

**INSTITUTION OF RAILWAY SIGNAL ENGINEERS
2017 EXAMINATION**

MODULE 4 – COMMUNICATION PRINCIPLES

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) Define the term Electromagnetic Compatibility and describe the criteria for a system to be deemed as being electromagnetically compatible. [5 marks]
- b) List the three mechanisms of Electromagnetic Interference and provide a definition of each. [6 marks]
- c) The EN50121 series of railway-specific standards define test limits for equipment placed within the railway boundary. With the aid of a diagram describe the principles of zoning. [8 marks]
- d) Copper cables installed on railways employing overhead traction systems can be susceptible to induced voltages. Define the two parameters typically measured to ascertain the level of induction, how the two parameters exhibit themselves on telecommunication cables and the maximum value levels as required by standard EN 50122-1 or in an equivalent standard in your country (please state the standard). [6 marks]

Question 2

Explain the principle of wireless protocol IEEE 802.11. Your answer must include typical data rates and the frequencies used, and explain how the same frequency can be used for multiple users on the same network. [25 marks]

Paper continued on next page.

Question 3

- a) With the aid of a block diagram describe how a Primary PCM Multiplexor works. [5 marks]
- b) Provide a definition for each of the following terms:
- i) Nyquist Sampling Rate [2 marks]
 - ii) Quantisation Noise [2 marks]
 - iii) Companding [2 marks]
 - iv) Channel Associated Signalling [2 marks]
 - v) Common Channel Signalling [2 marks]
- c) Describe the purpose of Timeslot 0 [2 marks]
- d) With the aid of a diagram describe HDB3 and AMI coding and state the advantages and disadvantages of one over the other. [8 marks]

Question 4

- a) Describe what is meant by the term Cybersecurity. [2 marks]
- b) Describe how an organisation should determine the level of information security required using the Confidentiality, Integrity & Availability triad. [8 marks]
- c) Describe what Malware is and give examples and descriptions of four different types of Malware. [9 marks]
- d) Describe how a Distributed Denial of Service attack works, the impact it has on a network and potential mitigations to prevent an attack [6 marks]

Question 5

- a) Describe and explain the purpose of each of the following network devices:
- i) Hub [3 marks]
 - ii) Switch [3 marks]
 - iii) Router [3 marks]
- b) Explain the differences between Layer 2, Layer 3 & Layer 4 Switching. [9 marks]
- c) Explain what MPLS is and how it works. Your answer should include the MPLS label format. [7 marks]

Paper continued on next page.

Question 6

- a) Explain the principles of AM and FM modulation techniques. [6 marks]
- b) Explain the principles of Phase Shift Keying and Amplitude Shift Keying. [6 marks]
- c) Explain the principles of QAM. State and explain the benefits of QAM over other digital and analogue modulation techniques. [7 marks]
- d) Describe and explain how spread spectrum techniques can be used to improve resistance to interference and improve the security of radio-based telecommunications. [6 marks]

Question 7

- a) Explain the principles of VoIP. Your answer shall include a schematic of the key components and network elements that support typical VoIP services. [10 marks]
- b) Explain each of the following terms related to VoIP services:
 - i) Session Initiated Protocol
 - ii) Real-time Transport Protocol
 - iii) Jitter
 - iv) Packet Switching
 - v) Quality of Service [10 marks]
- c) State and explain the key benefits of a VoIP solution over a traditional analogue PABX solution. [5 marks]

Question 8

- a) Describe, with the aid of separate diagrams, the principles of analogue & digital CCTV systems. [15 marks]
- b) Discuss the key design considerations for a digital CCTV system to be provided at a railway station for passenger security purposes and identify how these may differ from an analogue CCTV system. [10 marks]

End of paper.