
202a problem set, part III

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Pekeris Waveguide

Setup

```
function part_iii()

close all;

f = 100:1:200; %Hz
omega = 2*pi*f; %rad/s
c1 = 1500; %m/s
c2 = 1600;
d = 100; %m
```

Math

```
% Find the highest mode number that has a cutoff frequency below 100Hz
% m_max = f*2*d*sqrt(c2^2-c1^2)/(c1*c2) + 0.5;
m_max_100 = floor(100*2*d*sqrt(c2^2-c1^2)/(c1*c2) + 0.5);
m_max_200 = floor(200*2*d*sqrt(c2^2-c1^2)/(c1*c2) + 0.5);

k_rm_full = solve_pekeris(f);

k_zm_full = sqrt(bsxfun(@minus, ((omega/c1).^2)', k_rm_full.^2));

for m = 1:m_max_200
    % Cut off frequencies
    % Equation 8.44
    f0m(m) = (m-0.5)*c1*c2/(2*d*sqrt(c2^2-c1^2));

    % v(m, :) = omega ./ k_rm(m,:);
    % % Cutoff frequency (real wavenumber only above cutoff)
    % f0m(m) = m*c/(2*d);

    k_rm{m} = k_rm_full(:,m);
    k_zm{m} = k_zm_full(:,m);
```

```
v{m} = omega ./ k_rm{m}';

f_real{m} = f(f>f0m(m));

v_real{m} = v{m}(f>f0m(m));

% Find group velocity u
u_temp = diff(omega)./diff(k_rm{m}');
u_temp = [0 u_temp]; % shift it over so that the dimensions match
u_real{m} = u_temp(f>f0m(m));
end
```

A: Number of modes

```
fprintf('Number of modes propgating at 100Hz = %d\n', m_max_100);
fprintf('Number of modes propgating at 200Hz = %d\n', m_max_200);
```

Number of modes propgating at 100Hz = 5

Number of modes propgating at 200Hz = 9

B: Cut-off frequencies

```
fprintf('Cut off frequencies for each mode:\n');
for m=1:m_max_200
    fprintf('\t%d: %d Hz\n', m, f0m(m));
end
```

Cut off frequencies for each mode:

