Question 1

There are various methods of providing protection where roads cross railways at level (or grade) crossings.

a) Select five different control measures and for each of them describe their function, their effectiveness alone and when used in combination with another measure. [15 marks]

b) If the volume of traffic at a crossing changes, how would you determine if the control measures remain suitable? [5 marks]

c) What other factors might cause you to reassess the suitability of the control measures? [5 marks]

Question 2

a) Describe the causes of systematic failures in systems. [5 marks]

b) Describe two hardware and/or software design methods that can be used to mitigate the safety risk of systematic failures in a safety-critical system. [10 marks]

c) Compare the advantages and disadvantages of using each identified method. [5 marks]

d) How might the effectiveness of the methods change through the system lifecycle? [5 marks]
Question 3

A line is equipped with colour light signals and track circuits. The method of working is track circuit block. A train has passed a signal into an occupied section without authority.

a) What immediate action should be taken? [5 marks]

b) Describe three different possible causes. [6 marks]

c) Describe a process to investigate this scenario. Include who should be involved, what needs to be done to establish the cause and what the subsequent actions are. [10 marks]

d) If the cause cannot be found, describe how normal operation can be restored. [4 marks]

Question 4

A double track railway runs through a single-bore tunnel as shown in the ‘Existing Layout’ in the figure below. The tunnel constrains the loading gauge of the trains passing through it, so to allow larger trains to use the line it is proposed to either:

i) Enlarge the tunnel; or

ii) Single the line and slew it so that it passes through the centre of the tunnel as shown in the ‘Proposed Layout’ in the figure below.

a) Describe the new safety risks introduced if option (ii) is selected and propose mitigations for these risks. [15 marks]

b) What factors should you consider in deciding which option to select? [5 marks]

c) Describe a process that would determine which is the most suitable option. [5 marks]

![Existing and Proposed Layout Diagram]

Paper continues on next page
Question 5

a) Define, with the aid of a diagram, a generic project ‘life cycle’ model. [5 marks]

The detailed design phase of a major signalling or telecommunications renewal project is running several months behind schedule. It has been decided that the scope must be reduced to minimise the impact on time and budget.

b) How will existing safety risks be affected and what new safety risks might be introduced to the project by altering the scope at this time? How might these risks be mitigated? [10 marks]

In order to meet the project deadline, it is decided to proceed with elements of the construction phase before the design phase has been completed.

c) What additional safety risks might be introduced to the project as a result of this decision? How might these risks be mitigated? [10 marks]

Question 6

A track circuit has failed at a busy railway junction.

Describe at least three different methods in which the railway infrastructure maintenance company can facilitate the faulting team to rectify the fault safely. How should the company determine which is the most appropriate method and under what circumstances? Stating any assumptions made, include consideration of equipment, tools, competency, personal safety and safety of the worksite. [25 marks]

Question 7

It is often said that safety and high performance conflict in railway operations; in other words it is difficult to deliver both high safety and high performance. It can also be easier to justify significant expenditure on higher performance than higher safety.

Considering these statements discuss the relative merits of safety and performance, and possible unintended consequences of inappropriate expenditure. Give reasoned arguments for the extent to which you agree with the statements above, or not. [25 marks]

Question 8

a) Describe the measures that should be taken to make an electronic signalling or telecommunications system secure. Your answer should include the software design, physical location and types of users. [20 marks]

b) If unauthorised access is detected, describe the actions that should be taken. [5 marks]

Paper continues on next page
Question 9

The signalling system power has completely failed on a multi-track line in an area containing a junction. The following assumptions should be made:

i) the area affected by the power failure is remote from the controlling signal box;
ii) the area is fully track circuited with colour light signals;
iii) all points are operated by electric motors, with facilities for manual operation;
iv) there are no level crossings; and
v) trains are required to operate along any route through the junction.

a) Describe a safe system of working which would enable train movements to be made through the area. [5 marks]

b) Describe the hazards involved in this method of working. [10 marks]

c) What measures would you take to mitigate the consequence of these hazards and how would you judge their suitability? [10 marks]

Question 10

a) Describe the human factors safety considerations for a signaller working in each of the following environments:

i. Mechanical signal box with a signaller’s diagram
ii. Signal box with an entrance-exit panel
iii. Control centre with VDU workstations [6 marks]

b) For each of the four scenarios below, compare and contrast the process used during degraded mode working for each of the three work locations above. State any assumptions that you have made on how the equipment and systems have failed.

Scenario 1 Unable to clear a signal
Scenario 2 Unable to set a pair of points
Scenario 3 Failure of lineside telephone system
Scenario 4 Complete power failure [19 marks]

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