Two-Page Short Version: Guides will help you save time studying for the Final.

But No Guide or Review can cover absolutely everything.

The following areas have a very high degree of probability to being on your Final.

Equal Temperament Tuning - the 6% interest rule (5.9%) and using 1.06. The half step.

The big three: loudness, pitch, timbre and their physics counterparts.

The range of frequencies for human hearing. The range of frequencies on the piano.

Calculating numbers of octaves for frequency ranges.

Decibels - levels, rules, and calculations.

Binary numbers and their conversions.

Calculating half steps for intervals such as the second, third, fourth, tritone.

Recognizing wavelengths for transverse and longitudinal waves.

Formulas \( f = \frac{1}{T} \) and \( T = \frac{1}{f} \), the versions \( f = \frac{1000}{T \text{(in ms)}} \) and \( T \text{(in ms)} = \frac{1000}{f} \)

Velocity formula \( v = \lambda \cdot f \) and sound speed \( v = 340 \text{ m/s} = 1125 \text{ ft/s} = 750 \text{ mi/h} = \text{Mach 1} \).

The beat formulas.

Animal hearing qualitative - rank them in order of best to worst.

Doppler Effect, Gibbs Phenomenon.

Handy, Coltrane, Peterson, Parker, Ma Rainey, Bessie Smith, Ellington, Fitzgerald.

The musical periods and rough dates. Sonata Form, Blues Form.

Bach, Haydn, Mozart, Beethoven, Schumann (Robert, and Clara), Chopin, Debussy.

Bartók, Prokofiev, Rachmaninoff, Saint-Saëns, Stravinsky, Khachaturian, Jobim.

Reflection, Refraction, Diffraction, Interference - definitions and examples.

Lissajous Patterns, Degrees of the Scale, Intervals, and Interval Ratios.

Harmonics on strings and the associated formulas, nodes, antinodes, etc.

Harmonics on pipes (open and closed) and the associated formulas, nodes, etc.
Fourier Amplitudes for the "Big 5" timbres.

Modulation: amplitude (tremolo), frequency (vibrato), timbral.


Shouting and Echo Calculations.

Calculations involving LPs and Tapes. Memorize the LP value for rotations per minute.

The Power Equation $P = IV$ and Ohm's Law $V = IR$. Know the associated units.

RC Filter Circuits. Dolby Filters.

Logic Gate Symbols and Truth Tables.

Logic operations (the dot and the plus sign). The bar notation, De Morgan's Theorems.

Synthesizer symbols and modules.

Axes for the Oscilloscope, Fourier Spectrum, Spectrogram, Audiogram.

Recognizing Spectrograms, harmonics in spectrograms.

Formant regions. The vocal system as a closed pipe (15 cm) and arriving at 500 Hz.

Number of tone holes needed for open pipe instrument (flute), closed pipe (clarinet).

Number of playing positions needed for trombone, number values for trumpet. Why?

Figure out playing positions needed to play gaps between any two adjacent harmonics.

Signature songs for portions of the circle of fifths:

- 2-5-1 Laura (Movie Theme)
- 1-6-2-5 Heart and Soul
- 4-7-3-6-2-5-1 Autumn Leaves for Minor, Can't Take My Eye Off You (for major)

Interval ratios and interest rates. Going up by thirds, fourths, fifths, etc.


Circuit with battery, bulb, and resistor. Calculating voltages, currents, resistances.

Calculating power and electrical costs.

Theremin, Moog, Carlos.

Phase shifts for waves and the cycle of fifths such as 1-6-2-5.
The Long Version: This Guide will help you save time studying for the Final.

The guide refers to the Glossary in the Downloads section. You might want to download the glossary pdf and have it handy as you read the Guide.

Qualifier: Note that the Guide as well as power notes, old exams, silver-bullet reviews, are here to help you – and they will – but they do not contain 100% of everything that could be on the exam. A small percent of content is always missing in any review or guide. Also, critical thinking questions may appear on exams, questions you have never seen before.

This guide is divided into five sections.

