

Mathematics and Music: Structure and Form

CD #1: Rhythm

This CD illustrates the importance of rhythm in music by featuring many different styles of music (classical, rock, jazz, merengue, Cuban, Indian, African) as well as many different time signatures (e.g., $\frac{2}{4}$, $\frac{3}{4}$, $\frac{4}{4}$, $\frac{5}{4}$, $\frac{7}{4}$, $\frac{6}{8}$, cut time). Some polyrhythmic music (multiple rhythms played simultaneously) is included as well. As you listen to each piece, try to hear the different time signatures in the music. It is particularly useful to distinguish between similar meters such as $\frac{3}{4}$ versus $\frac{6}{8}$. The music compiled here accompanies the class unit on rhythm.

1. John Philip Sousa, *The Stars and Stripes Forever*, 1896. Track 58 on a CD compiled by Wynton Marsalis entitled Music Examples to Accompany Marsalis on Music, Sony Classical. This piece is in cut time (C with a vertical slash through the middle) which is equivalent to a $\frac{2}{2}$ meter. Incidentally, this is the official march of the USA.
2. Pyotr Ilyich Tchaikovsky, *The Nutcracker Suite: Russian Dance*, Op. 71A, 1892. Track 6 from the Fantasia Motion Picture Soundtrack, the Walt Disney Company. This lively dance in $\frac{2}{4}$ time accelerates to a climactic finish. Notice Tchaikovsky's use of the tambourine.
3. Elvis Crespo, *Suavemente*, Merengue. Track 1 off of a hit CD of the same name on the Sony label, 1998. The album reached the top of the Latin billboard charts in the US in 1998. Merengue is a popular style of music and dance originating in the Dominican Republic that features a fast rhythmic two-count in $\frac{2}{4}$ meter. This is the song we danced to during the outdoor class on 9/21.
4. Cuarteto Oriente, *Mueve La Cintura Mulata*, Cuban **son** music. Track 8 on the Putumayo CD Afro-Latin, Putumayo World Music, 1998. This features the common Afro-Cuban 3-2 son clave rhythmic pattern. The pattern derives from West African music and nearly all Afro-Cuban music (including salsa) centers around this famous clave rhythm. Try and tap out the 3-2 clave rhythm laid down by the claves.
5. Vieja Trova Santiaguera, *Me Dieron La Clave*, Cuban **guaracha**. Track 11 on the Putumayo CD Afro-Latin, Putumayo World Music, 1998. In contrast to the previous piece, the rhythmic underpinning here is the 2-3 clave rhythm. Can you hear the difference?
6. Pyotr Ilyich Tchaikovsky, *The Nutcracker Suite: Waltz of the Flowers*, Op. 71A, 1892. Track 7 from the Fantasia Motion Picture Soundtrack, the Walt Disney Company. This waltz, like most, is in $\frac{3}{4}$ time. To count along, say "one-two-three" along with the "oom-pah-pah" in the lower strings. Or, dance to it, remembering the "down-up-up" pattern we tried to emulate while waltzing outside. If you've never been to a performance of this masterful ballet performed live to Tchaikovsky's enchanting music, go see it next holiday season.
7. Billy Joel, *The Piano Man*, 1973. Track 1 on Disc 1 of his Greatest Hits album, Blackwood Music Inc. The $\frac{3}{4}$ meter rarely finds its way into popular rock music as it does here with this classic from one of the founders of piano rock. This meter is more common in the country/western genre. Billy Joel studied classical music at an early age and as a result, much of his music shows a deeper melodic and rhythmic sophistication than most "pop" music.