1: 1.077632e+01 Hz

2: 3.232895e+01 Hz

3: 5.388159e+01 Hz

4: 7.543423e+01 Hz

5: 9.698686e+01 Hz

6: 1.185395e+02 Hz

7: 1.400921e+02 Hz

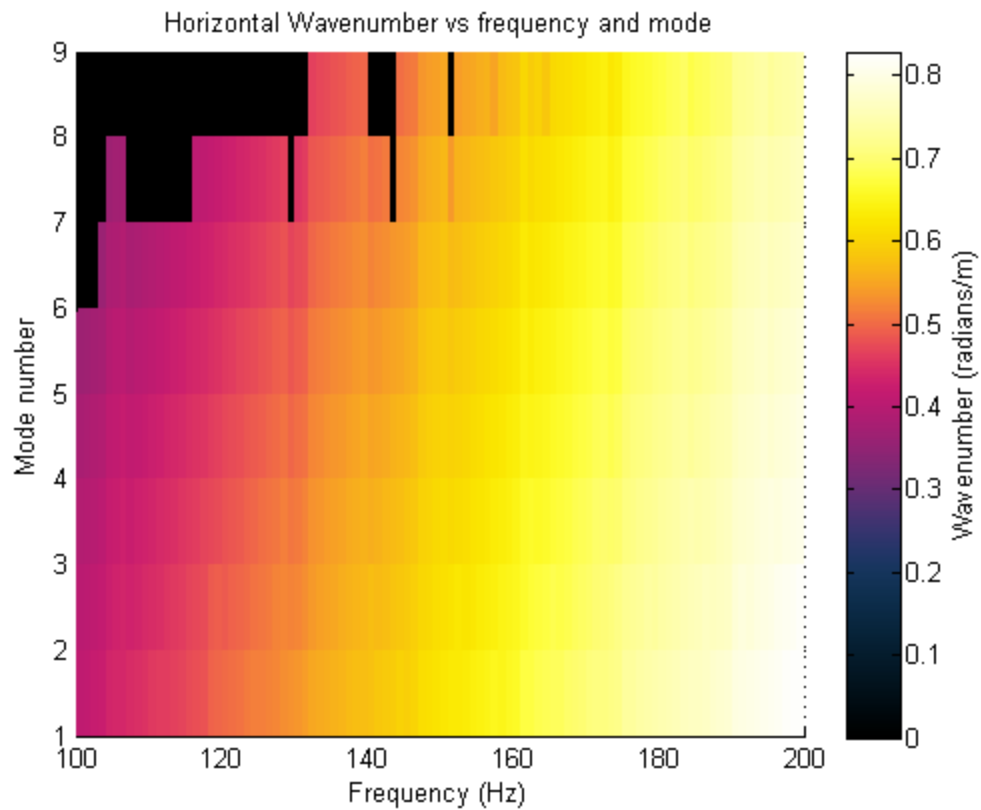
8: 1.616448e+02 Hz

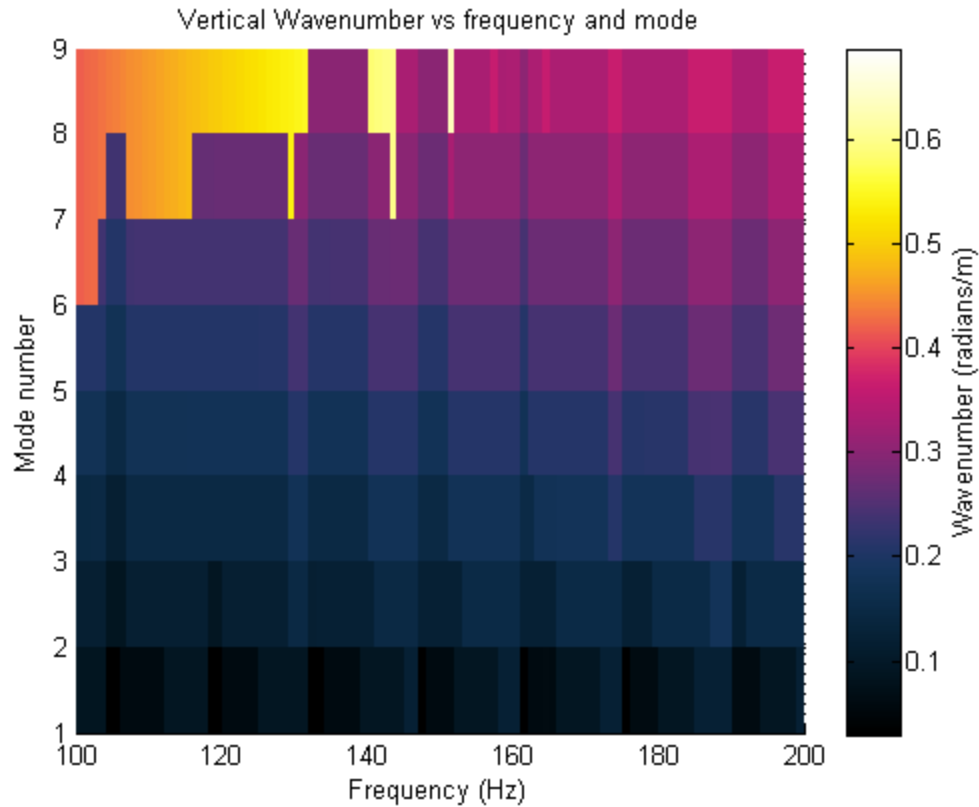
9: 1.831974e+02 Hz

C: Horizontal and vertical wavenumbers

```
m=1:m_max_200;
figure('name', 'Horizontal Wavenumber vs frequency and mode');
surf(f, m, k_rm_full(:,1:m_max_200)', 'EdgeColor', 'none');
colormap(morgenstemning());
view([0 90]);
axis tight;
xlabel('Frequency (Hz)');
ylabel('Mode number');
cbar = colorbar();
ylabel(cbar, 'Wavenumber (radians/m)');
title(get(gcf(), 'name'));
```

```
figure('name', 'Vertical Wavenumber vs frequency and mode');  
surf(f, m, k_zm_full(:,1:m_max_200)', 'EdgeColor', 'none');  
colormap(morgensstemning());  
view([0 90]);  
axis tight;  
xlabel('Frequency (Hz)');  
ylabel('Mode number');  
cbar = colorbar();  
ylabel(cbar, 'Wavenumber (radians/m)');  
title(get(gcf(), 'name'));
```





