CREATING A 12 TONE MATRIX:

"My music is not modern, it is merely badly played." A. Schoenberg

WHY CREATE A 12 TONE MATRIX?

"Having a chart like this (12 tone matrix) showing all variants of the series at a glance is an invaluable tool when composing or analyzing twelve-tone music."
Dallin, P. 194 *Twentieth Century Composition*

Having the skill to create a 12 tone matrix is a necessity for any student wanting to advance further in the study of music. Being able to build a matrix is the beginning to understanding 12 tone music. The ability to understand 12 tone music is an essential part for the maturity of a musician.

- **LETS GET STARTED………………..**

STEP ONE: THE ROW:
- To create a 12 tone matrix you must first have a row. The initial row we use is known as "THE ORIGINAL ROW"

Schoenberg's String Quartet No. 4. (You should listen to this piece)
The Original Row is:

D, C#, A, A#, F, D#, E, C, G#, G, F#, B

WRITE THE ORIGINAL ROW OUT IN THE BOX BELOW…

QUICK TIP

IF THERE ARE FLATS IN YOUR ORIGINAL ROW, USE THE ENHARMONIC EQUIVELENT.
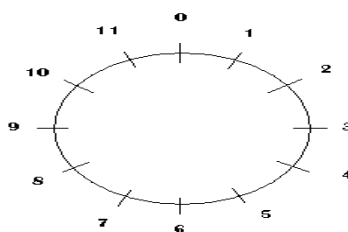[D, C#, A, Bb, F, Eb, E, C G#, G, F, B]
would be translated to
[D, C#, A, A#, F, D#, E, C, G#, G, F#, B]
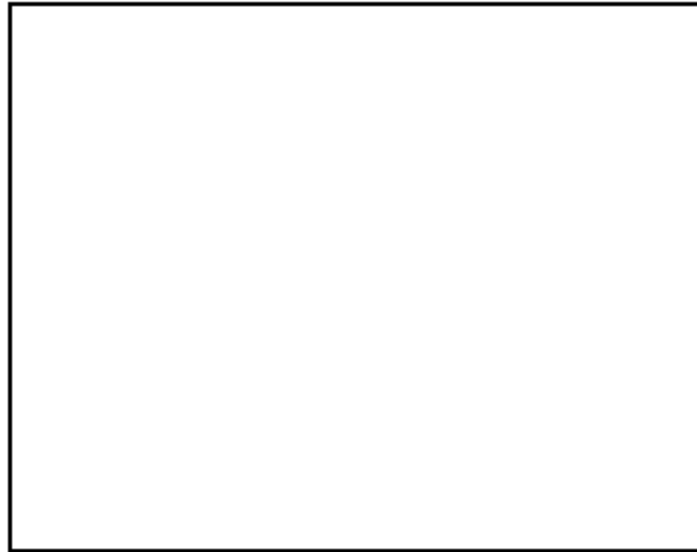
STEP TWO: THE CLOCK DIAGRAM
One of the 'building blocks' of a 12 tone matrix is a clock diagram. A clock Diagram looks like a clock, but instead of 12 at the top we substitute with a zero (0).
Here is what a clock diagram should look like.

TRY DRAWING YOUR OWN CLOCK DIAGRAM IN THE BOX BELOW:

The clock diagram is a tool that composers and analysts use to give pitches in a 12 tone row assigned numbers. This is known as the pitch class. These numbers (or pitch classes) will be the 'data' that we will be eventually 'plugging' into our matrix. Each pitch is equal (or a match) to a number, and each number to a pitch. The clock diagram is the road map we will use to figure out what pitch will be matched up to which number. The clock diagram will show us each pitch class for our original row.

PITCH CLASS: "Arranging pitches chromatically to give their number value. The first note of the tone row (original row) is designated as number 0. All numbers from 0 to 11 are used to refer to these classes."

!!! VERY IMPORTANT !!!

THE FIRST PITCH OF YOUR ROW WILL ALWAYS
BE ASSIGNED THE ZERO (0) SLOT ON YOUR CLOCK DIAGRAM.

