



Technology: Level 3
T305 Digital Communications

Licensed for use by the Arab Open University

T305

Computer-marked Assignment 3

Contents
T305 CMA 3 2007–2008

Cut-off date
23 December 2007

Q1

Table 1 lists eight values of frequency, in Hz, which are known to be accurate. The other two columns are supposed to list the corresponding values of angular frequency in rad s^{-1} and period in s. Identify the line which contains an error. (Values of angular frequency and period are given to three significant figures.)

Choose **one** option and pencil across the appropriate cell in row **1**.

Table 1 For use with Q1

	Frequency / Hz	Angular frequency / rad s^{-1}	Period / s
A	2	12.6	0.500
B	5	31.4	0.200
C	7	44.0	0.143
D	15	94.2	0.0667
E	29	182	0.0345
F	65	408	0.0154
G	110	619	0.00909
H	130	817	0.00769

Q2

Select from Figure 1 opposite the option which is the double-sided representation of the sinusoid:

$$20 \cos(2t - 3\pi)$$

Choose **one** option and pencil across the appropriate cell in row **2**.

Q3

Select from Figure 1 the option which represents the signal

$$20 \exp(-j3) \exp(j2t) + 20 \exp(j3) \exp(-j2t)$$

*Choose **one** option and pencil across the appropriate cell in row 3.*

Q4

Select two **true** statements about Fourier series from the following:

- A** A square wave has only even-numbered harmonic components.
- B** A sawtooth wave has only odd-numbered harmonic components.
- C** The amplitude of the seventh harmonic of a triangular wave is just over half the amplitude of the fifth harmonic.
- D** The mean value of a periodic signal is equivalent to the dc component of its Fourier series.
- E** A Fourier series must include a component at every integral multiple of the fundamental frequency.
- F** The fundamental angular frequency of a Fourier series is given by $1/T$, where T is the period of the signal.

