Math/Music: Aesthetic Links

Homework Assignment #3

DUE DATE: Friday, March 2, start of class.

Homework should be turned in at the beginning of class. You should write up solutions neatly to all problems, making sure to show all your work. You are encouraged to work on these problems with other classmates, although the solutions you turn in should be your own work. Please cite any references (web based or text) that you may have used for assistance with the assignment.

Note: Please list the names of any students or faculty who you worked with on the assignment.

> *The introduction of my method of composing with twelve tones does* **not** *facilitate composing. … One has to follow the basic set; but, nevertheless, one composes as before.*
>
> –Arnold Schoenberg

1. Listen to CD #2: *Modern Mathematical Music: Sets, Rows and Magic Squares* available on the Montserrat Moodle page for the course. Liner notes are available from the course webpage in the Handouts section and much of the written music for the CD was distributed in class. You may be tested on some of this music so be sure to read the liner notes and listen carefully. One approach to effectively absorbing the music is to make brief notes about each piece, listing significant details as you listen.

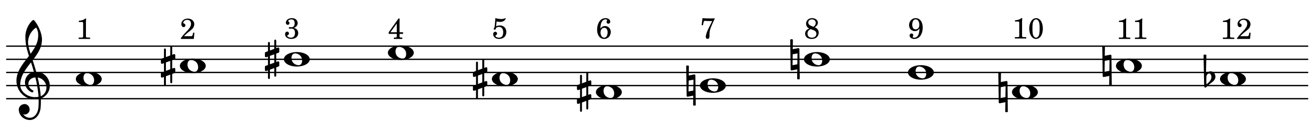
2. Read Chapter 8 of the course text, *Composing with numbers: sets, rows and magic squares*, by Jonathan Cross

   a. What two numbers did Alban Berg play around with in his *Lyric Suite* for string quartet in 1926. What are the personal meanings of each number?

   b. Which composer, and in what piece, used the twelve-tone method not only to generate the pitches of his piece, but also to create its rhythm, dynamics and mode of attack?

   c. What famous architect had a strong influence on Iannis Xenakis, as exemplified in his piece *Metastasis*?

3. Consider the tone row (P-0) given below:



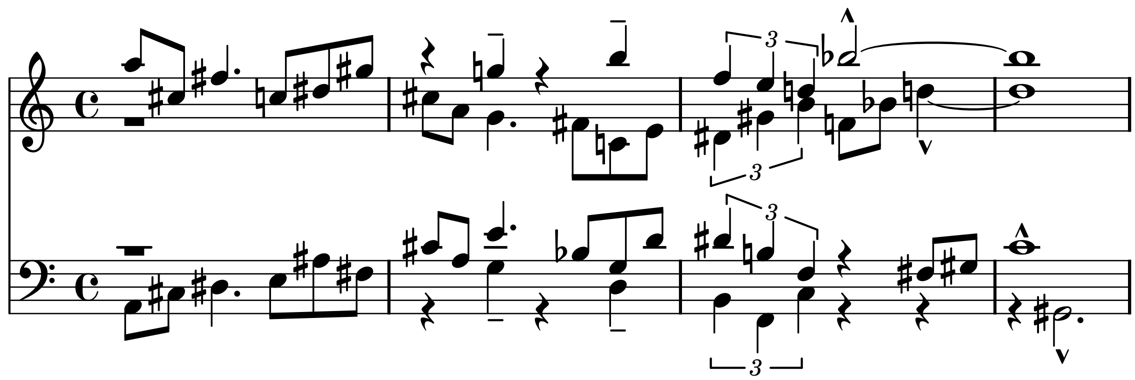
   a. Copy the tone row onto staff paper and give each of the musical intervals between successive notes (e.g., m2, M2, P4, tritone, etc.).

   b. In the treble clef, write out each of the following tone rows using correct accidentals: P-3, I-0, I-4, RI-4.

c. List the four tone rows that start on E. You do **not** need to write out each row, just give the name (e.g., P-3, R-5, etc.).

d. Consider the following twelve-tone excerpt based on the tone row P-0. Each of the four voice parts (soprano, alto, tenor, bass, arranged in order from the highest part to lowest) follows a different tone row. Identify the names of each row used (e.g., P-5, I-6, etc.).

Excerpt using Tone Row P-0



4. While most prime tone rows (P-0) generate a total of 48 rows under the operations of transposition, inversion, retrograde and retrograde-inversion, certain tone rows generate only 24 new rows (including the original row). One such example, discussed in class, is a simple chromatic scale, which has only 24 distinct possibilities, 12 ascending and 12 descending versions. In this case, R-1 = I-0, R-2 = I-1, … and P-1 = RI-0, P-2 = RI-1, …. Find another example generating only 24 new rows and state which tone rows are equivalent. *Hint:* Use symmetry.

5. Recall from class that the *magic constant* M_n, the sum of any row, column or main diagonal in an $n \times n$ magic square is given by

$$M_n = \frac{n(n^2+1)}{2}. \tag{1}$$

In this problem you will derive this formula.

a. Using a famous formula discovered by the very young Gauss (discussed on the very first class of the semester), find the total sum of *all* the numbers in an $n \times n$ magic square. *Hint:* Order them consecutively and combine in a clever way.

b. Alternatively, we can find the total sum of all the numbers in an $n \times n$ magic square by adding together the sums of each row. Since each row in a magic square sums to M_n, the total sum is _____________.

c. Equating your answers from parts **a.** and **b.**, solve for M_n to derive the formula given in equation (1).

6. Complete the following 6×6 magic square. Please show your work or describe how you arrived at your solution.

	1	6		19	24
3	32	7	21		25
31		2		27	20
8	28	33		10	
30	5	34	12		16
4	36		13	18	

7. Complete the following 4×4 magic square. Please show your work or describe how you arrived at your solution.

	13	11	
7			1
14			12
	8	2	

8. **Bonus Question:** Prove that the sum of the corners in any 4×4 magic square is also equal to the magic constant.