ME 513 Session 39 11/30/15

1

Homework Hints

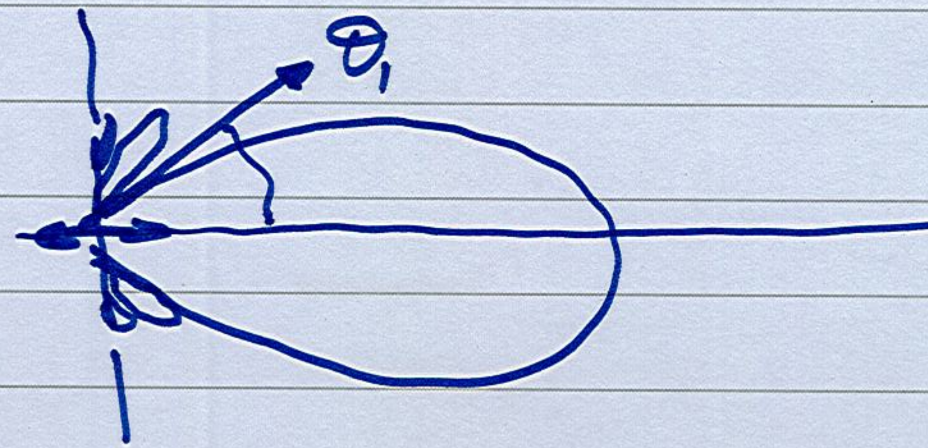
7.1.4 Eqn 7.2.16

$$\overline{\Pi} = \frac{1}{2}\pi \frac{\rho_0 c}{Z}\left(\frac{Q}{\lambda}\right)^2 \rightarrow Q$$

$\overline{\Pi}$: 10 mW

λ: $f = 400$ Hz

7.4.1



(a) θ_1 an a function of $ka\sin\theta$

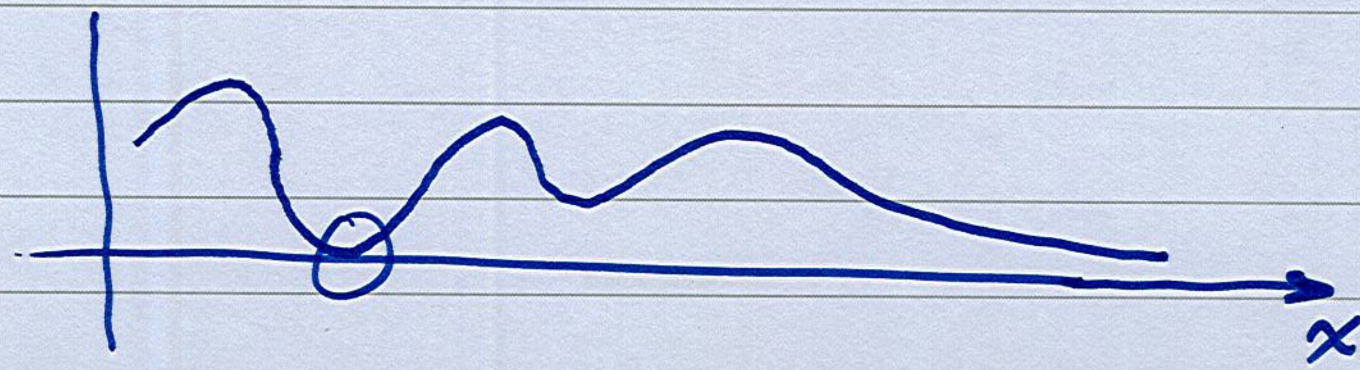
$\left[\quad \right]$ $\underline{ka\sin\theta}$

directivity factor

$= 0$

j_{11} θ_1

(b)



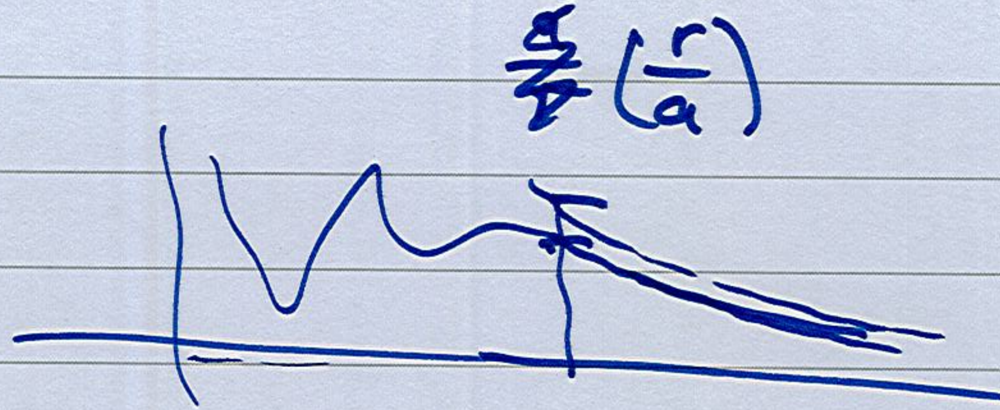
Eqn 7.4.4

$$\left(1 - \underbrace{\exp\left[-jk\left(\sqrt{r^2+a^2} - r\right)\right]}_{e^{j\theta}}\right)$$