A SOCRATIC CONVERSATION:
TEACHER: "In Schoenberg's String Qt. #4, D is the first pitch of the original row. Therefore, D would be assigned the zero (0) slot on our clock diagram."
STUDENT: "What do you mean by D would be assigned number 0?"
TEACHER: "Good question! What I mean is I would take the pitch D (the first pitch of my row) and insert it in the 0 slot of my clock diagram. It would look like this:
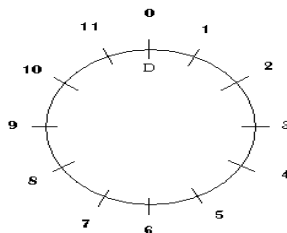
(write D in the 0 slot on your clock diagram)

TEACHER: "After we have our first pitch in the 0 slot, we can then proceed with plugging in the rest of our pitches."
STUDENT: "So if D is the first pitch of our original row, and it is in the 0 slot, then C#, the second pitch of our original row would go in the 1 slot, right?"
TEACHER: "That is a great question, and a great idea, but that is not how we will proceed! It makes sense to fill the diagram in that way, but it is not correct. Chromatic half-steps are the key to filling out the clock diagram."
STUDENT: "Half-steps?"

TEACHER: "Take D in slot 0. One half-step up from D is D#, D# is what will go in slot 1. One half-step up from D# is E, E is what will go in slot 2."

**STUDENT**: "One half-step up from E is F, so will F go in slot 3?"

TEACHER: "Yes, that is correct. The clock diagram will always raise in half-steps. The first pitch of your original row always gets put into slot 0, then you just go up one half-step for each number on the clock."

STUDENT: "So with D (the first pitch of our Original Row) at slot zero, and a half-step up for every number on the clock, would it look like this?
0-D, 1-D#,2-E,3-F,4-F#,5-G,6-G#,7-A,8-A#,9-B,10-C,11-C#?"

TEACHER: "Correct! You have done it!" For Schoenberg's String Qt. #4, these are our pitch classes.

THIS IS WHAT THE COMPLETED CLOCK DIAGRAM SHOULD LOOK LIKE:
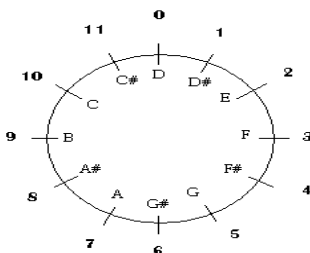
(fill in the rest of your clock diagram)
D (the first pitch in the original row) followed by half-steps going up the chromatic scale.

!!! IMPORTANT REMINDER !!!

The FIRST pitch of your ORIGINAL ROW will always go in the 0 slot of your clock diagram.
With our original row D is the first pitch, therefore, D will go in the 0 slot.
Slot 1 is ALWAYS one half-step higher than Slot 0.
Slot 2 is ALAWYS one half-step higher than Slot 1.
Slot 3 is ALAWYS one half-step higher than Slot 2.
Slot 4 is ALAWYS one half-step higher than Slot 3.
Slot 5 is ALAWYS one half-step higher than Slot 4.
Slot 6 is ALAWYS one half-step higher than Slot 5.
Slot 7 is ALAWYS one half-step higher than Slot 6.
Slot 8 is ALAWYS one half-step higher than Slot 7.
Slot 9 is ALAWYS one half-step higher than Slot 8.
Slot 10 is ALAWYS one half-step higher than Slot 9.
Slot 11 is ALAWYS one half-step higher than Slot 10.
AFTER ALL THIS SLOT 0 (WICH IS ALREADY FILLED IN) WILL ALWAYS BE ONE HALF-STEP HIGHER THAN SLOT 11.

NEXT WE NEED TO TAKE OUR CLOCK DIAGRAM 'DATA' AND MATCH EACH PITCH IN OUR ORIGINAL ROW WITH IT'S CORRESPONDING NUMBER. THIS GIVES US OUR PITCH CLASSES.
-   D on our clock diagram is in slot 0
-   C# on our clock diagram is in slot 11
-   A on our clock diagram is in slot 7, etc.