Par I. The Power Notes

Part II. How to Get the Best Out of the Old Exams

Part III. Highlights from Some of Office Hours with Students in the Past

Part IV. Grades, Science Courses in General, and Curving Exams

Part V. Thank You

Part I. The Power Notes

Though facts and specifics are important, the hallmark of the liberal-arts education is critical thinking. This means that some questions will appear on your Final that you may have never seen before. So it is important that you prepare for this. Our guide here will show you how to do so. You do not want to aimlessly study lots of isolated facts, but instead strive for deep understanding and insight as to how the entire course is connected. So where do we start?

First, psychologically stay focused and motivated. Have confidence in yourself. Though grades are important, try not to make the grades so important that you start to lose your balance. Motivation to master the material is the best goal and the grade comes as a by product. Put learning first and you will come out better in the long run in all your courses.

Let’s say I have not read the chapters consistently throughout the semester and I have missed some classes. Time is limited. There is no time now to read the text. So we will focus on the Power Notes since these notes are called “Power Notes” due to their power in putting the contents of each of the chapters into one single double-sided sheet. However, those that have read all the chapters and missed no classes do have a distinct advantage. In the following the pronoun “I” represents the shrewd learner or student preparing for the Final.
Power Notes A. I look this over and see that everything on this sheet is basic and important. I need to know it.

Power Notes B. This again is all basic stuff. I need to make sure my Power Notes are accurate. So I check mine against the posted Power Notes with Answers that are online. If I missed a class, I must definitely do this and should even ask a friend to explain the stuff to me.

Now one must use common sense and note that the dates of Haydn’s birth and death as well as the title of the piece and its date are not to be memorized. But I note that the period of music and the dates for this period – these periods appear in multiple classes. I also pay attention to the definition of the Sonata. Later this is compared to the Blues.

So I figure – wait. I should make a list of the periods in music and the composers in each period. I figure that he will not expect me to remember all the composers. So I ask myself which are the more important ones. I reason that when the same composer appears in more than one class or when time is spent analyzing a piece in terms of physics – then I should take note. As an example, Bach’s name came up during the last class and I have heard this guy mentioned in class more than once. So I make a list of composers and musical periods with dates. I list Haydn as my first composer and will add Bach and Mozart to my list when I get to Class C. Then I make a separate list for the jazz artists since I know they are coming later.

I notice in Power Notes B the appearance of formulas. I decide it would be nice to have a page where I list all the formulas for the course. There are less than 12.

I remember seeing a listing of Tutorials on Formulas for the Final Part I and Part II so I go right to these since my instructor has done the list for me in these two tutorials.

But I also sometimes get confused over the terms in the formulas. So I prepare a page listing each physical quantity, its abbreviation and the unit it is measured in. I start by listing A for amplitude. It can be a length if I am looking at a water wave, i.e., how many feet high is the wave from sea level. I also know from later chapters that there are electrical waves. In that case the amplitude is measured in volts, where zero volts means no wave, i.e., zero volts is the sea level. I then add T for period, f for frequency, lambda for the wavelength, etc. It is easier if I have columns like this:

<table>
<thead>
<tr>
<th>Physical Quantity</th>
<th>Abbreviation</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude</td>
<td>A</td>
<td>meters, feet, volts if electrical</td>
</tr>
<tr>
<td>Period</td>
<td>T</td>
<td>seconds, milliseconds, etc. (any time unit)</td>
</tr>
<tr>
<td>frequency</td>
<td>f</td>
<td>hertz (Hz) = 1/s, i.e., per second</td>
</tr>
</tbody>
</table>

And I keep adding as I review the course. I consult the Glossary if I want to quickly check a definition of something to make it clearer to myself.
I realize by consulting the Glossary that there is a lot of stuff there - power-packed with much content that includes physics, music, and math.

I also see some graphs showing up in the Power Notes. There are less than 10 graphs in the course. I decide to have another sheet to draw quickly a vertical and horizontal axis for each graph and label what is on the vertical and horizontal axis in each case. I then sketch a sample graph.

I study the description of the Berg video on the Power Notes. The Clio Award video I ignore.

Power Notes C. I add Bach and Mozart to my composer list. They were mentioned in several classes. My list of musical periods now include Baroque and Classic. Everything on this double-sided sheet is important, basic, and I can review it quickly. I do not have to read the chapter. It is all there for me.

