access the site.



- a) The reception office is adjacent to the level crossing and all arriving caravans need to stop at the office to register. The beach is on the opposite side of the railway to the caravan park. Identify safety hazards relating to both car and pedestrian users of the crossing. [6 marks]
- b) During the summer a large number of unaccompanied children cross the railway to get to the beach. What measures would you consider to provide a safer environment for them when crossing the railway? [8 marks]
- c) The road over the level crossing is only just wide enough for two caravans to pass each other. What arrangements could be considered to manage the traffic, including queues of vehicles? State any assumptions you have made. [11 marks]

End Of Paper.