Making a chart to group our original row pitches with there corresponding numbers is a helpful tool. Below is an example of a simple chart with the numbers from our clock diagram on top and pitches from our original row on the bottom.

Original Row Pitch Classes	0	11	7	8	3	1	2	10	6	5	4	9
Original Row	D	C#	A	A#	F	D#	E	C	G#	G	F#	B

FILL IN YOUR OWN PITCH AND NUMBER CHART IN THE BOXS BELOW:

Original Row Pitch Classes												
Original Row												

STEP THREE: THE MATRIX

We are now ready to start the actual matrix.

First you need to make a graph that is 12 boxes by 12 boxes

It should look something like this:

(create your own 12 by 12 matrix on a separate piece of paper)

Now we need to start filling in our matrix.

The first step in filling out our matrix is to take our Original Row and input our pitch classes into the first row of the matrix.

It should look like this:

0	11	7	8	3	1	2	10	6	5	4	9

(fill in the original row numbers in the first row of your matrix)

What we have just done is filled in what is known as Prime Row 0. Or P0.

Prime rows on a matrix are read left to right.

There are four ways to read a matrix. (Or four ways to read a matrix)
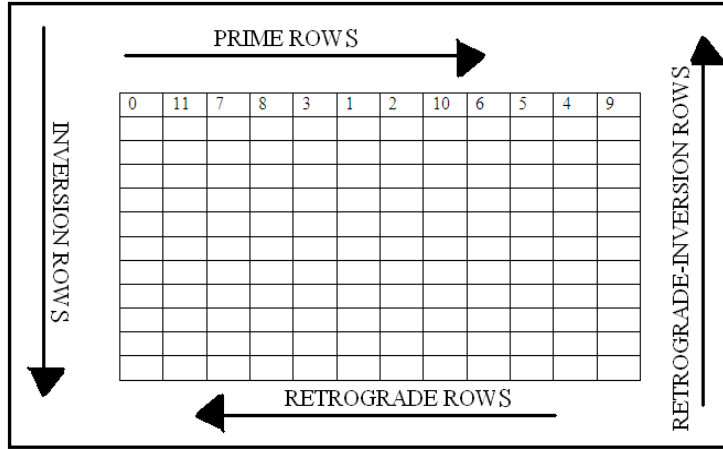
Prime Rows: Left to Right

Inversion Rows: Top to Bottom

Retrograde Rows: Right to Left

Retrograde-Inversion Rows: Bottom to Top

THIS WILL BE DISCUSSED IN GREAT DETAIL IN THE NEXT CHAPTER!

(THIS WILL BE EXPLAINED IN GREAT DETAIL IN THE NEXT CHAPTER)

Next we must fill in the first column of our matrix:

-(This column is know as Inversion Row 0)

!!! IMPORTANT TO REMEMBER !!!

BECAUSE WE ARE DEALING WITH A ROW THAT CONTAINS 12 PITCHES,
12 IS A VERY IMPORTANT NUMBER. WE WILL BE ADDING 12, SUBTRACTING 12,
AND USING 12 NON STOP. REMEMBER 12 IS YOUR FRIEND!
TODAYS MAGIC NUMBER IS....

12

HERE IS HOW WE WILL FIGURE OUT WHICH NUMBERS GO WHERE:
OR
WE WILL FIGURE OUT WHERE OUR PITCH CLASSES GO ON THE MATRIX:

- Going downwards (inversion), 0 is the first number in our first column (This first column is known as I0 or Inversion Row 0.)
- This is where we need our magic number: 12.
- To get the second number in our first column we take the second number of our original row and subtract it from 12. 11 is the second number in our original row, 12-11=1, therefore, 1 will be put in the second box of our first column. Look below to see what I mean:

0	11	7	8	3	1	2	10	6	5	4	9
1											

- This pattern will continue until we have filled out the entire first column. (I0)
- We must take each of our original row pitches and subtract them from 12 (just like we did above)
- So…….. 12-7=5   12-8=4   12-3=9   12-1=11
           12-2=10   12-10=2   12-6=6   12-5=7
           12-4=8   12-9=3

WE WILL ALWAYS USE THE NUMBER 12. THIS IS BECAUSE THERE ARE 12 PITCHES! 12 IS A VERY IMPORTANT NUMBER WHEN MAKING A 12 TONE MATRIX.