Power Notes D. I add Beethoven as a composer to my list as he appears later in Class F, the 1-5-4 class. I also add the new musical period called romantic and its dates. I note that Beethoven is a transition composer since he lives about half his life in one period (classic) and the latter half in the other (romantic). I ignore "Fools Rush In" and I ignore "Nine Months." I am studying for a final exam. This peripheral detail is not going to be on the exam. Everything else on the other hand is basic physics stuff I need to know.

Power Notes E. This is a quick one. I review the first side of this in two minutes. I was at this class and my Power Notes are good. On the reverse side I ignore the clipart images because all of this can be reasoned out. A siren changes pitch, bird songs glide up and down in pitch, a slide whistle does the same. I ignore crickets, spark plugs, arcade games and even the motors since they were more approximate. The sirens, birds, and slide whistle were the best examples as I later learned again with spectrograms. So I keep these and do not clutter my mind with the others.

I ignore Carmina Burana, the composer, and the date. This was mentioned once. There is no way this is going to be on the Final.

I add Robert and Clara Schumann on my composer list as they appeared the last week of class. Of course, I do not worry about names of compositions or dates of compositions of these composers. I note the composers in my composer list and I should also know one or two things about each composer.

Power Notes F. The jazz musicians appear. I start another list. If you are not a list person then do not start one. Remember that you are responsible for organizing the material in your own way. Some use the power notes and add things in the margins. Others use index cards. You must organize the material in some way and form a mental map of the course material if you are shooting for the A. Otherwise, the intellectual terrain will be unconnected and you will get lost on a comprehensive final, dropping a letter grade or maybe two letter grades. Isolated facts can only serve you up to a point –
perhaps a C. This is why for a comprehensive Final the Hit-Me method seeing isolated questions would take far too long to organize the course.

Note our first important diversity comparison on how Europeans use the 1-5-4 and how black musicians do in the United States. I pay particular attention to diversity individuals in the course.

I add Handy and Armstrong to my jazz listing as well as the three black singers: Ma Rainey, Bessie Smith, and Victoria Spivey. Henry Mancini appeared a few times in the course for his use of going up by a fifth and then again as a fifth. I add him just in class. I add John Williams (contemporary American composer for movies) since he appears later with Jurassic Park and the crystal scene from Superman (1978). I decide to know the songs for the octave, fifth, fourth, and third. I MUST KNOW all the intervals and their ratios as well and know how to apply ratios. The Lissajous figures are covered extremely well in the Power Notes.

Power Notes G. I do not worry about Pythagoras, Ptolemy and Zarlino. I skip them because their mention was only in passing. I will focus on names like Coulomb, Ampère, Faraday later since these scientists were given significant class time.

However, G is a very important class for the physics of strings, harmonics, and intervals. Everything here is very important and foundational. The strings have such elegant patterns that the formulas are easy to remember. I study Mersene’s Laws and realize these laws are common sense.

I add Chopin and Liszt (to my composer list is understood – from now on we will just say “I add”). Chopin was mentioned in several classes and there is much here about Liszt and the Mephisto Waltz. I note Chopin’s early death and cause of death is important as I need to know to know something about each composer. Both are romantic virtuosos.

Power Notes H. I note that there are strings, woodwinds, brass, and percussion in the orchestra, but do not worry about detailed names.

Everything that follows is foundational physics - the physics of pipes. I note the connection to strings for open pipes and see that the formulas are the same. I notice that the closed pipe has two modifications: the use of 4L instead of 2L and the presence of only odd harmonics. So memorization falls into place fairly easily.

Power Notes I. Here is a nice chapter with just one big idea. I do not add Brahms. I study well the harmonics and where they appear on the keyboard as this is rigorously analyzed later in the course. From the musical examples I only note that the "2001 theme" starts with a horn playing H2-H3-H4-H5 as this recurs later in course with the pipe instruments. It was also demonstrated in class with the "Twirl-a-Tune."

I ignore the cute word game at the bottom of the first side but do note that a specific Fourier spectrum is a recipe for the particular periodic wave I am analyzing.
I visually study the construction of the square wave and relate the little bumps to how many odd harmonics are being added.

