TERM TEST

Instructor: B. Ross
Date: March 18, 2008

NAME (print): ___________________________________
STUDENT NUMBER: ________________________________

A calculator without a memory bank may be used. No other aids permitted.
Please answer all questions on the exam paper. Use the backs of pages if necessary.
Keep written answers brief and to the point. Write neatly and legibly.
Carefully read all questions!

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Question 1 [16] Matching: Write the letter of the most appropriate answer.  
[no penalty for wrong answers]

1. _____ This view in Ableton Live lets you play clips in synch to the tempo.
2. _____ A physics concept used in ray tracing refraction (transmission).
3. _____ One-half the maximum sampled frequency.
4. _____ Sine and cosine calculations are efficiently computed by this.
5. _____ A serial protocol for musical events.
6. _____ Promotes rendering efficiency for complex polygonal models.
7. _____ The closest intersection to the viewer's eye.
8. _____ Synthesis technique that uses a carrier and modulator.
9. _____ Local lighting includes this effect.
10. _____ One audio signal's harmonics amplifies those in another audio signal.
11. _____ Put your Csound instrument definitions into this file.
12. _____ A standard for creating software instruments.
13. _____ Refers to how much amplitude increases by a filter or effect.
14. _____ A waveform that is an integral multiple of another.
15. _____ Gives exact solutions, but is impractical to implement on computers.
16. _____ A synthesis technique inspired by the photon model of light.

A. MIDI  L. mirror reflection
B. Bounding box  M. Arrangement
C. Douglas Davidson  N. Nyquist
D. Hit point  O. specular reflection
E. Granular  P. Orchestra
F. Fourier Series  Q. Gain
G. Session  R. dot product
H. Harmonic  S. Snell's Law
I. Decibel  T. Discrete Fourier Transformation
J. Score  U. FM
K. Convolution  V. VST
Question 2 [28] Multiple choice: select the best answer to each question
[+2 correct, 0 nothing, -0.5 wrong guess; one free wrong guess allowed]

1. Ray tracers generate shadows by:
   a. If the material has a shadow property in the local lighting, then render a shadow.
   b. If a shadow feeler detects a light between the hit point and an object, render a shadow.
   c. If a shadow feeler detects an object between the hit point and a light, render a shadow.
   d. Setting the diffuse coefficient to a very low value.

2. Regarding sphere intersections, the geometric solution is faster than the algebraic approach because:
   a. it determined when intersections were not possible at earlier stages.
   b. square roots were avoided
   c. it is on the order of $O(n \log n)$
   d. aliasing is avoided

3. The decibel scale is:
   a. $O(N^2)$
   b. logarithmic
   c. uses complex numbers
   d. between 20 Hz to 20 kHz

4. The MIDI hardware standard uses a data transfer rate of:
   a. 44,400 bits/sec
   b. 480 mBits/sec
   c. 20,000 bytes/sec
   d. 31,250 bits/sec

5. VST stands for:
   a. Virtual Synthesizer Toolkit
   b. Voltage-controlled Sequencer Tracks
   c. Virtual Studio Technology
   d. VCO Sample Table

6. Which of the following is not one of the 3 types of VST plug-ins:
   a. VST midi effect
   b. VST granular delay processor
   c. VST effect (audio)
   d. VST instrument

7. Effective subtractive synthesis is heavily reliant upon:
   a. subtraction
   b. good filters
   c. high-resolution wave tables
   d. Douglas Davidson being in a safe place outside the studio
8. The recursion depth limit is required in ray tracers in order to:
   a. prevent infinite reflection between objects
   b. avoid saturation of combined recursive rays
   c. reduce needless intersection computations
   d. permit simple allocation of threading in a distributed ray tracer

9. Ring modulation involves:
   a. adding two unipolar signals
   b. enveloping a modulator with a ringer
   c. multiplying two bipolar signals
   d. computing and playing a moving average of sample sequences

10. Csound’s slowest data rate (i-rate) is used to change variables that denote:
    a. audio data
    b. envelopes
    c. notes
    d. amplitudes

11. During the computation of a transmission vector, this optical property frequently arises:
    a. soft shadows
    b. perfect reflection
    c. total internal reflection
    d. stochastic dispersion

12. The VST SDK calls any user-selected value from the GUI interface a:
    a. sample
    b. note event
    c. parameter
    d. program

13. MIDI files contain:
    a. compressed audio samples
    b. event messages, such as note on/off signals
    c. Fourier series coefficients a and b
    d. none of the above

14. Granular synthesis is capable of:
    a. processing audio files to generate new and interesting sounds
    b. changing pitch while keeping time duration intact
    c. generating stochastic clouds of sound grains
    d. making Douglas Davidson sound even worse than usual
    e. all of the above
Question 3 [18]

a) [12] Draw a diagram showing the complete processing for sampling and playback of digital audio. Discuss all the steps in the diagram.
b) [2] What is a low-pass filter? Why is it used during digital audio recording?

c) [4] Why does the sampling rate have to be at least twice the frequency of the highest frequency to be recorded? Illustrate what happens if it is not. What term is used to describe the undesirable effect?
Question 4 [10]

a) [7] Define granular synthesis. Identify and briefly describe 4 user-controllable parameters to a granular synthesis engine.

b) [3] Why is enveloping of grains done during granular synthesis? Illustrate how the envelopes are applied.
Question 5 [20] Consider the discrete Fourier formula:

\[ f(t) = \sum_{n=1}^{T/2} \left( a_n \cos \left( \frac{2\pi nt}{T} \right) + b_n \sin \left( \frac{2\pi nt}{T} \right) \right) + a_0 \]

\[ a_0 = \sum_{k=0}^{T-1} \frac{x[k]}{T} \]

\[ a_n = \left( \sum_{k=0}^{T-1} x[k] \cos \left( \frac{2\pi nk}{T} \right) \right) \cdot \left( \frac{2}{T} \right) \]

\[ b_n = \left( \sum_{k=0}^{T-1} x[k] \sin \left( \frac{2\pi nk}{T} \right) \right) \cdot \left( \frac{2}{T} \right) \]

a) [6] Identify the meaning of the following terms:

- **n:**

- **T:**

- **f(t):**

- **x[k]:**

- **a_0**

- **b_n**
b) [6] The Fourier series is the sum of sine waves. Identify and discuss 3 defining characteristics of these sine waves. Also discuss how the 3 characteristics are determined from the above formulae.
c) [4] Explain what is happening in the formula for $a_n$ above. In other words, what is being computed, why is it being computed in this way, and how is it being used in the main formula?

d) [4] Define the STFT. What does it do differently than the standard DFT above? Under what circumstances is it a more preferred approach to audio analysis?
Question 6 [20] Write pseudo-code for the basic recursive ray tracing algorithm. Include program calls that process reflection, refraction, and shadows. Describe all the main components of the algorithm. (You do not need to include the mathematics behind any of the steps, nor detailed data structures.)
*** The End. ***