NOW WE NEED TO TAKE OUR DIFFERENCES AND PLUG THEM INTO OUR MATRIX:
You matrix should now look like this:

0	11	7	8	3	1	2	10	6	5	4	9
1											
5											
4											
9											
11											
10											
2											
6											
7											
8											
3											

"DO YOU UNDERSTAND HOW THAT WORKED?" LOOK BELOW:
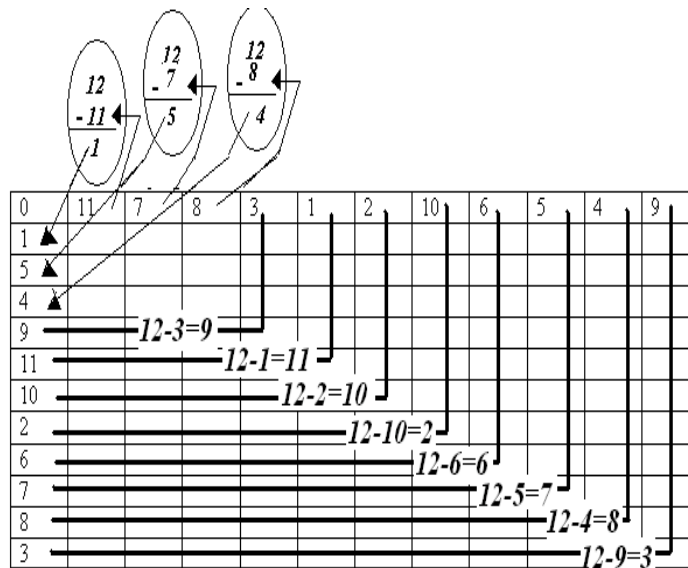
Now we can start to fill in the rest of our matrix.
- We will now be adding our first column (I0) with our original row.(P0)
- Remember 12 is a VERY important number in 12 tone music, because there are 12 tones!

!!! VERY IMPORTANT !!!

IMPORTANT RULE: When we start adding, any time we have a number greater than 11, we must subtract 12 from that number! For example if we take 9 and 10, add them together we get 19. 19 is greater than 12! So, we must subtract 12 from 19. 19-12 =7. Again any number greater than 11 must be subtracted by 12. Let's look further and this will make much more sense!

- We will start with the number (pitch class) 1 in our first column. (I0)
- Find the 1 in the first column. (I0)
- We will take our 1 and add it to each number in our row from our Original Row.

