UNIVERSITY OF ABERDEEN

Degree Examination in Communications Engineering

Date

Notes: *(i)* *Candidates ARE permitted to use an approved calculator*

   (ii) *Candidates ARE NOT permitted to use the Engineering Mathematics Handbook*

   (iii) *Data sheets are attached to the paper*

Candidate must answer ALL FOUR questions. – All questions carry 25 marks

PLEASE NOTE THE FOLLOWING

(i)   You **must not** have in your possession any material other than that expressly permitted in the rules appropriate to this examination. Where this is permitted, such material **must not** be amended, annotated or modified in any way.

(ii)   You **must not** have in your possession any material that could be determined as giving you an advantage in the examination.

(iii)   You **must not** attempt to communicate with any candidate during the exam, either orally or by passing written material, or by showing material to another candidate, nor must you attempt to view another candidate's work.

Failure to comply with the above will be regarded as cheating and may lead to disciplinary action as indicated in the Academic Quality Handbook (www.abdn.ac.uk/registry/quality/appendix7x1.pdf) Section 4.14 and 5.

1. Asynchronous Communications

(a)   A bus uses *asynchronous character framing* based on *EIA-432*. Sketch the signal waveform that is received when the hexadecimal value 0x0E was sent.   [6 marks]

(b)   If the transmission *baud rate* is 19.2 kbps, what is the duration of a *character/slot*?   [4 marks]

(c)   Why is the *slew rate* important when specifying the line driver to be used in a circuit?   [4 marks]

(d)   The NMEA standard for reading Global Positioning System (GPS) coordinates uses asynchronous character framing. Sketch the sequence of signals when the following three characters are sent "$GP"   [6 marks]

(e)   Why is it important to sample a transmission baud around the centre of the baud period?   [5 marks]

   NOTE:
   The following ASCII values in hexadecimal may be useful in answers:
   '$' is 0x36; 'G' is 0x71; 'P' is 0x80

[Continued]

2. Digital Multiplex (DMX)

(a)   How does a DMX-enabled fixture identify the start of a multiplexed frame?   [4 marks]

(b)   If the transmission **baud rate** is 250 kbps, what is the maximum frame rate?   [3 marks]

(c)   A simple DMX network is used to control three sets of lighting equipment, as show below.
       Explain how a single cable allows control of an individual lighting fixture.   [8 marks]
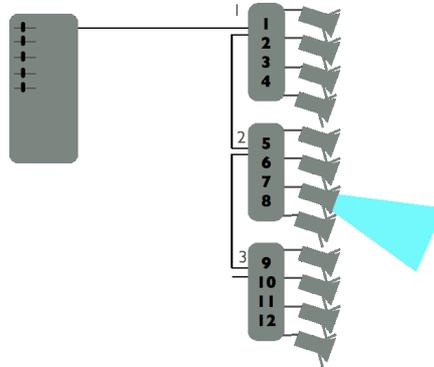
(d)   Provide a set of diagrams and detailed explanation on **one** of the following topics. Either:

       • explain how DMX may be used to control the output power supplied to a mains-powered device.
       Sketch the waveform that may be produced by a microcontroller and the corresponding waveform
       for the voltage across the device. Your answer should illustrate the output corresponding to a DMX
       slot value of 30 and 128.
       or
       • provide a flow chart or state machine diagram that illustrates how a microcontroller processes the
        DMX waveform up to the start of the first data slot in the DMX frame.

                                                                                                [10 marks]

3. Remote Device Management (RDM)

(a)   Explain the role of the DMX **Start Code** and give examples of its use.   [4 marks]

(b)   Explain the role of a **DMX Splitter** *and a Remote Device Management (RDM) Splitter*.
                                                                                                [4 marks]

(c)   Calculate suitable component values for the bias circuit, given that RDM uses a cable with
       a nominal impedance of 120 Ω.   [7 marks]

(e)   Provide a set of diagrams and detailed explanation on **one** of the following topics. Either:

       • explain how an RDM controller may identify the set of fixtures connected to the RDM bus.
       or
       • explain how the RDM protocol may simplify setting of the **base address** of a DMX fixture.
                                                                                                [10 marks]

[Continued]

4. Other Control Busses

(a)   Describe the use of ***Quadrature Phase Shift Keying (QPSK)*** to modulate the binary data {010111}. Your answer must include appropriate diagrams.   [4 marks]

(b)   Using the same sequence {010111}, explain how transitions in a QPSK signal may be plotted using a ***Constellation Diagram.***   [5 marks]

(c)   Explain how a ***Controller Area Network (CAN)*** receiver retains bit synchronisation when a sender transmits a sequence of bits with the same value.   [6 marks]

(d)   Provide a set of diagrams and detailed explanation on **one** of the following topics, either:

   • explain how the ***CAN bus*** can arbitrate between two messages simultaneously sent by different nodes.
   or
   • explain how ***wireless DMX*** may be used to extend the reach of a DMX bus, and the key differences between this technology and the WiFi system used for Ethernet.
                                                                                                    [10 marks]