

**INSTITUTION OF RAILWAY SIGNAL ENGINEERS  
2017 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**

Describe why it is sometimes necessary to provide a wayside system to detect hot axle boxes. Include what factors may lead to the provision of such a system, where they are best provided, and the likely distance interval between detection points. [5 marks]

Describe with the aid of a diagram a system for the detection of hot axle boxes. Include:

- The mechanism for detecting the hot axle box
- The mechanism for detecting which axle is affected
- The interface to the railway operator

You should also include details of how you would determine the relative temperatures over which the system will work and the information you expect to be passed to the operator. [15 marks]

What external factors may affect the reliability of a hot axle box detecting system? [5 marks]

**Question 2**

Provide a diagram outlining the key functions of a Train Control System which incorporates Automatic Train Operation. Include the method of block working, train protection and transmission of movement authority between the train and trackside equipment. [15 marks]

Describe the key functional interfaces between the trainborne equipment and the track side equipment for the Automatic Train Operation part of the system. Include which parameters of the train's performance need to be specified and monitored by the system in order to provide a safe operating system. [10 marks]

Paper continues on next page

### Question 3

A series of existing relay interlockings are controlled by a remote mimic panel using a remote control system and with a hard-wired manual back up system (override) which provides a basic level of control during times of multiplex system failure.

Provide a system drawing to show how the panel and remote control systems might be replaced to transfer control to a modern control centre using VDU technology. Your answer should include both normal and override methods of control. [10 marks]

Describe an outline strategy for the implementation of your system, including how the old system will be changed over to the new, and the level of testing needed to provide the required level of assurance. [15 marks]

### Question 4

A new colour light multiple aspect signalling system using a computer based interlocking and VDU control system is to replace a semaphore signalling area controlled by a series of mechanical signal boxes.

Describe the documentation and training requirements to be provided to each of the following groups of users:

- i) Signallers [5 marks]
- ii) Train drivers [5 marks]
- iii) First line signalling maintainers [5 marks]
- iv) Second line technical specialist maintainers [5 marks]

What records and artefacts should the re-signalling project produce to allow any future modifications of the system to be correctly specified? [5 marks]

### Question 5

A busy suburban road close to a school crosses a double track railway which has a line speed of 140 km/h. The road has an automatic level crossing system which uses barriers which cover half the road width to protect the railway.

Provide a diagram showing the key features of this level crossing [10 marks]

Describe the operating sequence for a train approaching and departing from the level crossing. [10 marks]

What additional features might you provide in the design in order to manage any safety hazards? Describe how these features would be implemented. [5 marks]

Paper continues on next page

### Question 6

A new signalling system is being installed to replace a life expired system. The new system is to have a 30 year life.

Describe the considerations, with respect to construction and maintenance, for each of the following project activities:

- a) Design of the new system [10 marks]
- b) Installation of the new system alongside the existing system prior to entry into service [5 marks]
- c) Interfacing to the adjacent existing systems [5 marks]
- d) Management of the installed assets throughout the system life cycle including any mid-life renewals [5 marks]

### Question 7

The protection of trackside staff whilst carrying out their duties is of great importance.

Describe, with diagrams if appropriate, an automated staff warning system that is able to provide adequate and safe warning to a group of trackside workers who are carrying out maintenance activities on a set of points on a busy main line railway. The activity may include use of hand held tools which are quite noisy. [15 marks]

If the physical location of the group were to change by 500 m how would the system ensure adequate warning was maintained as the group moved from the first worksite to the second worksite? [5 marks]

How does the system that you have described affect the normal running of train services through the worksites and what interfaces, if any, are there with the signalling system? [5 marks]

### Question 8

The trackside signal is a vital interface to train drivers. Describe, with the aid of a diagram, how this interface is made as safe as possible. You should include details of each of the following:

- i) How the viewing range and visibility of the signal can be established and maintained [10 marks]
- ii) The effect of changing lighting conditions [5 marks]
- iii) The impact that adjacent signals might have on the signal being described [5 marks]

Describe two conditions which may lead to degraded sighting of a signal and provide possible solutions to address these conditions. [5 marks]

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### **Question 9**

A 40 km long single line in a remote area has three passing loops. There is an hourly passenger train in each direction which pass each other in one of the loops. There are also occasional freight trains.

Describe, with the aid of a diagram, an economic signalling system suitable for controlling this line. [15 marks]

Describe the interface with the signaller and the method by which trains receive their movement authorities. [5 marks]

If there was a failure of the signalling system between opposite ends of a single line section, how could train services continue to run safely? [5 marks]

### **Question 10**

Describe, with diagrams, the operating principles of a single rail or double rail AC track circuit suitable for use in an area featuring DC traction rolling stock. You should consider within your answer the equipment located at each end of the track circuit and the function of this equipment. [15 marks]

Following introduction of an AC track circuit, the track circuit is failing in service. List any design factors that might be contributory to the failures. [7 marks]

Explain how the equipment provided protects signalling equipment from traction faults within the traction supply system or on trains. [3 marks]

End of paper.