UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

Department of Computing

B. Sc. Examination 2017

IS51016A/B
Audio-Visual Computing

Duration: 2 hours 15 minutes

Date and time:

This paper is in two parts: part A and part B. You should answer ALL questions from part A and TWO questions from part B. Part A carries 40 marks, and each question from part B carries 30 marks. The marks for each part of a question are indicated at the end of the part in [.] *brackets.*

There are 100 marks available on this paper.

THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM

Part A

Please answer all questions

Question 1 What is the direction of (5,12) expressed by a unit vector?

[4]

(a) (0.5, 0.12)

(b) (5/13, 12/13)

(c) (1/5, 1/12)

(d) (25, 144)

Question 2 If you are at (0,0), and you want to move in the direction (1,0) but at the same speed as velocity (3,4) per second, where will you be after 1 second?

[4]

(a) (5,0)

(b) (7,0)

(c) (3,4)

(d) (0.3,0.4)

Question 3 Which statement is true?

[4]

(a) Grey scale filter is a neighbourhood filter; high pass filter is a local filter.

(b) Grey scale filter is a local filter; high pass filter is a neighbourhood filter.

(c) Grey scale filter and high pass filter are both neighbourhood filters.

(d) Grey scale filter and high pass filter are both local filters.

Question 4 We have two matrices A (dimension 4×5) and B (dimension 3×4). Which of the following statement is true?

[4]

(a) $A \times B = B \times A$. The result matrix C has a dimension of 4×4

(b) $A \times B = B \times A$. The result matrix C has a dimension of 5×3

(c) $A \times B \neq B \times A$. The result matrix C of B $\times$ A has a dimension of 3×5.

(d) $A \times B \neq B \times A$. The result matrix C of A $\times$ B has a dimension of 4×4.

Question 5 Which of the following statement is NOT true?

[4]

(a) Air resistance can be modelled using “Collision”

(b) Hair can be modelled using “Spring”

(c) A car crash can be modelled with “Collision”

(d) A cars suspension can be modelled using “Spring”

Question 6 Which of these wave types produces smoothest sound and has no partials?

[4]

(a) Sine Wave

(b) Sawtooth Wave

(c) Square Wave

(d) Triangle Wave

Question 7 Look at the following code. What value of modFreq would cause the frequency to modulate every five seconds ? (HINT: Hz can stand for cycles per second)

```
float modFreq = ?; //a value in Hz
float modAmp = 100;
float modOffset = 440;


modulator = new Oscil(modFreq, modAmp, Waves.SINE );
modulator.offset.setLastValue(modOffset);
carrier = new Oscil( 440, 0.2f, Waves.SINE );
```

[4]

(a) 0.2

(b) 12

(c) 300

(d) 5

Question 8 Which of these would be a sensible input for a Fast Fourier Transform?

[4]

(a) An array of frequency bins

(b) The audio signal from a microphone

(c) A single sine wave

(d) A constant value

Question 9 Look at the following code. Which of the given statements describes what synthesis is happening?

[4]

```
58 void generateAudioOut(float[] buffer)
59 {
60
61   for (int i = 0; i < buffer.length; i++)
62   {
63
64     float output = 0;
65
66     for (int j = 0; j < 10; j++)
67     {
68       int partial = j + 1;
69       float increment = frequency * partial * TWO_PI/44100.0;
70       phases[j] += increment;
71       output += sin(phases[j])%TWO_PI * 0.1;
72     }
73
74     buffer[i] = output;
75   }
76 }
77
```

(a) subtractive synthesis modulated by sine harmonics

(b) additive synthesis using an inharmonic series of frequencies

(c) frequency modulation of multiple sine tones

(d) additive synthesis using a harmonic series of frequencies

Question 10 What would you use an envelope follower for?

[4]

(a) Analysing the amplitude of a signal.

(b) Analysing the frequency of a signal.

(c) Reducing the higher frequencies of a signal.

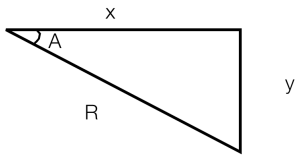
(d) Changing the volume of a signal.

Part B

Question 11 Trigonometry and Synthesis

(a) How is radians defined? Write down the results of the following radians-degree conversion: [8]
$a = degrees(2 * PI)$; a =?
$b = radians(180)$; b = ?
$c = degrees(radians(45))$; c = ?