I make sure I have committed to memory the table of the Fourier amplitudes for the sine, triangle, square, ramp, and pulse train. I find such a table on two of the silver bullet reviews, in the power notes, and of course in the text.

On the second side, I ignore the music references at the very bottom of the page.

Power Notes J. I memorize the definitions and when I get to the graphs, I make sure I understand how the answers are arrived out. I pay attention to all the physics. I note that this is a definition chapter with some acoustic stuff plus a process for analyzing balanced modulation. I make sure I know how to analyze balanced modulation problems - given the input waves, I know how to arrive at the output spectrum.

I add Berlioz and Tchaikovsky as these composers were given considerable class time and much biographical information was included in class. Two most important examples of inharmonicity are bells and noise. The Church bells and the cannons used in Tchaikovsky’s 1812 Overture are excellent examples of these.

Power Notes K. I have already added Tchaikovsky. But I do not worry about the March (Marche) Slav, Serbia, or Turkey. I study all the physics. At the end of side two, what I take away from the music part is that Tchaikovsky liked to alternate rapidly the 1 and 5 in his exciting endings and then give us 1, 1, and 1 at the very end - and finally one long drawn-out 1, the home harmony.

Power Notes L. I study all the physics but I do NOT memorize the details of part “2. Amplitude (The Vertical Dimension of the Graph).” However, I do know how to figure out the maximum number for so many bits, e.g., I can figure out that 1111 is 15 and with four bits you therefore have 16 values: 0, 1, 2, 3, ... 15.

Power Notes M. This is a fundamental chapter on electronics. I study everything. For my list of physical quantities I start adding voltage, current, resistance, etc.

Power Notes N. This is part two of the fundamentals of electronics. I study everything here. I also recall that Homework N5 gave me specific instructions to know HN-5. So I know HN-5, which introduces logic arithmetic, the BAR notation, and discusses De Morgan’s Theorems.

Power Notes O. I add Debussy. He is our first impressionist. He is also mentioned later in conjunction with the whole tone scale. So we are applying our composer rule consistently. Think of impressionism as falling in the latter half of the 1800s – your century for romanticism. You might note that in humanities they go with more like 1800-1850 for romanticism and then impressionism is later. But in humanities they are trying to embrace music, art, literature, etc. all at once. Now it is time to double check your music periods and dates. With music we can go with our 1600-1750 (baroque), 1750-1800 (classic), 1800-1900 (romantic), and 1900-1950 (modern) dates.
The filters on the first page include a review of the Fourier spectrum of the ramp wave. The filter names indicate what the filters do, e.g., low-pass means pass the low frequencies. I get through these graphs in a couple of minutes. The circuit diagram at the bottom of the first page slows me down. I recall that I had to read the pdf text Chapter O to understand filters better. I find p. O6 and use this page to get this material back in my mind. I skim over pp. O-7, O-8, and O-9 to make sure I got it.

I see W. C. Handy again. He and the blues are extremely important and central to the course. I study Wynton Marsalis who talked about the blues and know what is on the power notes about him. I note that the blues structure was adopted by mainstream American - two generations - WWII crowd and the teenagers of the 1950s. And of course, everyone knows about Elvis, but I do not worry about Glenn Miller in particular.

Power Notes P. Debussy appears again. I have him on my list. I don’t worry about Ravel for the Final Exam. This Chapter is the first of two chapters treating the synthesizer. I study each module well. The guide at the top of the answers to the power notes with the circle, triangle, and rectangle as well as the convention for the arrows form my first foundation. Then I proceed to each module.

At the very end of the power notes, I don’t worry about the composer and arranger for the movie “Annie” but I do note the appearance again of John Williams as the composer for the movie “Superman” which we already have seen earlier. He is already on my list.

What about the Theremin? I remember much discussion on this. I also know that the Power Notes cannot have everything. So I study the Extra Credit P2 Moog to refresh my memory on Theremin and Moog.

Power Notes Q. I add Rachmaninoff (late romanticist). We spent much time on him, telling his story and seeing more than one video on him. He is also mentioned in another class. For example, when discussing Prokofiev’s reaction to critics, the sensitive Rachmaninoff and Tchaikovsky are mentioned. These connections help us remember him. You should know a couple of things about each composer that makes your list. Everything else is important on these.

