P Tagg: Entry for EPMOW — tuning

tuning: 1. system or convention according to which pitches are determined; 2. manner or process of adjusting instruments to such a convention.

1. EXTERNAL TUNING. 2. INTRA-OCTAVE TUNING.
2. STRING INSTRUMENT TUNINGS. 3. TUNING AND TIMBRE.

There are two types of tuning convention: *external* and internal or *intra-octave*.

1. EXTERNAL TUNING is best exemplified by the *concert pitch* standard which establishes an agreed reference pitch for a named note: **a** at 440 Hz (see OCTAVE, PITCH). External tuning conventions are used to ensure, for example: (i) that, before a performance or recording session, musicians playing portable pitched instruments in the same ensemble will produce the same pitch (in unison or at octave intervals from that pitch) for the same designated note, or for its sounding equivalent on TRANSPOSING INSTRUMENTS; (ii) that the overall pitch of non-portable instruments (e.g. piano, organ) matches that of a generally agreed overall standard, in order to facilitate tuning when such instruments are part of an ensemble; (iii) that unaccompanied vocalists start at a pitch allowing them to reach, with a minimum of difficulty, the highest and lowest notes of whatever they are about to sing.

2. INTRA-OCTAVE TUNING organises pitches internally *within the octave*, dividing it into its constituent intervals. The functions of such tuning are: (i) to ensure that any designated pitch included in a performance or recording session will be sounded in unison by all ensemble members; (ii) to facilitate the learning and application of tonal conventions.

Notes an octave apart are separated by a frequency factor of 2 (e.g. **a** at 220, 440, 880 Hz) and are universally treated as unison, i.e. as the same note sounding higher or lower (see OCTAVE). The number and pitch of intervals within the octave is, however, subject to a wide variety of tuning.

The most common tuning system for popular music is *equal temperament* or *equal-tone tuning*. It divides the octave into twelve equal intervals semitones and has been used in the West since the late eighteenth century. It was developed to solve problems caused by discrepancies between certain intervals as constituent parts of the octave and the same intervals in their pure form, i.e. as the simple frequency ratios of *just tuning* or *just intonation* (see Table 1). For example, the **g**♯ at the top of the three superimposed pure major thirds **a**♭-**c**, **c**-**e**, **e**-**g**♯ is one fifth of a tone lower than the octave above the initial **a**♭, while the top **a**♭ in the four superimposed pure minor thirds **g**♯-**b**-**d**-**f**-**a**♭ is over a quarter of a tone lower than the octave above the **g**♯. These natural discrepancies posed particular problems for keyboard players needing to produce both **g**♯ (as in an E7 chord) and **a**♭ (as in an F minor triad) in the same piece: one or the other would be seriously out of tune. *Equal temperament* tackled the problem by slightly detuning each of the octave s twelve constituent semitones so that the interval between each one became equal. Intervals smaller than an equal-temperament semitone (microtones) are measured in cents (hundredth parts of a semitone).

Table 1 Just and Equal Temperament intervals[1]

Interval	Unison/Tonic	Minor 2nd	Major 2nd	Minor 3rd	Major 3rd	Perfect 4th	Augmented 4th/ Diminished 5th	Perfect 5th	Minor 6th	Major 6th	Minor 7th	Major 7th	Octave/Tonic
Just	1:1 1	25:24 1.042	9:8 1.125	6:5 1.2	5:4 1.25	4:3 1.333	45:32 1.406	3:2 1.5	8:5 1.6	5:3 1.667	9:5 1.8	15:8 1.875	2:1 2
Equal	1	1.060	1.123	1.189	1.260	1.335	1.414	1.498	1.587	1.682	1.782	1.888	2
in A	a	a#/b$	b	c	c#/d$	d	d#/e$	e	f	f#/g$	g	g#/a$	a

1. Numerical expressions show the factor by which to multiply or divide the frequency of the unison pitch (1) to obtain the pitch of each interval within an octave of that unison.