7.4.6 C

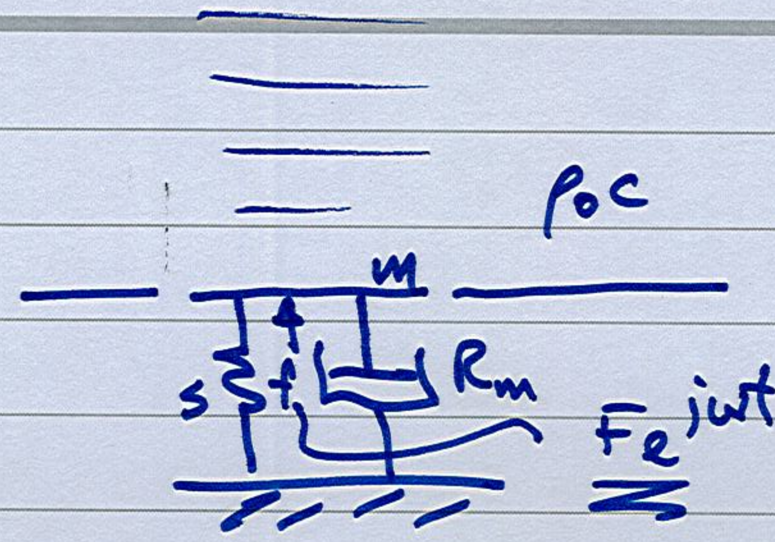
7.4.5

(a)



(b) 7.4.7 ✓

7.5.1



$ka \gg 2$

$\Rightarrow$ piston is large

$Z_r \to R_r \to S\rho_0 c$

Resonance

$\underline{Im\{Z_m + Z_r\}} = 0$

(b) Eqn 7.5.16

6. Room Acoustics

6.1 Introduction

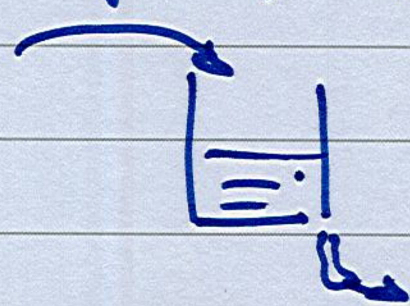
Wallace Sabine

T, V, A

$$T \propto \frac{V}{A}$$

Energy Acoustics

- relates space-averaged acoustic energy density in a space to the rate at which acoustic energy is ~~added~~ added to the space & the rate at which energy is absorbed at the walls or any furnishings (or people)



Basis of Theory

- sufficient reflections to create a diffuse sound field
  - → sound equally likely to arrive from any direction
- significant of reflections must occur
- total ~~ato~~ absorption in the space cannot be too large
- energy density in the space is instantaneously uniform

Energy Acoustics - does not work at low frequencies - modal response is very significant

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<u>Reverberation</u> - sensation created by The superposition of <u>many</u> reflections

- long rev time - direct sound is reinforced by many reflections
  - level increases - benefit

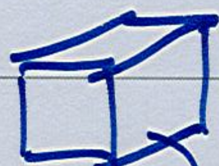
- if rev time is too long
  - intelligibility is reduced
- speech "masks" itself

Short Rev time - Clarity & low sound levels

Long Rev time - lack of clarity - but high levels

6.2 Energy Density

- sound propagates past a point in space – moves the fluid locally & also compresses



dU

- kinetic energy
- potential energy

fluid element of fixed mass

(i) Kinetic Energy

$$E_K = \frac{1}{2}\rho_0 u^2 V_0$$

(mass: $\rho_0 V_0$; ρ_0 – ambient density; V_0 – volume; u – particle speed)

(ii) Potential Energy

- energy ~~associat~~ associated with a change in volume.

$$E_p = -\int_{V_0}^{V} p\,dV$$

express dV in terms of p & evaluate the integral

$$\boxed{E_p = \frac{1}{2}\frac{p^2}{\rho c^2}V_0}$$

(iii) Total Energy in V_0

$$E = E_k + E_p$$

$$= \frac{1}{2} \rho_0 \left(u^2 + \frac{p^2}{(\rho_0 c)^2} \right) V_0$$

u = instantaneous total real particle speed

p = real sound pressure