The rest of Q is important and basic synthesizer material. I note that the master diagram at the end of page two is on a silver bullet review sheet. I commit this diagram to memory.

At the very end of the second side, I skip the music material and the Google Doodle. But the video of the Google Doodle played in class, which is in our e-text, helped me master some of the basic concepts of the synthesizer.

Power Notes R. Saint-Saëns does make my list since 1)he appears twice - we hear a work of his on the theremin and 2)his work is directly connected to physics (the tritone in his skeleton dance and the harmonics in his organ symphony). I master the tritone since it is introduced here with him and in our course analyzed rigorously in terms of half steps. I know that 6 half steps make a tritone. This is the equivalent of three whole steps. If I start on Do as a which key as usual then where does this tritone fall?
I study all the math, physics, and biology here. All of this is very important. I challenge myself to call out from memory all the parts of the ear in order as the sound enters.

I add Duke Ellington to me list as he appears twice in the course - once here with the blues and again later with the 2-5-1. I include Billie Holiday since she is an important historical jazz singer. I also note Oscar Peterson since he occurs in more than one class.

Power Notes S. Stravinsky gets added since the example used is rich in physics - analysis with the harmonics. Read over this description. Then know all the physics and biology in these notes. Note that Duke Ellington appears again. We already have him on the list.

I study well all the physics but I only take from the Fletcher-Munson Equal-Loudness curves the fact that our thresholds for detecting sound level depends on frequency. And I already knew this. If you play a high pitch sound, it irritates me. I am more sensitive there. The curves are telling me this essentially. I do note the perceptual effects and their definitions.

I add John Coltrane as considerable time was spent on him in class. The two things I remember about John Coltrane is that he does something analogous in jazz compared to what Stravinsky does: there is dissonance and reaching for unconventional sounds and harmonies. The second thing is that Coltrane’s use of settling down with little harmonic movement for a long time inspired the Doors to do something similar in the middle improvisational section of Light My Fire. This is a "non-western" element - "no harmonic progression." If you know these two things already you are critically listening in class and supplementing the Power Notes very well. Remember that the Power Notes, though indeed very powerful, are not 100% of everything.

I skip the movie The Mask (1995).

Power Notes T. I add Prokofiev due to the strong connection to physics: the use of the ninth harmonic. Note Tchaikovsky and Rachmaninoff appearing again. The keyboard-harmonic exercise that appears next is very important. We encountered H1 through H8 in the context of interval structure back in Chapter G.

This kind of exercise represents the kind of questions your instructor asks students during office hour help sessions. Know all the physics on this handout. You can skip the celebrities. But do KNOW Laura and the 2-5-1 since Laura is our signature song for this sequence of harmony. You do not need to know the composer Raksin. If you want a break from studying you might watch the movie excerpt The Competition (1980) in the Extra Credit T2 and pick up some extra credit. By the way, do you recognize the movie star Amy Irving in this movie as well as Carrie (1976) shown at the end of the semester?

Power Notes U. Add Bartók since the analysis of his work involved fifths. The 1, 5 and 2 where the 2 is in the next octave – all played simultaneously to obtain an eerie effect. Know all the physics. Note that Mozart appears again.
Get a feel of the piano - the middle octave is about 250 Hz to 500 Hz. The piano goes from 27.5 Hz to about 4000 Hz (as mentioned in the course, in particular Class V). Chapter U has a nice review of closed-pipe physics with its use of 4L for the fundamental wavelength and its mention of the odd harmonics for a closed-pipe system in conjunction with vocal formants.

I particularly note the percentage rule applied to frequency modulation. The case given is for a fundamental of 500 Hz that goes to 505 Hz as it swings upward in pitch. This is 1%. So when you apply that to the second harmonic, the 1000 Hz would swing to 1010 Hz. The fifth harmonic 2500 Hz would swing to 2525 Hz (the example on the power notes). This is why the "squiggles" in the vibrato appear larger for the higher harmonics - percentage-wise they are the same, but a given percentage of a larger amount means more.

Skip Kim Crosby, Sondheim, Legrand, Clooney for the Final. But know the Brazilian composer Jobim as he appears in more than one class.