While equal-tone tuning is essential in most genres using classical harmony, for example parlour song, operetta, musicals, brass band music, hymns, evergreens, most types of jazz, bossa nova, symphonic film scoring, etc. (see HARMONY 2), it is unimportant in music requiring no enharmonic alignment (between **d**♯ and **e**♭, **g**♯ and **a**♭ etc.) for purposes of MODULATION or harmonic colour. Equal temperament is unnecessary in, for example, most types of blues, bluegrass, blues-based rock, folk rock, not to mention the traditional musics of Africa, the Arab world, the Balkans, the British Isles, the Indian subcontinent, Scandinavia etc. In fact, equal temperament is more likely to be the exception than the rule for musics whose tonality is modal and/or DRONE-based because the constant sounding of tonic and fifth produces natural overtones inconsistent with equal-tuning intervals and because the relationship of pitches within the octave to one unchanging tonic is essential to the expressive dynamic of such musics. In popular music of the traditions just mentioned, then, just tuning is far more likely to be used, unless instruments like piano, accordion or non-detunable synthesizer are included in the ensemble.

Within the general framework of just temperament there are, however, a wide variety of tunings used in different popular music traditions. Despite a few exceptions, such as the various *pelog* and *slendro* systems of Java (Malm 1977:45-47), most tunings include the natural fourth (4:3) and fifth (3:2) scale degrees (see Tables 1 and 2). However, Arab and Indian music theory divides the octave into 16 and 22 unequal steps respectively, reflecting intra-octave tuning conventions which differ those of the urbanised West. For example, the heptatonic Arab mode closest to ionian, *Rast*, features a neutral third and seventh roughly half way between Western major and minor pitches (see BLUE NOTE), while *Bayati* (similar to dorian or aeolian) contains a neutral second and sixth.

Table 2 Octave division of four heptatonic modes (intervals in cents)

	100 →	100 →	100 →	100 →	100 →	100 →	100 →	100 →	100 →	100 →	100 →	100 →	
Chromatic	**a**	**b♭**	**b**	**c**	**c#**	**d**	**e♭**	**e**	**f**	**f#**	**g**	**g#**	**a**
Ionian	**1** 200 →		**2** 200 →		**3**	**4** 200 →		**5** 200 →		**6** 200 →		**7**	**8**
Rast	**1** 200 →		**2** 150 →	**3** 150 →		**4** 200 →		**5** 200 →		**6** 150 →	**7** 150 →		**8**
Bayati	**1** 150 →	**2** 150 →		**3** 200 →		**4** 200 →		**5** 150 →	**6** 150 →		**7** 200		**8**
Pelog	**Nem** 167 →		**Pitu** 245 →		**Siji** 125 →	**Loro** 146 →	**Teilu** 252 →			**Papat (Pelog)** 165 →		**Lima** 100 →	**Nem**

3. STRING INSTRUMENT TUNINGS. Unlike monophonic instruments, which merely need adjusting to a common reference pitch, polyphonic instruments (actual or potential) require further tuning. Piano and pipe organ tuning is carried out by experts but portable string instruments are internally tuned by their players. The pitches to which open strings are tuned vary considerably from one instrument to another. Table 3 shows examples of standard tuning for some of popular music s most common string instruments. String note names are provided for clarification and do not necessarily indicate concert pitch. (In Scandinavian fiddling, for example, standard violin tuning is often raised by a whole tone).

Table 3 Examples of standard open string tunings for common instruments

instrument	**Low string**					**high string**	**instrument**
Banjo		g	d/c	g	b	d	Banjo
Banjo – Tenor	c	g	d	a	c		Tenor Banjo
Bass	e	a	d	g			Bass
*Bouzouki			g	d	a	d	Bouzouki*
Charango		g	c	e	a	e	Charango
Fiddle			g	d	a	e	Fiddle
Guitar (see Table 4)	e	a	d	g	b	e	Guitar (see Table 4)
Mandolin			g	d	a	e	Mandolin
*Saz			c/d	g	c		Saz*
Sitar (e.g.)	sa-1 c-1	pa-1 g-1	sa c	ma e	pa g	sa+1 c+1	sa+2 c+2
*Ud (Arabian)	d	g	a	d	g	c	Ud (Arabian)*
Ukelele			a	d	f#	b	Ukelele

* Standard tunings vary widely for this instrument. Only one common tuning is given in the Table 3.