- We are dealing with Prime Row 1. This is called Prime Row 1 because it reads left to right, and 1 is the first number.
- Because we are in Prime Row 1, we will add 1 to every pitch class, after 0, from our original row. This is how we will fill in Prime Row 1.
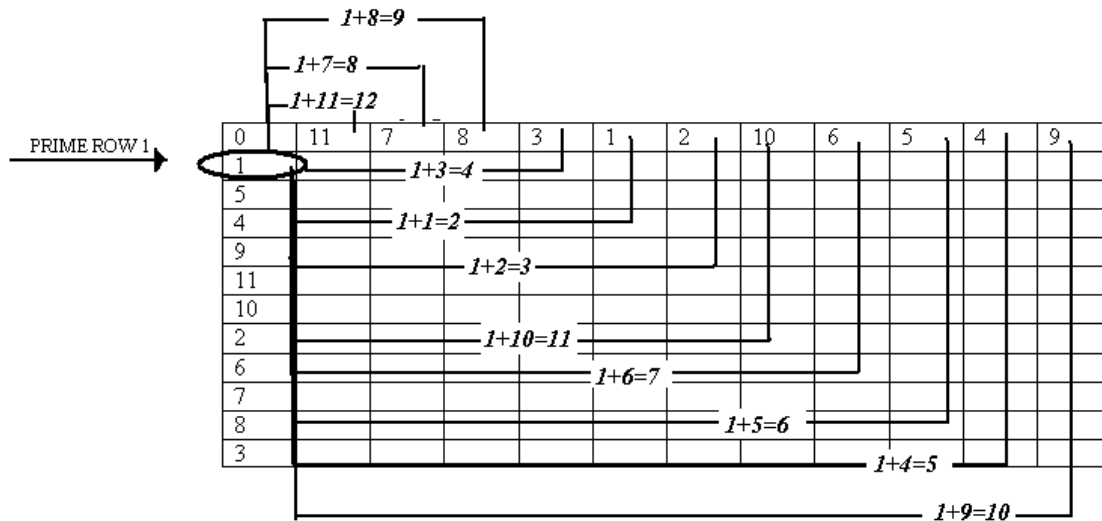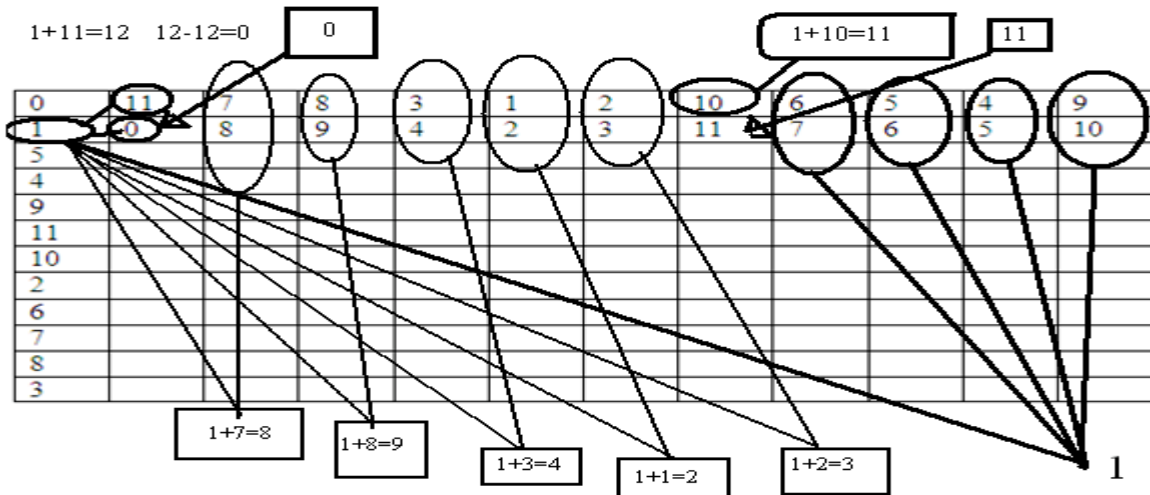

- Do you see how we added these number (pitch classes)?
- Remember anytime you get a sum greater than 11 you must subtract 12 from that sum.
- Our additions should look like this…

> 1+11=12 (!!!BUT WAIT!!!) The sum is 12, but 12 is greater than 11. Therefore we must subtract 12 from this sum!
>
> 12-12=0. So our sum here is actually 0.
>
> So….We have: 1+11=0   1+7=8   1+8=9   1+3=4
>
> 1+1=2   1+2=3   1+10=11
>
> 1+6=7   1+5=6   1+4=5   1+9=10

- Now we can plug these sums into our matrix.
- Here is how we do it:
  - Take each sum and place it at the cross point between the two numbers you added.
  - **FILL IN THE SUMS ON YOUR MATRIX**, IT SHOULD LOOK LIKE THE ONE BELOW:

0	11	7	8	3	1	2	10	6	5	4	9
1	0	8	9	4	2	3	11	7	6	5	10
5											
4											
9											
11											
10											
2											
6											
7											
8											
3											

1+11=12   12-12=0   [0]   1+10=11   [11]