Power Notes V. Add Khachaturian as his example incorporates the physics in this chapter – the use of the half step in the non-western setting of Armenia, his home. He also uses the Asian pentatonic scale (the black keys alone) which is the main theme for this chapter. Considerable time was also spent with him.

Note that you DO NOT have to memorize the derivation of the "black keys." But you should be able to follow each step, especially working out ratios, e.g., 27:24 reduces to 9:8.

All other physics as related to music is important on the power notes. We need to add Charlie Parker to the jazz list since he is being discussed in the context of the blues infusing it with 2-5-1 harmonic content. This is an important development in jazz history. A comment was made in class about how Parker’s music is important to jazz students everywhere. This is like Bach being important to classical piano students. All campuses with jazz programs have students work on Charlie Parker pieces. You can skip the Little Boa. It introduces us to a longer cycle of fifths but there will be adequate additional coverage of this later.

I would know how to figure out the interval questions at the very end of the power notes as this is a review of interval analysis that derives from Chapter G.

Power Notes W and X. The first part is a nice review consisting of four parts as we apply physics to a musical instrument in the form of a pipe. The synthesizer module arrangement is likewise a review/application. The closed-pipe section is even more review material. The keyboard is an additional review of half steps and counting as related to the interval H1 to H2 for the flute (open pipe) and H1 to H3 for the clarinet (closed pipe). All the other pipe instruments are open pipes.

You need to know some of the details of the trombone positions and trumpet valve combinations. You should know the following? Why do you need 7 positions for both the trombone and trumpet as this answer comes from physics. Know that the trombone
realizes these in extensions of pipe length via actually moving a slide. Know that the trumpet realizes these extensions internally by pressing values (3 in combinations) to open internal pipe sections. You should know that one needs to extend a pipe by 6% to lower the pitch by one-half step. This is your 6%-interest rule for equal-temperament.

For the "cycle of fifths," know Generation 1 since Heart and Soul is our signature song for the 1-6-2-5. Know Ella Fitzgerald, who sings our signature song, as she appeared earlier in our course with the Memorex commercial. Also know that the Jeopardy Theme (covered later) follows this 1-6-2-5 pattern.

You should know differences between western and non-western music. This is core diversity-intensive material. It is important that we understand music in the broader context of world music.

We add Dizzie Gillespie to the jazz list since his example with the timbre is important. What did he do in the video?

KNOW there is a family of songs that use the 1-6-2-5 starting on the 2 in order to get 2-5-1-6 and we saw an example with a 6-1-2-5 (Diamond Commercial). Why are these analogous to phase shifts in physics?

Power Notes Y. There is a nice review of the 2L rule for the fundamental wavelength of a string. There is also a review of the velocity formula. Know the important use of physics in obtaining the fourth harmonic. We include the composer Sibelius here as this example is an excellent bridge between physics and the art of music.

Know the "Golden Rule" for guitar-fret placement. Also know the basic physics behind the electric guitar (Faraday's Law). The second page of the power notes includes interval analysis again. It reviews the ratio for the tritone. How can you arrive at this ratio from the diagram?

What about the scales. Well, if you can sketch the one-octave keyboard, you can figure out so much. Draw 8 keys and then shade in the pair of black keys and the trio of black keys with the proper spacing. The major scale is simply your 8 white keys. How do get the interval formula for the major scale as W-W-H-W-W-H from your diagram? How can you put dots on your keyboard to illustrate the whole-tone scale? What is a whole tone? What is the chromatic scale? The blues scale formula you can skip.

You can skip Neil Sedaka but I would know the Chuck Berry in one of his songs, "neutralized" the blues with all 1-harmonices, taking turns with the regular blues formula and the neutralized version.

Power Notes Z. Start at the top with the "Circle of Fifths" - also called the “Cycle of Fifths.” I would memorize 4-7-3-6-2-5-1 rather than take time on the final exam to derive it from scratch. Which interval is the cheat? Not a fifth? I skip the detailed sheet music on the lower half of the first page.
I memorize the signature songs for the 4-7-3-6-2-5-1, the one in the minor key is *Autumn Leaves* and the one in a major key is the middle section of *Can't Take My Eyes Off You*. I take this opportunity to review my composers Bach, Mozart, Chopin, and the Schumanns and where they fit into things. My best bet here is to highlight what was written on the board for this class.

