INSTITUTION OF RAILWAY SIGNAL ENGINEERS
2018 EXAMINATION

MODULE 5 - SIGNALLING APPLICATIONS

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

a) Describe a process that could be followed during scheme design to evaluate the risk of a signal being passed at danger. You should comment on opportunities that could be taken during scheme design to reduce the likelihood of a signal being passed at danger as well as those that could be taken to minimise the consequences of signals being passed at danger. [15 marks]

b) How would the impact of each opportunity be evaluated? [5 marks]

c) Using a diagram, describe an example of an engineering solution that could minimise the consequences of a train that passes a signal at danger. [5 marks]

Question 2

a) Describe a system which provides train protection for a stop signal or limit of movement authority. Your answer should include clear descriptions of each of the following using one or more diagrams:

   i) How the speed of a train approaching a stop signal or limit of movement authority is monitored and controlled;
   ii) How a train is prevented from ignoring a signal displaying a stop aspect or limit of movement authority; and
   iii) The necessary interfaces to the signalling system including the interlocking and control system. [15 marks]

b) An incident has occurred where a train has passed a red signal or limit of movement authority and has continued beyond the safe overrun distance in to an unprotected area of railway. Using a fault tree, outline the possible causes of such a failure. [10 marks]

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Question 3

Describe and explain with the aid of sketches, the construction and electrical principles of an impedance bond for use on either a d.c. electrified railway with low frequency a.c. track circuits OR for use on an a.c. electrified railway with audio frequency track circuits.

Your answer should describe how the design and implementation of your chosen type of impedance bond allows correct operation of the track circuits whilst allowing the electrification system to perform as required. [25 marks]

Question 4

a) With the aid of a diagram, describe a system to provide electrical power to a trackside signalling system. Your answer should include consideration of each of the following:

- Initial supply from a national electrical distributor or similar;
- Back-up power supply;
- Considerations to give continuous availability; and
- Distribution of power over long distances.

Your answer should include details of power characteristics in relation to all of the following items of lineside infrastructure:

- Signals;
- Points; and
- Train detection. [15 marks]

b) Describe the features that enable the power supply to be reconfigured to overcome a failure in part of the system. What are the benefits and drawbacks of the features you have described? [10 marks]

Question 5

A new level crossing is being installed, which provides one barrier (boom) at each side of the railway, each covering just half of the road on each side (a half barrier crossing).

a) Using a diagram, describe a mechanism for raising and lowering a level crossing barrier. Your answer should include how the barrier is raised and lowered together with any safety features. [10 marks]

b) Provide an outline test plan for the testing of the barrier mechanisms, including their integration with the whole level crossing system. Your answer should detail the different types of testing required of the barrier mechanism from completion of assembly in the factory to entry into service. [10 marks]

c) Describe the training and documentation that you would expect to be provided to the future maintainer of the barrier mechanism. [5 marks]

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Question 6

Trackside signalling systems have to endure a range of environmental conditions. For each of the equipment types below:

- Lineside signalling apparatus case;
- Signal post and head; and
- Point machine and connections to the switch blades,

provide details of the issues, effects, and mitigation measures for each of these environmental conditions:

- Extremes of temperature;
- Being located in a tunnel;
- Being located in a coastal position (near to the sea); and
- Being located in a busy city centre. [25 marks]

Question 7

a) Provide a clearly labelled diagram of a point operating mechanism. Your answer must include details of each of the following:

   i) How the point blades are moved; [5 marks]
   ii) How the point blades are detected; and [5 marks]
   iii) How the point blades are locked. [5 marks]

b) Describe a suitable system to provide an additional or supplementary drive to such a set of points, again including details of movement and detection. [5 marks]

c) Provide an outline of an appropriate maintenance schedule for such a set of points, including the tasks to be undertaken the frequency of such activities. [5 marks]

Question 8

A single line railway 10km in length diverges off a secondary main line and serves two passenger stations and a freight terminal. The freight terminal is located at the end of the line. Trains may be left at the freight facility to carry out shunting while a passenger train is using the single line. The passenger services operate on an hourly basis during the day. All train movements are to be controlled from a single control centre located at the junction between the mainline and the branch.

a) Describe, with a diagram, an economical signalling system that will allow use of the single line by both passenger and freight services. You should state your assumed method of train detection, if any, as well as the means of ensuring that both passenger and freight services can safely use the line. [20 marks]

b) How could trains be safely controlled if the system that you have proposed suffered a prolonged failure? [5 marks]

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Question 9

The electrification of an existing railway is expected to electromagnetically affect the existing signalling and telecoms systems which are to be retained. You have been asked to determine the measures necessary to ensure that the existing signalling and telecoms systems remain unaffected by the new electric trains and their power supply system.

a) Briefly outline the architecture of the proposed electrification system and either the existing signalling or the existing telecommunications system [10 marks]

b) Based on your system architecture, detail three issues that might be created by the implementation of the electrification system on three of the following asset types and explain how these issues can be overcome:

i) An a.c. track circuit
ii) A d.c. relay line circuit
iii) An a.c. point machine
iv) A lineside telephone
v) A cable running along the lineside
vi) A station Public Announcement system [15 marks]

Question 10

When implementing a new signalling system that features an electronic interlocking and associated control system it is possible to validate the data in an 'off site' data test environment.

a) List, with reasons, which elements of the data could be fully validated in a data test environment and how the correct integration of the various subsystems would be confirmed. [10 marks]

b) Describe which elements of the validation would still need to be carried out on site. [5 marks]

c) A project has reached the final stages of implementation but needs to be modified in some way. Describe the controls that would need to be put in place to ensure that integrity of the completed tests is not compromised. [5 marks]

d) Other than implementation engineers, who else could benefit from the facilities afforded by 'off site' tools? [5 marks]

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