(b) Given the triangle in the figure, write down the expression of x and y using R and A (hint: use $sin(A)$ and $cos(A)$) [2]



(c) Write the Processing code that draws a circle using beginShape() and the x and y value from question (b) [5]

(d) Give the float f defined as: $floatf = Asin(\omega t + \phi)$, explain the meaning of A, ω, t, and ϕ with a sine wave graph. Demonstrate with graphs how does the sin wave change when A, ω, t, and ϕ changes. . [10]

(e) Write down the 2D rotation matrix around z axis (3x3), and explain why matrices are used in transformation. [5]

Question 12 Image processing and computer vision

(a) What is the difference between Raster graphics and Vector Graphics? List one file format for each. [4]

(b) Write down the code (using one for-loop) which loops over each pixel of a entire image (PImage img), and sets the value of each pixel to white. [5]

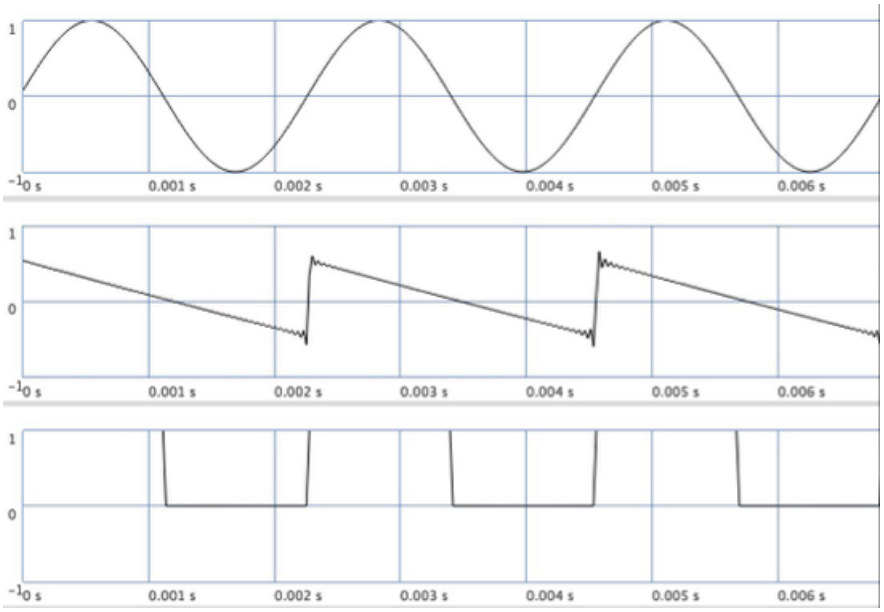
(c) Will the above code work for neighbourhood filters? Explain why and write the code that is needed for neighbourhood filters [10]

(d) List three useful tasks mentioned in the lecture in computer vision [6]

(e) Choose one from the above 3 tasks and briefly explain how it works. [5]

Question 13 Audio: Synthesis

(a) Look at the images and name each wavetype and write a brief comment on the timbre for each. [3]



(b) Draw an approximate visual representation for the audio buffer each of the following code excerpts. Name the type of signal that each produces. [4]

```
for (int i = 0; i < buffer.length; i++)
{
  buffer[i] = random(-1.0,1.0);
}
```

```
for (int i = 0; i < buffer.length; i++)
{
  sig =  sig + random(-0.01,0.01);
  sig = min(1.0, max(0.0, sig));
  buffer[i] = sig;
}
```

(c) Fill in the following details to make a filter sweep which starts with the full frequency spectrum and gradually thins the sound leaving only the higher frequencies. [3]

Filter Type: _____
Start Frequency: _____
End Frequency: _____

(d) You are using minim to make a drum machine. Describe how you would synthesise between three and five sounds which could be part of an electronic drum kit (e.g. bass drums, snare drums, toms, cymbals, or bells). You should describe your sounds with as much detail as possible commenting on aspects such as synthesis techniques, types of wave form, filters, envelopes, and parametrical ranges. [10]

(e) Now you want to provide an audio-visualisation to accompany the resulting drum

track. Describe how you would use signal analysis techniques to link visual elements to the sound. You can optionally use pseudo code and drawings to make your proposed visualisation clearer. [10]