**Part II. How to Get the Best Out of the Old Exams**

From time to time students tell me they are disappointed after they study practice exams as on the real exam they do not do as well as they expected. This section addresses this issue. Perhaps a medical analogy is helpful here. A doctor prescribes medicine which in most cases is effective in treating the illness but for some reason, perhaps allergy or something, you are not getting the benefit. Perhaps the prescription is changed or a combination of medicines might be used.

As in medicine, there is never a guarantee any specific thing will work for you. You need to know yourself well and with consultation with your instructor or yourself come up with an alternative plan if what you study does not help you. This is true in any learning situation.

We have two extreme ends of the scale for exams encountered in life: 1) you are given old questions like the NC Driver’s Test and the same questions appear on the exam or 2) you are given no sample questions to help you prepare for exams. The latter is the typical practice in science courses. Some instructors believe sample exams are bad because they take the student away from fundamental study. The student is tempted to jump right in on the questions before reading the chapter a couple of times and learning the fundamentals. The sample questions can then be a distraction. Here is how you can make the old exams work for you in studying for the final exam.

The secret is to study “in the neighborhood” of each question. I will illustrate the approach by taking some old exam sample questions.

Exam 1 Sample Question 1. A speed of 3000 miles per hour is approximately Mach (A)1 (B)2 (C)3 (D)4 (E)5. Mach 1 is the speed of sound, which is 750 miles per hour, i.e., 750 mi/h. Therefore the answer is 3000/750 = 4, i.e., Mach 4. To study “in the neighborhood” here focuses on the speed of sound. He is asking me about sound speed. What are the other ways he can ask about sound speed. He could ask about meters, feet, etc. So I study the speed of sound as

\[
\text{sound speed} = \text{Mach 1} = 750 \text{ mi/h} = 340 \text{ m/s} = 1125 \text{ ft/s}
\]

and I am ready for metric conversions since he used mm/s with the bats:

\[
340 \text{ m/s} = 34,000 \text{ cm/s} = 340,000 \text{ mm/s}.
\]
I can even introduce kilometers if needed: $340 \text{ m/s} = 0.340 \text{ km/s}$.

Exam 1 More Sample Questions.

2. The pattern at the left (below the scale) corresponds to the interval of a perfect (A) unison (B) third (C) fourth (D) fifth (E) sixth.

3. If the horizontal frequency is 120 Hz in the figure at the left, then the vertical frequency is (A) 60 (B) 80 (C) 90 (D) 160 (E) 180 Hz.

4. The pattern is called a (A) Doppler (B) Fourier (C) Gibbs (D) Lissajous (E) Newton figure.

I then study all the patterns, i.e., the patterns for all the intervals in the text. I also invert Q3 where the vertical is given and I am asked for the horizontal. With Q4 I quickly check to see if any names listed are in the first part of the course. If they are, I know them.

More on Exam 1. I see a string question with a picture of say H6. I make sure I can do H1, H2, H3, and on. I make sure I know the general case to be fully prepared. I most likely will not see H6 on my exam.

Exam 2. Sample Question 1. What is the voltage across the resistor? (A) 1.8 (B) 2 (C) 2.2 (D) 4.0 (E) 8.0.

Exam 2 Sample Question 2. What is the current in amps flowing through the resistor? (A) 0.12 (B) 0.18 (C) 0.22 (D) 1.8 (E) 2.2.

I notice that the first question helps me answer the second one since I need the voltage across the resistor for Q2. So I take this first question away and see if I can answer Q2 without it. I first find the voltage across the resistor to be $V_R = 4.0 - 2.2 = 1.8$ volts. I then use Ohm’s Law $V = IR$ to find $I = (1.8 \text{ volts})/(10 \text{ ohms}) = 0.18$ amps. But I am not finished studying. I recall seeing milliamps in this course so I note that the current $I = 0.18$ A = 180 mA. Now I feel confident I exhausted this question. I see in another question that he wants to know if the current in the circuit is less than 1 amp. Yes it is. The same current flows everywhere since we have one simple loop.
Exam 3 Sample Question 1. If the oscillator at the left produces a high-frequency sine wave, this wave is more easily seen at (A) R (B) C.

