INSTITUTION OF RAILWAY SIGNAL ENGINEERS
2009 EXAMINATION

MODULE 3 - SIGNALLING PRINCIPLES

TIME ALLOWED - 1 1/2 HOURS

EITHER ANSWER **ALL** OF PART A AND **ONE** QUESTION FROM PART B
OR ANSWER **THREE** QUESTIONS FROM PART B.

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

Please read carefully these notes applicable to Part A:

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.

PART A

Using the attached **layout 3**;

1. Give the full Interlocking and Controls for the following signalled routes:

   416B (M/C), 365A (M/W/C) and 371D

2. Give the full interlocking and controls for the following points:

   235 and 236

[50 marks]

Paper continued on next page.

PART B

ALL QUESTIONS IN THIS PART CARRY EQUAL MARKS

Question 1

A route is to be provided with both lineside signals (based on distance to go rather than speed) and a cab signalling system. Some trains will be fitted with the cab signalling system, others will not.

Describe how the two signalling systems may be integrated and how to address the problem of contradictory information being presented to the driver. [15 marks]

It is proposed to sub-divide some of the lineside sections for cab signalling fitted trains only. Describe the changes required to the lineside signals and to the operating rules to enable this to take place. [10 marks]

Question 2

The proving of a route prior to issuing a movement authority (or proceed aspect) needs to consider items of infrastructure within, beyond and adjacent to the route.

List the items you would expect to be considered within the route with brief reasons. [7 marks]

Discuss what items of infrastructure could be included beyond the route and the reasons for inclusion or exclusion. [9 marks]

Discuss what items of infrastructure adjacent to the route may need to be proved, with reasons for consideration. [9 marks]

Question 3

Describe the aspects and other indications displayed by a lineside signalling system of your choice, including their meaning to the train driver. [7 marks]

Discuss the issues which should be considered when combining aspects and indications? [7 marks]

Considering the aspect sequences of the system you have described, discuss the risks of train driver anticipation or confusion which may arise from signalling controls or the movement of other trains. [11 marks]

Paper continues on next page.

Question 4

"A level crossing (grade crossing) should be treated as an obstruction in the overlap/overrun".

Discuss this statement. Your answer should consider different types of crossing, including automatic crossings, and the risks of signals passed at danger. [25 marks]

Question 5

An administration uses a route-based lineside signalling system. Describe the affect of the following failures on the ability of the system to set routes, clear aspects and cancel routes:

i) train detection section remains occupied after passage of train,
ii) train detection section shows occupied without the passage of a train,
iii) crossover fails to detect in correct position,
iv) signal aspect fails to light,
v) controlled level crossing cannot be proved operating/clear.

[5 marks]

Discuss the risks associated with operating the railway whilst the system is in a failed state. [8 marks]

Describe facilities for each of the above failures which could be provided to assist the signaller in managing the failure and maintaining a safe train service. Discuss the relative merits, hazards and costs of each facility. [12 marks]

Question 6

A new level crossing (grade crossing) system will include four barriers completely closing the road. The barriers shall close automatically with minimal delay to rail traffic.

Derive a formula for the "strike-in" distance required for a railway running at 140km/h utilising 3 aspect lineside signalling, stating any assumptions. [10 marks]

Describe the potential impact on the strike in distance of:-

i) changing to 4 aspect signalling,
ii) automating the crossing clear function (e.g. using radar) as opposed to human surveillance via CCTV,
iii) a change to a cab signalling system.

[6 marks]

There is a station 200m on the approach to the crossing at which 30% of trains stop. Describe how the system could be changed to minimise road closure time with a brief description of how the solution could be implemented. Describe how items i), ii) and iii) above could be affected by the solution. [9 marks]

Paper continues on next page.

Question 7

A railway utilising a cab signalling system which displays the permissible speed is considering raising the degraded mode speed (when the cab display is unavailable) from 40km/h to 80km/h.

Describe the infrastructure and signalling facilities to be considered when making the change, particularly those which relate to safety.

[7 marks]

Authority to operate in degraded mode consists of a written order (dictated over a radio link) including stopping position, speed profile and particular hazards. Describe how the process may be affected by the change in degraded mode speed and, particularly, discuss any human factors issues.

[8 marks]

The railway plans to provide limited lineside speed signage for restrictions below the degraded mode speed. What issues would need to be considered when trains have differing speed profiles (e.g. freight and passenger) where some are below and some are above the degraded mode speed. Include the impact of signage on both normal and degraded operation and issues of driver training/behaviour which need to be considered.

[10 marks]

Question 8

On a lineside signalled railway without automatic train protection, discuss the layout designs and interlocking controls which may be used to constrain/divert overruns. [12 marks]

Describe, with the aid of diagrams, detailed options for the interlocking controls in the event of an overrun. [13 marks]

Question 9

A busy double track suburban railway has trailing and facing crossovers every 5km. In order to reduce train delays resulting from point detection failures, it is suggested that trains be permitted to run under unrestricted proceed aspects when the point end in the route is correctly detected even though there is no detection on the other end of the crossover.

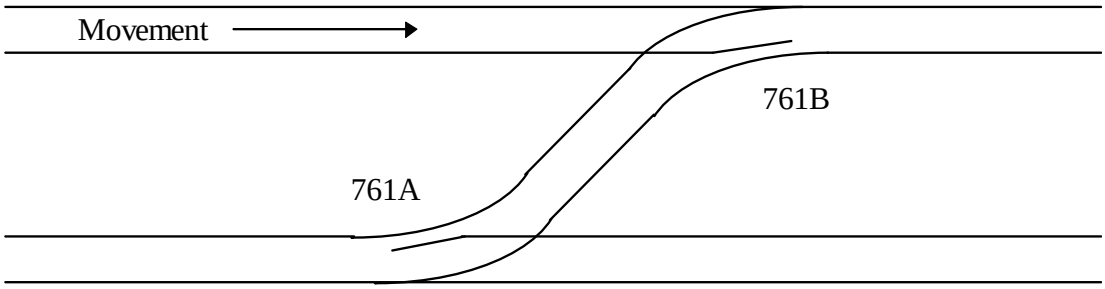
Discuss the conditions under which this may be permissible, any special controls that may need to be applied and any risks associated with these arrangements. Include a description of the indications the signaller will require. [18 marks]

Discuss the effects if the detection failure is in the overlap of the signal. [7 marks]

Paper continues on next page.

Question 10

A set of points have been trailed through against their set position as shown in the attached diagram.



Briefly describe the type of power operated point operating mechanism you are assuming and explain the likely remedial actions required following the incident.

[10 marks]

Describe the tests required before allowing the points to be restored to service.

[15 marks]

End Of Paper.