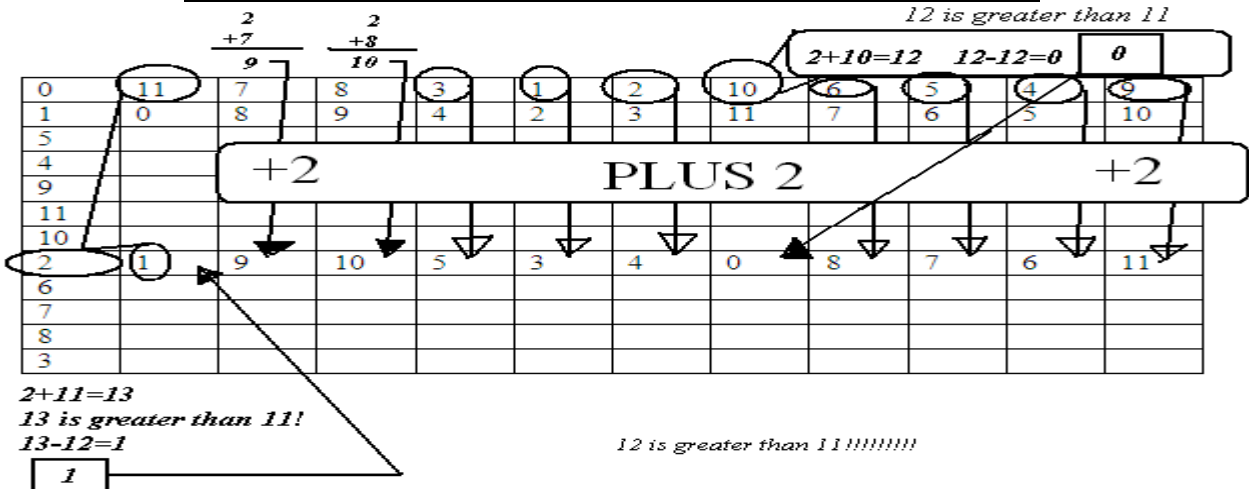1+7=8   1+8=9   1+3=4   1+1=2   1+2=3   1

- This addition process will be the same for every other number in our first column. (I0)
- Just like with Prime Row 1, each other number in our first column (I0) will be added with the remaining pitch classes (after 0) of our original row.
    o Or (11,7,8,3,1,2,10,6,5,4,9)
- **Fill in Prime Row 2** (This is the Prime Row that begins with a 2)
    o Hint: you will have to add 2 to each remaining pitch class, after 0, in our original row, (11,7,8,3,1,2,10,6,5,4,9).
    o Remember any sum greater than 11 is not finished yet! You need to subtract 12 from any sum greater than 11!
    o Take each sum and place it at the cross point between the two numbers you added.

Here is what your matrix should look like now:

0	11	7	8	3	1	2	10	6	5	4	9
1	0	8	9	4	2	3	11	7	6	5	10
5											
4											
9											
11											
10											
2	1	9	10	5	3	4	0	8	7	6	11
6											
7											
8											
3											

DO YOU REMEMBER HOW WE GOT EACH NUMBER???

2 +7 / 9   2 +8 / 10   12 is greater than 11   2+10=12   12-12=0   [0]

PLUS 2   +2   +2

2+11=13
13 is greater than 11!
13-12=1
[1]

12 is greater than 11 !!!!!!!!!

Now that we got this down we can fill out the rest of our matrix.
- It is done with the exact same process that we used to get the pitch classes for Prime Rows 1 and 2.
- **Fill in Prime Row 3** (This is the Prime Row that begins with a 3)
- Now we will add 3 to each of the remaining numbers from our original row. (11,7,8,3,1,2,10,6,5,4,9).
- Your additions should be: 3+11   3+7   3+8   3+3   3+1   3+2   3+10   3+6   3+5   3+4   3+9
    - Remember if any of those sums are greater than 11, YOU MUST SUBTRACT 12 FROM THAT SUM TO GET YOUR FINAL NUMBER.
    - Here is how you can check your work, look at all your sums. There should be every number 0-11 present (with the exception of 3, because we are beginning with 3.
    Your sums should have been: [2,10,11,6,4,5,1,9,8,7,0]

