Test ID: TESTID Name: _____

MAT 120 **Midterm Exam** Fall 2024

1. Which of the following are rational numbers?

   i) .010110111 ii) $2^{1/2} \cdot 2^{3/2}$ iii) $\left(\frac{16}{9}\right)^{1/2}$

   a) all of them b) i) and ii) only c) iii) only d) i) and iii) only e) i) only

   Correct Answer: all of them

2. Which of the following numbers are complex non-real? Here i is the square root of -1. (Hint: simplify first, where possible.)

   i) $-\sqrt{-4}$ ii) $(1+i)^2$ iii) $(\sqrt{-2})^2$

   a) i) and ii) only b) all of them c) i) only d) ii) only e) iii) only

   Correct Answer: i) and ii) only

3. The number $1 + \frac{9}{100}\left(1 + \frac{1}{10} + \frac{1}{100} + \cdots\right)$ can be simplified to which of the following?

   a) $\frac{33}{20}$ b) 2 c) $\frac{11}{10}$ d) 3 e) $\frac{21}{10}$

   Correct Answer: $\frac{11}{10}$

4. Suppose that $0 < r < 1$. Simplify $-1 + (1 - r^2)(1 + r + r^2 + r^3 + \cdots)$:

   a) 1 b) $2 + r$ c) 2 d) $\frac{2}{1-r}$ e) r

   Correct Answer: r

5. The number $3\sqrt{2}$ represents a frequency ratio for an interval. How many semitones off from two octaves is it?

   a) 2 b) 1 c) 3 d) 4 e) 6

   Correct Answer: 1

6. Suppose we attempt to create a major scale with only: 1) the Mean Tone whole tone and 2) the Just semitone $\frac{16}{15}$, and usual pattern of whole and half steps. How far off will we be at the octave? Express your answer to the closest multiple of five cents.

   a) 15 cents flat b) 5 cents flat c) 5 cents sharp d) 10 cents flat e) 10 cents sharp

   Correct Answer: 10 cents flat

7. Same scale as in the previous question. What is the frequency ratio that represents the Perfect Fourth, or fourth degree of the scale?

   a) 4/3 b) 3/2 c) $\frac{2}{3}\sqrt{5}$ d) $2\sqrt{5}$ e) $\sqrt{5/4}$

   Correct Answer: 4/3

8. Same scale as in the previous question. What is the frequency ratio that represents the Perfect Fifth, or fifth degree of the scale?

   a) 4/3 b) 3/2 c) $\frac{2}{3}\sqrt{5}$ d) $2\sqrt{5}$ e) $\sqrt{5/4}$

   Correct Answer: $\frac{2}{3}\sqrt{5}$

Test ID: TESTID Name: _____

9. A frequency ratio of 10 corresponds to a just interval of three octaves plus which interval?

   a) minor whole tone b) minor third c) major third d) major whole tone e) perfect fourth

   Correct Answer: major third

10. A frequency ratio of 10 is about how many semitones?

    a) 24 b) 28 c) 36 d) 40 e) 50

    Correct Answer: 40

11. Approximately how many equal-tempered semitones fit into the audible range of a fox, assuming this goes from 20 Hz to 80000 Hz?

    a) 152 b) 132 c) 143 d) 220 e) 183

    Correct Answer: 143

12. If F_1 and F_2 are frequencies, with $F_1 < F_2$, and the frequency ratio F_2/F_1 is measured as x cents, then these numbers can be related in which of the following formulas:

    a) $x^{\frac{2}{1200}} = \dfrac{F_2}{F_1}$ b) $1200 \cdot 2^x = \dfrac{F_2}{F_1}$ c) $x = 1200 \cdot \ln\left(\dfrac{F_2}{F_1}\right)$ d) $1200 \cdot \ln 2 = \dfrac{F_2}{F_1}$ e) $2^{\frac{x}{1200}} = \dfrac{F_2}{F_1}$

    Correct Answer: $2^{\frac{x}{1200}} = \dfrac{F_2}{F_1}$

13. How many different types of Just Major Third show up in one octave of the Just Chromatic Scale? ("show up" means to observe the frequency ratio by choosing any two notes from the tonic up to the octave which are separted by a major third. Different type means different frequency ratio, but still qualifying as a major third.)

    a) 3 b) 2 c) 1 d) 4 e) 5

    Correct Answer: 3

14. Suppose we use the perfect fifth with cent value 695 to tune a keyboard with fifths and octaves. If we start the tuning process with A as 220 Hz and tune all the A's, then proceed to E etc., what is the cent value of the wolf fifth from D to A? (Note: when we get to D we are done with the tuning, and we have to accept the final value of the fifth from D to A. You can think of this fifth as making up the last step in the circle of fifths in order to have the sum of all the cent values of fifths add up to the same sum for seven octaves.)

    a) 750 b) 740 c) 745 d) 755 e) 760

    Correct Answer: 755

15. With the same keyboard tuning as in the previous question, what is the cent value of the larger of the two semitones?

    a) 117 b) 115 c) 110 d) 105 e) 125

    Correct Answer: 125

16. With the same keyboard tuning as in the previous question, what is the cent value of the major third from C to E?

    a) 360 b) 440 c) 460 d) 420 e) 400

    Correct Answer: 440

The Meantone Major (Diatonic) Scale

$$\frac{1}{1} \longrightarrow \sqrt{\frac{5}{4}} \longrightarrow \frac{5}{4} \longrightarrow \frac{\sqrt{2}}{\left(\frac{5}{4}\right)^{\frac{1}{4}}} \longrightarrow \sqrt{2}\left(\frac{5}{4}\right)^{\frac{1}{4}} \longrightarrow \sqrt{2}\left(\frac{5}{4}\right)^{\frac{3}{4}} \longrightarrow \sqrt{2}\left(\frac{5}{4}\right)^{\frac{5}{4}} \longrightarrow \frac{2}{1}$$

$$\left(\sqrt{\frac{5}{4}}\right) \quad \left(\sqrt{\frac{5}{4}}\right) \quad \left(\frac{\sqrt{2}}{\left(\frac{5}{4}\right)^{\frac{5}{4}}}\right) \quad \left(\sqrt{\frac{5}{4}}\right) \quad \left(\sqrt{\frac{5}{4}}\right) \quad \left(\sqrt{\frac{5}{4}}\right) \quad \left(\frac{\sqrt{2}}{\left(\frac{5}{4}\right)^{\frac{5}{4}}}\right)$$

The Just Chromatic Scale

$$\frac{1}{1} \longrightarrow \frac{16}{15} \longrightarrow \frac{9}{8} \longrightarrow \frac{6}{5} \longrightarrow \frac{5}{4} \longrightarrow \frac{4}{3} \longrightarrow \frac{64}{45} \longrightarrow \frac{3}{2} \longrightarrow \frac{8}{5} \longrightarrow \frac{5}{3} \longrightarrow \frac{16}{9} \longrightarrow \frac{15}{8} \longrightarrow \frac{2}{1}$$

$$\left(\frac{16}{15}\right)\left(\frac{135}{128}\right)\left(\frac{16}{15}\right)\left(\frac{25}{24}\right)\left(\frac{16}{15}\right)\left(\frac{16}{15}\right)\left(\frac{135}{128}\right)\left(\frac{16}{15}\right)\left(\frac{25}{24}\right)\left(\frac{16}{15}\right)\left(\frac{135}{128}\right)\left(\frac{16}{15}\right)$$