Physics 113 - December 11, 2012

Physics 113 - Exam 3 distribution

Solutions are posted on class website

(mean)
Understanding Normalization - Fictitious Illustrative Example

4 Exams
You are allowed a "drop"
I can't make all 4 exams of equal difficulty
⇒ Must do something to take into account the different difficulties
⇒ Suppose you were sick for exam I
Scale all exam grades for Exam n by \[
\frac{100}{\text{Mean of Exam } n}
\]

Highest possible score ... 100 on Exam III
\[\frac{(100)(100)}{50} = 200\]
$E_1 = \frac{53}{83} \times 100 = 64.1$

$E_2 = \frac{70}{57} \times 100 = 122.8$

$E_3 = \frac{75}{57} \times 100 = 132$

And so forth for exams.
I use the new normalized scores in the algorithm weighting components appropriately.

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Exam 1</th>
<th>Exam 2</th>
<th>Exam 3</th>
<th>Final exam</th>
<th>Lab</th>
<th>Prob sets</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>20%</td>
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I look at these cases individually.

Get a new distribution \( \rightarrow \) call it best numerical average distribution (not necessarily a 0-100 scale)

Typical forms:
- A range: \( 20-25 \% \)
- B range: \( \sim 50 \% \)
- C range: \( \sim 20-25 \% \)
Waves on string - reflection

Fixed end ~ 180° phase change

Loose end
No phase change
look at wave propagating on string and add together with reflected wave (both have same frequency + amplitude)
use principle of superposition, they “interfere”

\[ y(x,t) = (-2A) \sin(\omega t) \cos(kx) \]

- Fixed form in space
- Periodic in \( \chi \)

**Standing Waves**

*2A = Amplitude of superposition*

*Time Variation*
Tension, $T$
Mass/length, $m$

Fundamental $L = \frac{L}{2}$ 1st harmonic

2nd harmonic $L = 2 \cdot \frac{L}{2} = \lambda$

3rd harmonic $L = 3 \cdot \frac{L}{2}$

Higher harmonics $\rightarrow L = n \frac{L}{2}$  $n = 1, 2, 3 \ldots$

\[ v = f_n \lambda_n \]
\[ v = \sqrt{\frac{T}{m}} \text{ on string} \]

\[ f_n = \frac{v}{\lambda_n} \]
\[ f_n = \frac{n}{2L} \sqrt{\frac{T}{m}} \text{ are frequencies that "resonate" on string} \]
For Tubes/sound (wind instruments)

- Open end
- Displacement antinode (pressure node)
- Closed end
- Displacement node (pressure antinode)

What are frequencies that resonate in a tube of length $L$ that is closed at 1 end?
fundamental: \( L = \frac{\lambda}{4} \)

2nd harmonic: \( L = \frac{3}{4} \lambda \)

3rd harmonic: \( L = \frac{5}{4} \lambda \)

where \( n = 1, 3, 5 \ldots \)

\[ v = \frac{f \lambda}{n} \]

\[ v = \frac{f_n}{n} \lambda_n \]

\[ L = \frac{n \nu}{4L} \quad n = 1, 3, 5 \]

Frequencies that resonate on this instrument

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Tune + warm up musical instrument

\( v \) sound = \( 343 \text{ m/s} \) at \( 20^\circ \text{C} \)
Beats

Two waves passing a fixed point \((x=0)\)
Differ slightly in frequency
Equal amplitudes

Wave 1
\[
\chi_1(x,t) = A \sin(k(x-x_0),t) = A \sin(\omega t)
\]
\[
\chi_2(x,t) = A \sin(\omega_2 t)
\]

Use superposition
\[
\chi(x,t) = \chi_1(x,t) + \chi_2(x,t)
\]
\[
\chi(x,t) = A \sin(\omega t) + A \sin(\omega_2 t)
\]

Use Trig ID
\[
\sin A + \sin B = 2 \sin \left( \frac{1}{2} (A+B) \right) \cos \left( \frac{1}{2} (A-B) \right)
\]
\[ X(t) = 2A \sin \left( \frac{(\omega_1 + \omega_2)t}{2} \right) \cos \left( \frac{(\omega_1 - \omega_2)t}{2} \right) \]

Sensitive way to detect small frequency differences: Hear this sound!

Think of this as amplitude (intensity \( \sim \) Amplitude\(^2\)) that varies in time with frequency \( \sim \frac{\Delta \omega}{2} \)
Energy flow in waves

\[ \frac{dE}{dt} \sim A^2 V \]

This is why I say intensity \( \sim A^2 \).

\[ \text{same Energy} \]
\[ \text{larger Area} \Rightarrow 4\pi r^2 \]

Energy flow (intensity)

\[
\frac{\text{Energy flow}}{\text{Area}} \text{ drops as } r^2
\]

True for light, sound...
Intensity = \frac{\text{Power}}{\text{Area}} \quad \text{Watts} \quad \text{M}^2

Intensity of Sound

Define \( I_0 \) as reference intensity
\( 1 \times 10^{-12} \ \text{W/M}^2 \)

Threshold of hearing for average person

\[ \beta \ (\text{decibel}) = 10 \log \frac{I}{I_0} \]
Threshold  \( \frac{dB}{0} \)
Whisper  \( \sim 20 \)
Street Traffic  \( \sim 70 \)
Siren @ 30 m  \( \sim 100 \)
Rock concert at pain Threshold  \( \sim 120 \)
Jet engine at 30 m  \( \sim 140 \)

**Example:**
Stereo Ad flat response \( \pm 3 \text{ dB} \) from 30 Hz to 18,000 Hz

What does this mean for relative intensity variation?
\[ \beta - \beta_1 = 10 \log \frac{I}{I_0} - 10 \log \frac{I_1}{I_0} \]

\[ 3 \, \text{dB} = 10 \log \frac{I}{I_1} \quad \Rightarrow \quad \frac{I}{I_1} = 2 \]
If $r_1 = r_2$

Constructive interference

$$r_1 - r_2 = n\lambda$$

If $r_1 - r_2 = n\lambda - \frac{\lambda}{2}$

Destructive
Doppler effect

Source moving toward you

\[ f_{\text{hear}} = \frac{f_{\text{source}}}{\left( 1 - \frac{v_{\text{source}}}{v_{\text{wave}}} \right)} \]

Source moving away

\[ f_{\text{hear}} = \frac{f_{\text{source}}}{\left( 1 + \frac{v_{\text{source}}}{v_{\text{wave}}} \right)} \]