*Choose **two** options and pencil across the appropriate cells in row 4.*

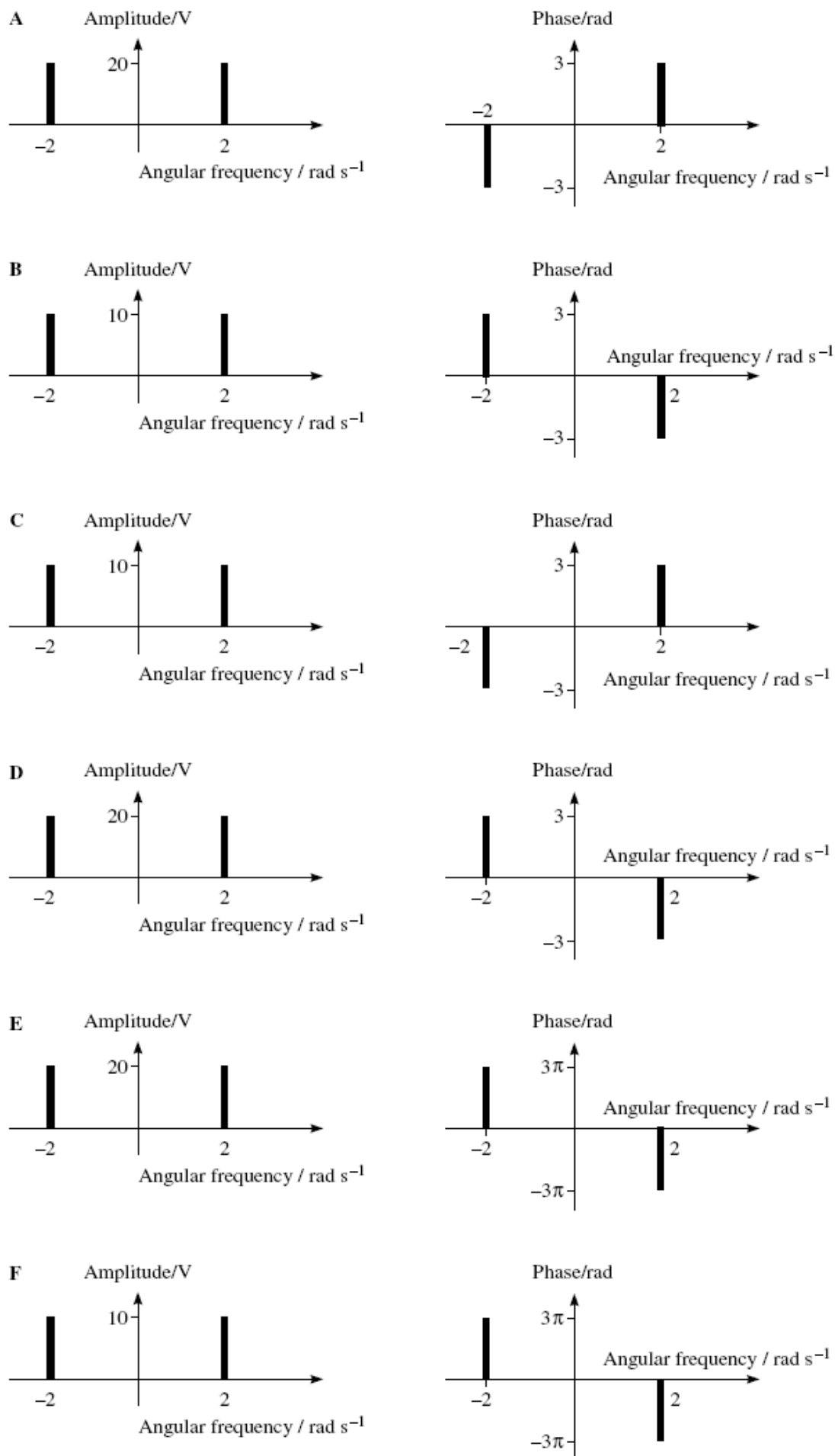


Figure 1 Options for Q2 and Q3

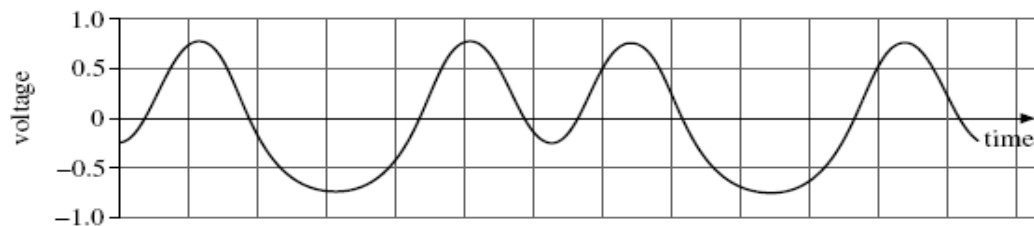


Figure 2 For Q5

Q5

Figure 2 shows a periodic waveform with three cosine components: the fundamental and the second and third harmonics. The fundamental has an amplitude of 0.5 volts and zero relative phase. Use a spreadsheet to determine the amplitude and phase of the other two components. Choose from the options A–D the values of amplitude and phase of the second harmonic, and from E–H those of the third harmonic.

Second harmonic

	amplitude/V	phase/rad
A	1	0
B	0.5	0
C	1	π
D	0.5	π

Third harmonic

	amplitude/V	phase/rad
E	0.25	0
F	0.5	0
G	0.25	π
H	0.5	π

Choose **two** options and pencil across the appropriate cells in row 5.

Q6

A periodic signal can be represented by the following expression.

$$f(t) = 0.5 \cos 2000\pi t + 0.5 \cos 4000\pi t + \cos 6000\pi t$$

Choose two **true** statements from the following:

- A** The fundamental frequency of the signal is 2 kHz.
- B** All components have the same amplitude.
- C** The amplitude of the second harmonic is twice that of the fundamental.
- D** All components have the same relative phase.
- E** The period of the signal is 1 ms.
- F** The relative phase of the third harmonic is π rad.
- G** The angular frequency of the second harmonic is 2000 rad s^{-1} .

Choose **two** options and pencil across the appropriate cells in row 6.

Q7

There are seven symbols, a to g, in a source alphabet. Given that the symbols occur with the probabilities of Table 2, what is the entropy of the source?

Table 2 For Q7

Symbol	Probability
a	0.6
b	0.16
c	0.13
d	0.05
e	0.03
f	0.02
g	0.01

- | | |
|--------------------|--------------------|
| A 1.20 bits | E 1.65 bits |
| B 1.35 bits | F 1.80 bits |
| C 1.40 bits | G 1.95 bits |
| D 1.55 bits | |

Choose **one** option and pencil across the appropriate cell in row 7.

Q8

Four-digit binary words are transmitted using a 7-digit Hamming code. The 7-bit word 0111011 is received. What was the original 4-bit word transmitted, assuming that no more than one bit was corrupted during transmission?