D: Group speed dispersion curves

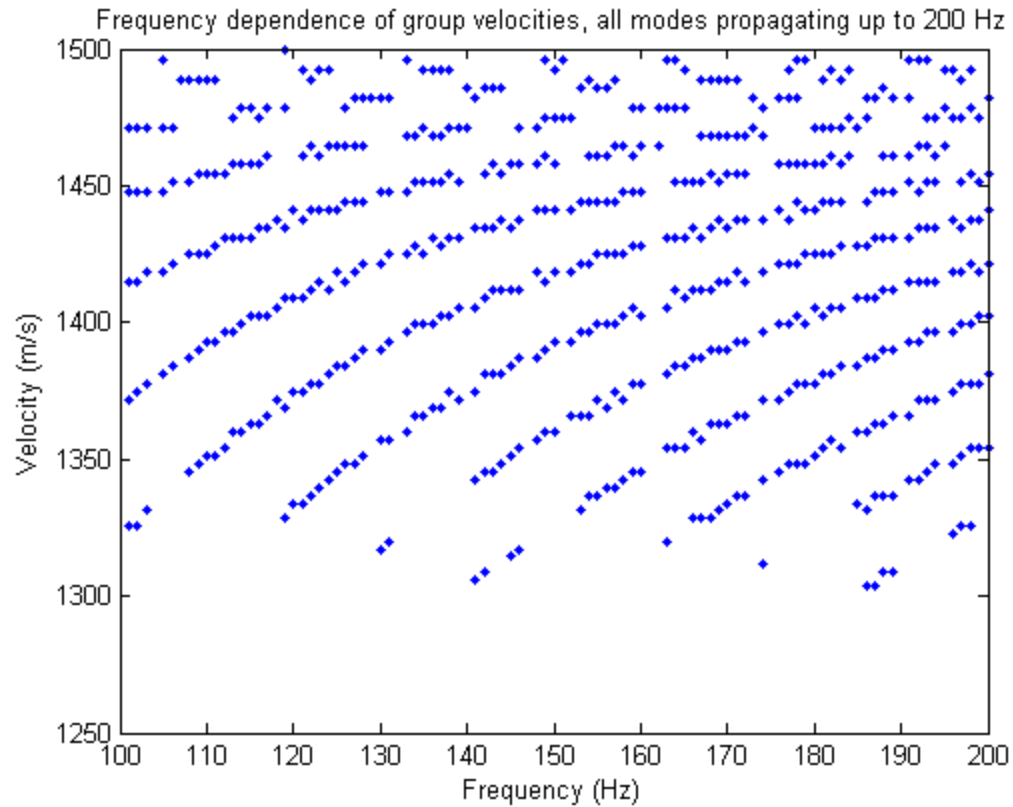
```
figure();

for i = 1:length(f_real)
    plot(f_real{i}, u_real{i}, '.');
    hold on;
end
ylim([1250 1500]);

% plot(f_real{1}, u_real{1}, 'r--');
% hold on;
% plot(f_real{2}, u_real{2}, 'g--');
% plot(f_real{3}, u_real{3}, 'b--');

% plot(f_real{1}, v_real{1}, 'r');
% plot(f_real{2}, v_real{2}, 'g');
% plot(f_real{3}, v_real{3}, 'b');

%ylim([1300 1500]);
%legend('u1', 'u2', 'u3', 'Location', 'SouthEast');%, 'v1', 'v2', 'v3')
xlabel('Frequency (Hz)');
ylabel('Velocity (m/s)');
title('Frequency dependence of group velocities, all modes propagating up to 200 H
```



E: Shape of the modes

```

z = 0:0.1:50;

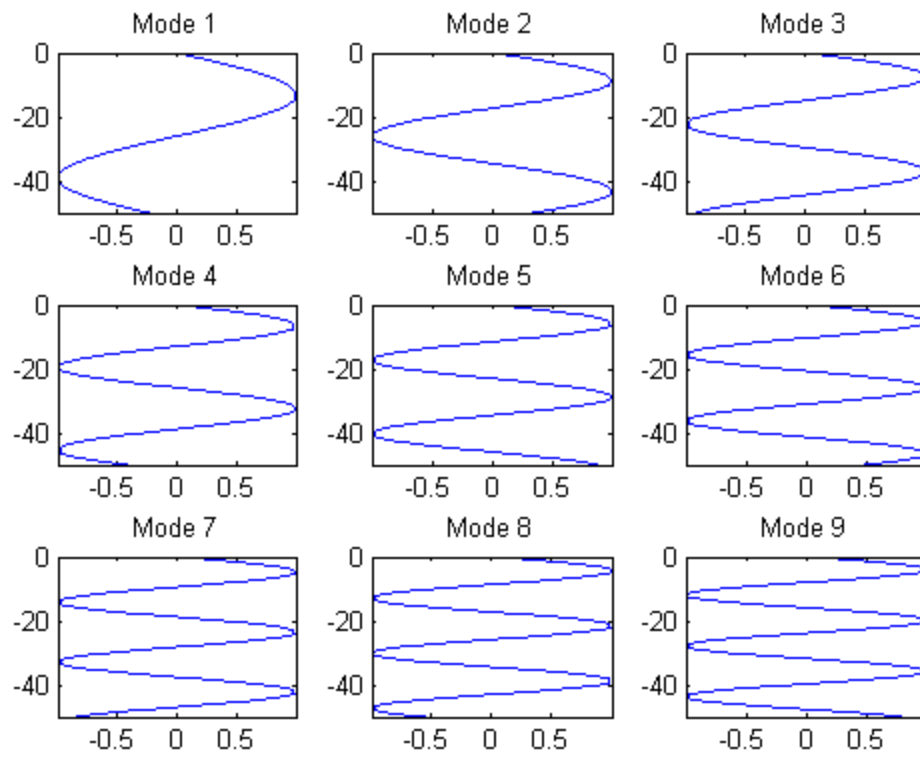
figure('name', 'Shape of modes in depth');

for m = 1:m_max_200
    shape = sin(k_zm{m}(end)*z);
    subplot(3,3,m);
    plot(shape, -z);
    axis tight;
    title(['Mode ' num2str(m)]);
end

disp('done');

done

```



end

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