Now your matrix should look like:

0	11	7	8	3	1	2	10	6	5	4	9
1	0	8	9	4	2	3	11	7	6	5	10
5											
4											
9											
11											
10											
2	1	9	10	5	3	4	0	8	7	6	11
6											
7											
8											
3	2	10	11	6	4	5	1	9	8	7	0

- We now have Prime Row 0, Prime Row 1, Prime Row 2, and Prime Row 3 completed.
- **Fill in Prime Row 4, Prime Row 5, Prime Row 6 and Prime Row 7.**
    - Remember the rules and hints given above!

Your matrix should look like this:

0	11	7	8	3	1	2	10	6	5	4	9
1	0	8	9	4	2	3	11	7	6	5	10
5	4	0	1	8	6	7	3	11	10	9	2
4	3	11	0	7	5	6	2	10	9	8	1
9											
11											
10											
2	1	9	10	5	3	4	0	8	7	6	11
6	5	1	2	9	7	8	4	0	11	10	3
7	6	2	3	10	8	9	5	1	0	11	4
8											
3	2	10	11	6	4	5	1	9	8	7	0

DOES YOUR MATRIX LOOK THE SAME?
    IF NOT:
        o Go back and check your math.
        o Do you have any numbers larger than 11?
        o Did you add the proper numbers?
        o Did you place the sums in the proper row and column?
        o Do you have each number (only once, no duplicates) 0-11

- If your matrix matches the above, let's proceed and finish.
- **Fill in Prime Row 8, Prime Row 9, Prime Row 10, and Prime Row 11.**

Your finished matrix should look like this:

0	11	7	8	3	1	2	10	6	5	4	9
1	0	8	9	4	2	3	11	7	6	5	10
5	4	0	1	8	6	7	3	11	10	9	2
4	3	11	0	7	5	6	2	10	9	8	1
9	8	4	5	0	10	11	7	3	2	1	6
11	10	6	7	2	0	1	9	5	4	3	8
10	9	5	6	1	11	0	8	4	3	2	7
2	1	9	10	5	3	4	0	8	7	6	11
6	5	1	2	9	7	8	4	0	11	10	3
7	6	2	3	10	8	9	5	1	0	11	4
8	7	3	4	11	9	10	6	2	1	0	5
3	2	10	11	6	4	5	1	9	8	7	0

DOES YOUR MATRIX LOOK THE SAME?
     IF NOT:
- o   Go back and check your math.
- o   Do you have any numbers larger than 11?
- o   Did you add the proper numbers?
- o   Did you place the sums in the proper row and column?
- o   Do you have each number (only once, no duplicates) 0-11