Q2. Increasing the capacitance in the circuit in the figure (A) decreases the cutoff frequency (B) has no effect on the cutoff frequency (C) increases the cutoff frequency.

Q1 calls for the high-frequency case. I make sure I know the low-frequency case also. And I want to know the context here. We are talking about filters. So I study that a low-pass filter passes low frequencies and a high-pass filter passes high frequencies. I study the circuit diagrams for the filters.

In Q2 I am given that we are going to increase the capacitance. So we are going to swap out the one we have and replace it with another having greater capacitance. If the capacity of the capacitor increases, it takes longer to charge. If it takes longer to charge the frequency has to decrease. I remember this is the same logic as \( f = \frac{1}{T} \).

I also make sure I do not confuse cutoff frequency with the multitude of frequencies that enter a filter. The multitude of frequencies are represented with the oscillator symbol. You dial in the frequency you want then analyze that frequency in terms of the cutoff. So I need to look at the oscillator, R, and C in the circuit to make sure I understand each element and what it does to cover all my bases. Then I make sure I know what happens to the cutoff frequency if R increases, R decreases, C increases, and C decreases. Now I have exhausted this question. I should be able to nail a variation on this one if it shows up.

**Part III. Highlights from My Best Office Hours with Students**

Here are some of the questions I posed during my most best office hours. Also see the Video Tutorials for more of this type of thing.

Can you list all the graphs we encountered in the course and describe them. A quick flipping through all of the power notes will reveal the basic graphs encountered in the course. Do you know what is plotted on the horizontal and vertical axes and can you give a sample graph of each type.

Can you, from first principles, show me on a keyboard where to place H1 through H9? Can you place H10? H12? It is important that you do this from first principles. These being 1) your memorization of the major scale (the “musician’s scale”) 1:1, 9:8, 5:4, etc. and 2) your memorization of the harmonics (the “physicist’s scale”) f, 2f, 3f, 4f, 5f, etc. which you can express as 1:1, 2:1, 3:1, 4:1, 5:1, etc. when referencing each harmonic to the fundamental.

Can you describe a ramp wave in the following ways: oscilloscope picture (amplitude versus time), Fourier spectrum, and spectrogram? Can you do the same if you add...
vibrato? Can you sketch the modular synthesizer arrangement that will produce this sound?

In your imagination take the toy with cylindrical pieces I used in class to an alien planet where the speed of sound is 160 m/s. Then add an equal-length piece to four equal pieces to increase the length in the ratio of 5:4. What is the second pitch if the pitch for the four pieces is 200 Hz? Why must your answer be less than 200 Hz? Did you get 160 Hz? Now find the wavelength for this pitch from the velocity formula. What is the total pipe length for the 160-Hz pitch? Finally, what is the length of each of your smaller toy pieces? Do you get 10 cm for your answer?

What are the three types of modulation? Give a typical frequency for a carrier wave and a typical frequency for a modulator when we apply modulation to sound. How would you coach a singer to do each of these – granted that singers will always have some vibrato present.

**Part IV. Grades, Science Courses in General, and Curving Exams**

When I taught humanities for 20 semesters I often curved exams by grading leniently on the essay questions. Since we have multiple choice in our science class, I curve using statistics.

So never freak out during an exam. If you are having a tough time, others most likely are too and the exam will be curved.

You are taking a physics course with basic math. Now, granted this intro course is not the real freshman physics major intro course. That one requires calculus. Our course is also not the intro pre-med freshman physics course – that one requires trigonometry. But it is still physics and it is a college course. So it is still very challenging.

Over the past 20 years we find that grade inflation has occurred across the United States in college courses. This means there are many classes on campus where everyone gets an A or B and you can fairly easily find classes where most get an A. However, not much grade inflation is found in the natural sciences across the country when you compare with the average college course. The “going rate” in science is in the 2.5 - 2.8 range on average when you deal with hundreds of students. This means that the class average usually comes out to a C or C+.

**Part V. Thank You**

Thank you for taking my class and making suggestions this semester that have led to improvements in our course as we go - such as your request for this review pdf file. I always listen to students to keep my courses in top form. I appreciate your support. Happy studying. See you at the Final. Good luck.