- | | |
|---------------|---------------|
| A 0010 | E 1110 |
| B 0101 | F 0110 |
| C 1001 | G 1011 |
| D 1010 | |

Choose **one** option and pencil across the appropriate cell in row 8.

Q9

In a system for recording incidents occurring from Monday to Saturday inclusive, each day is coded as a three-bit binary word. Assuming that the incidents are equally likely to occur on any of these days, calculate the efficiency of the coding scheme. Choose the value nearest to the efficiency from the options below.

- | | |
|---------------|---------------|
| A 0.60 | E 0.77 |
| B 0.63 | F 0.86 |
| C 0.67 | G 0.90 |
| D 0.70 | H 0.95 |

Choose the **closest** option and pencil across the appropriate cell in row 9.

Q10

In a particular binary transmission system, on average 4 binary digits in a thousand are in error. It is necessary to transmit four-digit binary words.

What is the probability that a four-digit word will contain at least one error? Select the nearest value from the options.

- | | |
|---------|---------|
| A 0.010 | E 0.018 |
| B 0.012 | F 0.020 |
| C 0.014 | G 0.022 |
| D 0.016 | |

*Choose the **closest** option and pencil across the appropriate cell in row 10.*

Q11

A communications channel has a bandwidth of 3 kHz and a signal-to-noise ratio of 30 dB. Choose from the options the value closest to the theoretical channel capacity.

- | | |
|--------------|--------------|
| A 20 000 bps | E 28 000 bps |
| B 22 000 bps | F 30 000 bps |
| C 24 000 bps | G 32 000 bps |
| D 26 000 bps | |

*Choose the **closest** option and pencil across the appropriate cell in row 11.*

Q12

A monochrome picture is stored electronically in a space probe as an array of 400 by 600 pixels (picture elements) which can each have one of 32 equally probable brightness levels. The picture is sent back to Earth using a 200 Hz channel in which the average noise power is one-quarter of the average signal power. Each picture takes 3 hours to transmit.

What is the information rate of the channel as a percentage of its ideal capacity? Select the nearest option.

- | | |
|-------|-------|
| A 55% | E 35% |
| B 50% | F 30% |
| C 45% | G 25% |
| D 40% | H 20% |

*Choose the **closest** option and pencil across the appropriate cell in row 12.*

Q13

A delta modulation speech encoder uses a sampling rate of 400 kHz and a step size of 0.02 V. It is tested with a sinusoidal signal of amplitude 1 V at various frequencies. At what frequency, to three significant figures, will slope overload start to occur?

- | | |
|------------|------------|
| A 1.27 kHz | E 12.5 kHz |
| B 4.81 kHz | F 25.7 kHz |
| C 6.24 kHz | G 34.3 kHz |
| D 8.95 kHz | H 45.2 kHz |

Choose **one** option and pencil across the appropriate cell in row **13**.

Q14

A line segment of alternating black and white runs of pels is coded using the modified Huffman code of Table 7.6 of Chapter 7 of the *Reference Book*. The number of pels in consecutive runs is 25, 20, 68, 10, 5, 130. The first run consists of white pels. What is the modified Huffman coding of the line segment?

- A 010101100001101000111000000011010001101000011001000000
- B 00010100000011010001101110110000100110000001100100000000110111
- C 01010110000110100011011011101100010011000110111011000100110011011
1011
- D 101100010000000110000011011101100010011000101000000110100
- E 0101011000011010001110010000111011000100000000100110001
- F 11001000011101100010000001001100001000100000001110001000
- G 0101011000011010001101110110000100110000001100100011
- H 101100010000001001100001000100110000010110001000010001000000

Choose **one** option and pencil across the appropriate cell in row **14**.

Q15

Select two **true** statements from the following:

- A In GSM the audio speech signal is initially encoded at 8000 samples per second using a 13-bit *A-law* encoder.
- B Huffman coding is an example of lossy encoding.
- C A code with a Hamming distance of 5 can correct up to 4 errors.
- D MPEG P-type pictures are coded using prediction and motion compensation.
- E CELP is an example of waveform coding.
- F MPEG audio coding is an example of lossless coding.
- G In MPEG II audio coding, the message is split into 16 equal and adjacent frequency sub-bands.
- H There are 13 excitation pulses in each standard rate GSM frame.

Choose **two** options and pencil across the appropriate cells in row **15**.