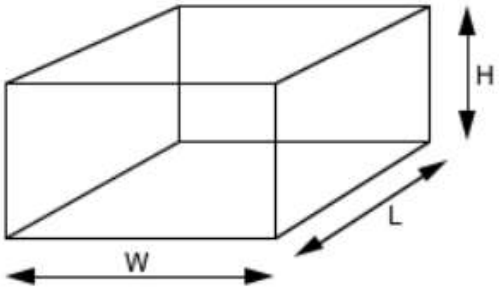
Lektion 4

Lydens opførsel i lukkede rum



1. Beregn de første 10 rum-resonanser i lyttestuen. Angiv hvilke der er aksiale. Beregn også Schröder-frekvensen og estimer efterklangstiden T60.

$$f_r = \frac{nc}{2L}$$

$$\text{Frequency} = \frac{c}{2}\sqrt{\frac{p^2}{L^2} + \frac{q^2}{W^2} + \frac{r^2}{H^2}}$$

$$T_{60} = 0{,}16\frac{V}{S}$$

$$f_s \approx 2000\sqrt{\frac{T_{60}}{V}}$$

```
% Konstanter
Lx = 5; Ly = 4; Lz = 2.5;      % Rummets dimensioner
c = 344;                       % Lydens hastighed (m/s)

f1 = (c/2) * (sqrt(((1^2)/Lx^2) + ((0^2)/Ly^2) + ((0^2)/Lz^2)))
```

```
f1 = 34.4000
```

```
f2 = (c/2) * (sqrt(((0^2)/Lx^2) + ((1^2)/Ly^2) + ((0^2)/Lz^2)))
```

```
f2 = 43
```

```
f3 = (c/2) * (sqrt(((1^2)/Lx^2) + ((1^2)/Ly^2) + ((0^2)/Lz^2)))
```

```
f3 = 55.0669
```

```
f4 = (c/2) * (sqrt(((0^2)/Lx^2) + ((0^2)/Ly^2) + ((1^2)/Lz^2)))
```

```
f4 = 68.8000
```

```
f5 = (c/2) * (sqrt(((1^2)/Lx^2) + ((0^2)/Ly^2) + ((1^2)/Lz^2)))
```

```
f5 = 76.9207
```

```
f6 = (c/2) * (sqrt(((0^2)/Lx^2) + ((1^2)/Ly^2) + ((1^2)/Lz^2)))
```

```
f6 = 81.1322
```

```
f7 = (c/2) * (sqrt(((2^2)/Lx^2) + ((0^2)/Ly^2) + ((0^2)/Lz^2)))
```

```
f7 = 68.8000
```

```
f8 = (c/2) * (sqrt(((1^2)/Lx^2) + ((1^2)/Ly^2) + ((1^2)/Lz^2)))
```

```
f8 = 88.1238
```

```
f9 = (c/2) * (sqrt(((0^2)/Lx^2) + ((2^2)/Ly^2) + ((0^2)/Lz^2)))
```

```
f9 = 86
```

```
f10= (c/2) * (sqrt(((2^2)/Lx^2) + ((1^2)/Ly^2) + ((0^2)/Lz^2)))
```

```
f10 = 81.1322
```

```
% Indeks
fLx = zeros(1,2);
fLy = zeros(1,2);
fLz = zeros(1,2);

% Aksiale resonanser
for n = 1:2
    fLx(n) = (n*c)/(2*Lx);
    fLy(n) = (n*c)/(2*Ly);
    fLz(n) = (n*c)/(2*Lz);
end
fLx
```

```
fLx =

   34.4000   68.8000
```

```
fLy
```

```
fLy =

    43    86
```

```
fLz
```

```
fLz =

   68.8000  137.6000
```

```
V = Lx*Ly*Lz;                % Rummets volume (m3)
S = (Ly*Lz);                 % Lydabsorberende areal S (alpha for gardin)
T60 = 55.3*(V/(S*c))         % Efterklangstiden (s)
```

```
T60 = 0.8038
```

```
fs = 2000*sqrt(T60/V)        % Schröder frekvensen
```

```
fs = 253.5790
```