IF YOUR MATRIX DOES MATCH THE ABOVE, GREAT JOB, YOU HAVE TAKEN A BIG STEP INTO A VERY IMPORTANT ASPECT OF THE MUSICAL WORLD!
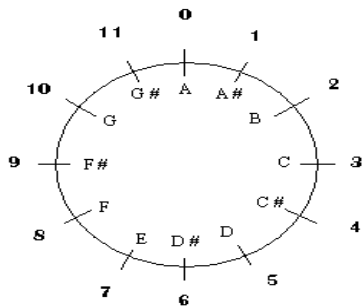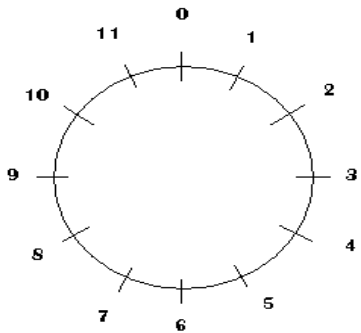
LET'S REVIEW THE PROCESS:
1) Obtain 12 tone row
2) Make clock diagram 0-11
3) Assign the first pitch of your row the 0 slot of the clock
4) After your first pitch is in slot 0 assign slots 1-11 pitches by a raised half step.
   (slot 1 will be a half step higher than the first pitch of your row{slot 0}, slot 2 will be a half step higher than slot 1, etc.)
5) Match each pitch in your row with its corresponding slot number from your clock diagram. This gives each pitch in the original row its pitch class.
6) Create a blank matrix. (**12 boxes X 12 boxes**)
7) Put the pitch class numbers of your 12 tone row into the first row of your blank matrix. **THE ROW WILL ALWAYS START WITH 0.** This first row is Prime Row 0, or P0.
8) Fill in the first column going downwards, (This row is called I0):
   - Subtract each pitch in your original row (each pitch following 0) from 12.
   - Each difference will be placed in the first column in the order it was subtracted. (12 minus the 2nd column will be put in the 2nd row. 12 minus the 3rd column will be put in the 3rd row, etc.)
9) Fill in Prime Row 1 (**This is the Prime Row that starts with a 1**):
   - Add 1 to each pitch following 0 in your original row, putting the sums in the boxes that intersect Prime Row 1 and the pitch from the original row that was used in the addition. (**IF YOU HAVE A NUMBER GREATER THAT 11 YOU MUST SUBTRACT 12 FROM THAT SUM.**)
10) Fill in Prime Row 2, adding 2 and the remaining numbers from the original row placing the sums in the boxes that intersect Prime Row 2 and the pitch from the original row that was used in the addition.
11) Fill in the remaining Prime Rows with the corresponding numbers and the remaining numbers form the original row, placing the sums in the boxes that intersect the Prime Row and the pitch from the original row that was used in the addition.

TRY ONE ON YOUR OWN:

- Try building a 12 tone matrix on your own now!
- Remember all the steps, tips, hints, and rules given above.
- If you get lost go back to the start and try again.
  - Building a matrix is like making a cake. Each step is very important.
  - If one step is missed, it will not work. So, start over and try again.
  - YOU CAN DO IT!

ANSWERS FOR: Schoenberg Violin Concerto (1936)	Here is the Original Row: Schoenberg Violin Concerto (1936)
	A, A#, D#, B, E, F#, C, C#, G, G#, D, F **MAKE CLOCK DIAGRAM:** (make your clock diagram below)
	INSERT PITCHES ONTO CLOCK DIAGRAM: (fill in the pitches on your clock diagram above)
	ALLIGN PITCHES WITH THEIR PITCH CLASS:

A	A#	D#	B	E	F#	C	C#	G	G#	D	F
0	1	6	2	7	9	3	4	10	11	5	8

MAKE 12 X 12 BOX MATRIX
(use 12x12 matrix below, or make your own for this example)

FILL IN ORIGINAL ROW (P0)

FILL IN I0 (The first column)

FILL IN P1-P11

ANSWER ON THE NEXT PAGE:

COMPLETED MATRIX:

0	1	6	2	7	9	3	4	10	11	5	8
11	0	5	1	6	8	2	3	9	10	4	7
6	7	0	8	1	3	9	10	4	5	11	2
10	11	4	0	5	7	1	2	8	9	3	6
5	6	11	7	0	2	8	9	3	4	10	1
3	4	9	5	10	0	6	7	1	2	8	11
9	10	3	11	4	6	0	1	7	8	2	5
8	9	2	10	3	5	11	0	6	7	1	4
2	3	8	4	9	11	5	6	0	1	7	10
1	2	7	3	8	10	4	5	11	0	6	9
7	8	1	9	2	4	10	11	5	6	0	3
4	5	10	6	11	1	7	8	2	3	9	0

ASSIGNMENT:

1) Take this Original Row from Youmans' *Into the Frozen Forest* and create a 12 tone matrix:

2) Listen to Schoenberg's String Quartet No. 4
3) Listen to Schoenberg's Violin Concerto (1936)

NEXT CHAPTERS:
- How to read a 12 tone matrix
- Finding prime forms, inversions, retrogrades, inversion-retrogrades in musical examples
- Rules to 12 tone music
- Composing your own 12 tone row
  - **THERE ARE OVER 400 MILLION DIFFERENT POSSIBLILITIES FOR A ROW!!!**
- Composing your own 12 tone piece