8. Franz Gruber, *Silent Night* (words by Josef Mohr), 1820. Track 3 on a Windham Hill CD titled Windham Hill: The Night before Christmas, performed by Barbara Higbie, Sony BMG Music Entertainment. This famous Christmas carol is an excellent example of $\frac{6}{8}$ meter. Note the difference with the two previous pieces in $\frac{3}{4}$ time. Although it is possible to count along with the piece in 3, it is most definitely not a waltz. Music in $\frac{6}{8}$ time often has a swaying, singsongy feel to it and the typical bar is usually subdivided in two rather than six. The English folk song *Greensleeves* is another popular example of this compound meter.
9. R.E.M., *Everybody Hurts*, 1992. Track 4 off the band's 8th album Automatic for the People, on the Warner Bros. label. This somber ballad is also in $\frac{6}{8}$ time, a rarity in rock music. The song was rearranged by Simon Cowell to raise relief funds for Haiti after the devastating earthquake that occurred there on January 12, 2010. Apparently, the song was listed by the PRS Music society as the #1 song to make "real men" cry.
10. Pyotr Ilyich Tchaikovsky, *Allegro con grazia*, 2nd movement of the Symphony, No. 6, "Pathétique", Op. 74, 1893. Track 2 from a Chicago Symphony recording, conducted by Claudio Abbado, CBS Records. The entire second movement of this symphony is in $\frac{5}{4}$ time, a very unusual meter for its day. The five beats of each measure can be broken down into $2 + 3$ giving the music its dance-like character. Try counting along directly from the start of the movement by repeating "one-two one-two-three" over and over again.
11. Paul Desmond, *Take Five*, 1959. Track 3 on the first side of the best-selling jazz album Time Out by The Dave Brubeck Quartet on the Columbia label. As the name indicates, this catchy tune is also written in $\frac{5}{4}$ time and is offered here as a contrast to the classical piece in 5 by Tchaikovsky. Unlike that piece, here the division of each measure is into $3 + 2$. Try counting along to feel the subdivision.
12. Peter Gabriel, *Solsbury Hill*, 1977. Track 2 on the first side of Gabriel's first studio album titled Peter Gabriel, on the Atco label. This reflective song was written by Gabriel based on a spiritual experience he had atop Solsbury Hill in Somerset England, just after leaving the band Genesis. Interestingly, the piece is written in $\frac{7}{4}$ time. Try counting along with a seven count subdivision of $3 + 4$. There is also a nice *hemiola* (a 3 against 2 pattern) on the words "boom-boom-boom."
13. Coldplay, *Clocks*, 2002. Track 5 off the band's second album A Rush of Blood to the Head, released in the US by Capitol Records. This song is featured here due to its repeated use of the same rhythmic pattern in the piano, a technique called an *ostinato*. The pattern subdivides each measure into $3 + 3 + 2$, generating an *additive rhythm* reminiscent of those used by minimalist composers like Philip Glass. This repetitive pattern underlies the entire song and is a creative way to enliven a simple $\frac{4}{4}$ meter, the actual time signature for the song.
14. *Raga for Tabla* (Indian classical music). Track 2 from a CD entitled The Best of India, Madacy Entertainment Group, Inc. 2001. (Unfortunately, no information is given concerning the names of the performers.) The tabla is a common Indian percussion instrument central to Indian classical music, consisting of two drums, one for each hand. The two hand drums are different sizes and timbres. Often, a tabla player is asked to simultaneously subdivide a measure into a different numbers of beats for each hand, (say 7 versus 11), a task that requires years of training. As discussed in class, the least common multiple is the underlying mathematical principle at work. Notice the variety and complexity of the rhythms in this piece.

15. *Improvisations for Tabla and Vamsa* (Indian classical music). Track 6 from the previous CD featuring a creative collaboration between tabla and the bamboo flute *vamsa*. The young mathematician/musician Manjul Bhargava at Princeton University claims that it is crucial for the number of units of an Indian rhythm to be a prime number. In this way it cannot be subdivided into equal parts, making for more complex yet interesting music. The French composer Olivier Messiaen was aware of this importance and used many Indian rhythms in his music. Check out the link on the course homepage where you can listen to Bhargava play the tabla and hear an interview with him on National Public Radio discussing connections between math and music.
16. Babatunde Olatunji, *Ajaja*, 1988. Track 1 from a CD entitled Drums of Passion: The Invocation, Rykodisc, 360° Productions. This polyrhythmic African music features an array of performers on various percussion instruments such as the Djembe drum (the drum I used to call everyone to class outdoors), the Talking drum, the Hoop drum, the Junjun drum and cowbell. Try and distinguish each individual part, noting both its independent motif as well as how it contributes to the entire ensemble. Note that the title of the piece is a palindrome.
17. Igor Stravinsky, *Le Sacre Du Printemps* (The Rite of Spring), 1913. Track 5 of a recording by the Cleveland Orchestra conducted by Pierre Boulez. This is the first of an amazing two-part piece “Scenes of Pagan Russia.” One of the great orchestral masterpieces of the 20th century, this work features dissonance, polytonality and polyrhythms. The work premiered as a ballet in Paris and the jarring rhythms accompanied with the exotic, sexual dance led to a riot in the theater! Notice the way Stravinsky uses a variety of orchestral sounds to create passion and fury in his music, all the while keeping it rhythmically vibrant through ostinato (repetition of the same note,) multiple meters (at one point he changes from $\frac{5}{4}$ to $\frac{7}{4}$ to $\frac{6}{4}$ in consecutive measures) and polyrhythmic creativity. This is a marvelous piece of music to see performed live by a huge orchestra. You are encouraged to listen to the complete piece, for which many copies are available in the music library.
18. The National, *Fake Empire*, 2008. Track 1 off the band’s 4th studio album titled Boxer, on the Beggar’s Banquet label. This wonderful song features a 4 against 3 polyrhythm throughout the entire piece, perhaps the first rock song to ever accomplish such a feat. Both the right-hand of the piano and the guitar play in four, while the left-hand of the piano, vocals and drums play in three! The piece was written by Bryce Dessner who quite consciously meant to use the polyrhythm. A “minimalist horn fanfare” was written by Padma Newsome to give a “Steve Reichian” feel to the ending (quotes from Dessner). Steve Reich is a minimalist composer we will study in greater detail next semester. Listen to this song a few times counting out the parts in three and four until you really internalize the polyrhythm.