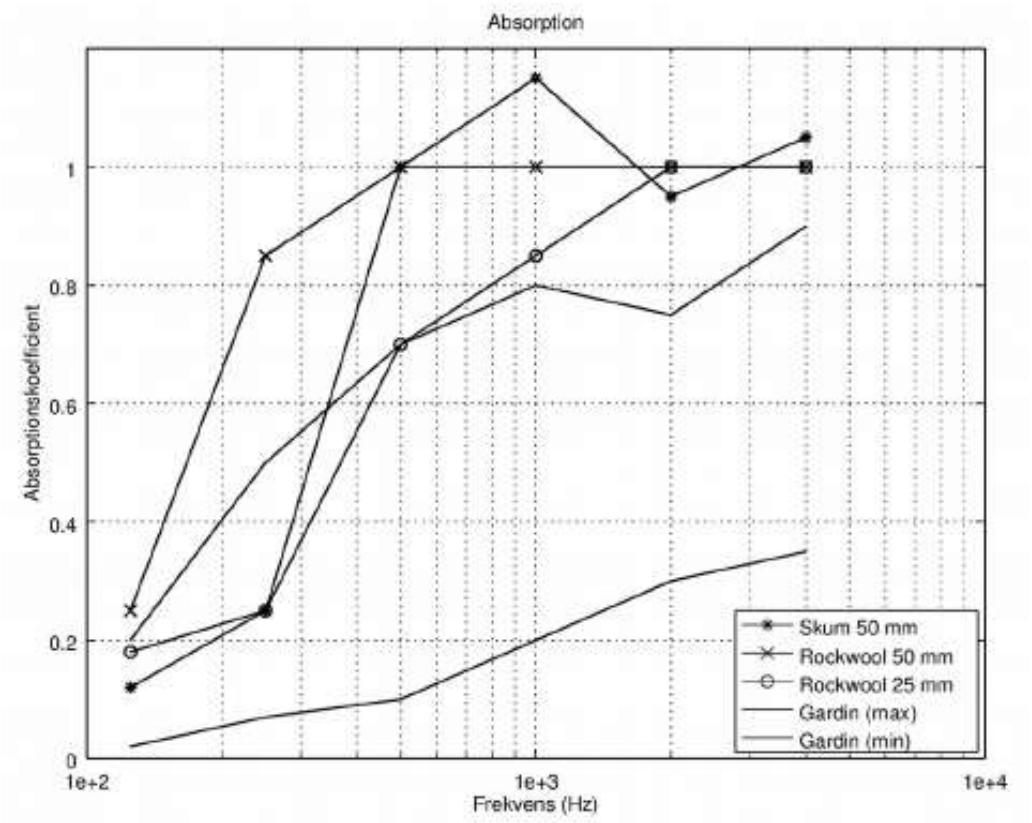
```

```

2. Giv et bud på delay og relativ styrke for alle 1. ordens reflektioner (for faste kilde/lytter placeringer). Tegn impulsresponsen som søjler langs en tidsakse, hvor lyddæmpningen medtages efter afstandsreglen og eventuelt en vurdering af dæmpningen ved refleksion i fx loftplader.

3. Beregning af efterklangstiden *T*60 efter Sabine for forskellige rum. Vurdering af absorption ved brug af kurverne i "Elektroakustik" (50 – 51) eller "Report 2 – Absorber" fra Campus, eller formler fundet på nettet.

$$T_{60} = \ln(10^6)\frac{4V}{Sc} \qquad T_{60} = 55{,}3\frac{V}{Sc} \qquad T_{60} = 0{,}16\frac{V}{S} \qquad S = \alpha_1 S_1 + \alpha_2 S_2 + \ldots$$




```
% Beregning af efterklangstiden
Lx = 5; Ly = 4; Lz = 2.5;        % Rummets dimensioner
V = Lx*Ly*Lz;                    % Rummets volume (m3)

disp('T60 for skum, rockwool 25mm, gardin')
```

```
 T60 for skum, rockwool 25mm, gardin
```

```
alpha = [1 0.83 0.35]            % [skum, rockwool 25mm, gardin]
```

```
 alpha =

    1.0000    0.8300    0.3500
```

```
S = (Ly*Lz).*alpha;              % Lydabsorberende areal S

T60 = 0.16*(V./S)                % Efterklangstiden (s)
```

```
T60 =

    0.8000    0.9639    2.2857
```

4. Bestem de rumakustiske parametre T60, EDT, og C80 ud fra impulsresponsen i filen roomir.mat.

- **Reverberation Time:** *RT: RT60 or T60: the time it takes for the sound pressure level to fall by 60 dB after the sound has been turned off.*
- **Early Decay Time:** *EDT is derived from the Reverberation Time decay curve - the section between 0 dB and 10 dB below the initial level.*

```
load roomir.mat
N = length(room);
f_axis = ((1:N)*48000/N);

plot(f_axis, room)
title('RIR - Room Impulse Response')
xlabel('Samples'), ylabel('Level (dB)')
```