Question 1

a) Describe the difference between Plesiochronous Digital Hierarchy and Synchronous Digital Hierarchy. [5 marks]

b) With the aid of a diagram describe the SDH Multiplex structure for STM Frames. [10 marks]

c) Describe methods of hardware protection within SDH systems. [6 marks]

d) Describe two forms of SDH path protection and the considerations that need to be made when choosing them. [4 marks]

Question 2

a) With the aid of a diagram show the components that make up a GSM-R system and describe the function of each component. [12 marks]

b) Describe the main call features found in GSM-R systems. [8 marks]

c) Describe the modulation techniques used for GSM-R and the difference between traffic and control channels. [5 marks]

Paper continues on next page.
Question 3

a) Describe the OSI 7 Layer Model and the functionality of each layer. [14 marks]
b) Explain what is meant by TCP/IP and UDP. [4 marks]
c) With the aid of diagrams describe how MPLS Routing works. [7 marks]

Question 4

a) What is Electromagnetic Compatibility? [6 marks]
b) Describe three sources of Electromagnetic Interference commonly seen within the railway environment. [9 marks]
c) Describe a range of methods available to mitigate interference on railway telecommunications equipment. [10 marks]

Question 5

a) With the aid of diagrams, explain the typical construction of a multi-pair copper cable suitable for use in:
   i. an internal communications room; [5 marks]
   ii. an external environment adjacent to the railway.

b) List and explain the relevance of the properties that should be considered when selecting a multi-pair copper cable. [10 marks]
c) What tests would you undertake to demonstrate that a multi-pair cable meets its procurement specification? [10 marks]

Question 6

a) State and explain two safety functions of earthing systems. [4 marks]
b) State and explain the non-safety related functions of earthing systems. [4 marks]
c) Using a diagram, explain the key features of a typical earthing system and how the safety functions are achieved. [10 marks]
d) Describe the purpose of surge protection systems and explain how they fulfil their purpose within a typical installation. [7 marks]

Paper continues on next page.
Question 7

a) Using examples, describe and explain the purpose of the following types of coding:
   i. Line; \[3 \text{ marks}\]
   ii. Channel; \[3 \text{ marks}\]
   iii. Source. \[3 \text{ marks}\]

b) Explain the differences between error detection and error correction. Your answer should include typical schemes. \[8 \text{ marks}\]

c) Describe and explain the purpose of “frequency hopping” and how it is used in radio telecommunications. \[8 \text{ marks}\]

Question 8

a) State and explain the frequency range of the human ear. \[3 \text{ marks}\]

b) Explain how an analogue voice signal is processed for fixed transmission using TDM. \[6 \text{ marks}\]

c) Explain how an analogue voice signal is processed for fixed transmission using IP. \[6 \text{ marks}\]

d) Using a diagram, explain the advantages and disadvantages of IP transmission versus TDM. \[10 \text{ marks}\]

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