Several instruments listed in Table 3 have common *alternative tunings*. For example, a *saz* can be tuned CFC, while other common *bouzouki* tunings are CFAD or DAFC (2 x 4-string), and DAD (2 x 3-string, common in REBETIKI). *Ud* tunings vary considerably from region to region (Turkey, Armenia, etc.) and *fiddle* tunings are often adjusted to the character of the music to be played, typically to create tonic-and-fifth drone effects (GDGD, G#D#G#D#, ADAD, AEAE, etc.). Some common alternative guitar tunings (a.k.a. *scordatura*) used in the Anglophone music traditions are set out in Table 4. All these tunings can be transposed using a capo tasto.

It should also be noted that several string instruments used in popular music of the Middle East, the Arab world and the Indian subcontinent (e.g. the Turkish saz or tambur) are provided with ligatures which function as moveable frets allowing the musician to accommodate tunings based on a division of the octave into more than twelve intervals (see Table 2).

Table 4 Some alternative guitar tunings

Name	Low string					high string	Usage
STANDARD	**e**	**a**	**d**	**g**	**b**	**e**	general
Open E	e	b	e	g#	b	e	slide, Delta blues, folk
Open D or Vestapol	d	a	d	f#	a	d	
Drop D	d	a	d	g	b	e	folk
Drop double D	d	a	d	g	b	d	
D modal	d	a	d	d	a	d	
DADGAD	d	a	d	g	a	d	folk, esp. Irish etc.
Open G or Taro-patch	d	g	d	g	b	d	slide, Delta blues
Dobro	g	b	d	g	b	d	Delta blues, Country
Open A or Hawai-ian	e	a	e	a	c#	e	Hawaiian, slide
C sixth	c	g	c	g	a	e	New Age

4. TUNING AND TIMBRE. Many instruments are provided with double sets of strings, for example the 12-string guitar (2 x 6 strings), the rebetiki bouzouki (3 x 2) and different types of balalaika, each pair of strings being tuned in unison or an octave apart. Each of the piano s upper keys is assigned its own triple set of strings. The point of such unison or octave doubling (tripling in the case of pianos) seems to be to create a brighter or fuller sound for each note. The bright effect is due to doubling at the octave or higher, as in the case of 4-foot, 2-foot and mixture stops, tabs or drawbars on the organ. The full effect, however, more likely relates to unison doubling and works as follows. Two simultaneously sounding strings, pipes or reeds tuned to the same pitch rarely produce that pitch in perfect unison, with the result that a greater number of partials is created for each note than issues from just one of the two. Popular music exploits this timbral aspect of tuning in many ways, of which three can be summarised as follows. (i) The characteristic rich sound of the French accordion derives from each note being assigned two reeds which are slightly out of tune with each other. (ii) Recorded tracks are often doubled, sometimes several times, either digitally or live , to create an effect of multiplicity. Not only can the copied or repeated tracks be offset from the original by a few milliseconds, they can also be slightly detuned, either naturally or by digital manipulation. The effect of slightly detuning a copied track without simultaneous offsetting resembles the wider sound produced by applying chorus or modest amounts of phasing to the same signal source (Lacasse 2000:126-131). (iii) Digitally detuning a copied piano track and playing it back with the original produces a ragtime or barrel piano effect similar to that created by an out-of-tune piano or by one that has been intentionally soured .

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GENERAL TUNINGS www.peak.org/~ritabill/Tunings/Web/Tunings.html

JUST TUNING www.sfu.ca/sonic-studio/handbook/Just_Tuning.html

STRING INSTRUMENT TUNINGS www.silverbushmusic.com/Tunings.html

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