

## Contents

---

- [3.15](#)
- [3.17](#)
- [3.18](#)
- [3.20](#)
- [4.1](#)
- [4.3](#)

### 3.15

---

```
%{
N = 31; a = 15; wc = 0.5*pi;
n = 0:(N-1); omega = linspace(-pi, pi, 101);
h = sin(pi.*(n - a))./(pi.*(n - a)); h = rmmissing(h); new_n = 0:(N-2);
H = numerical_dftft_2(h, new_n, omega);

H_ideal = zeros(size(omega));
for j = 1:length(omega)
    if abs(omega(j)) <= wc
        H_ideal(j) = 0 + 0i;
    else
        H_ideal(j) = exp(-1i * a * omega(j));
    end
end

figure();
subplot(3, 2, [1 2]); stem(new_n, h, 'filled');
title("Plot of impulse response  $h_d(n)$ ", 'interpreter', 'latex');
subplot(3, 2, 3); stem(omega, abs(H), 'filled');
title("Magnitude of DTFT  $H_d(\omega)$ ", 'interpreter', 'latex');
grid on;
subplot(3, 2, 4); stem(omega, angle(H), 'filled');
title("Argument of DTFT  $H_d(\omega)$ ", 'interpreter', 'latex');
grid on;
subplot(3, 2, 5); stem(omega, abs(H_ideal), 'filled');
title("Magnitude of ideal  $H_d(\omega)$ ", 'interpreter', 'latex');
grid on;
subplot(3, 2, 6); stem(omega, angle(H_ideal), 'filled');
title("Argument of ideal  $H_d(\omega)$ ", 'interpreter', 'latex');
grid on;
%}
```

### 3.17

---

```
omega = linspace(-pi, pi, 101);

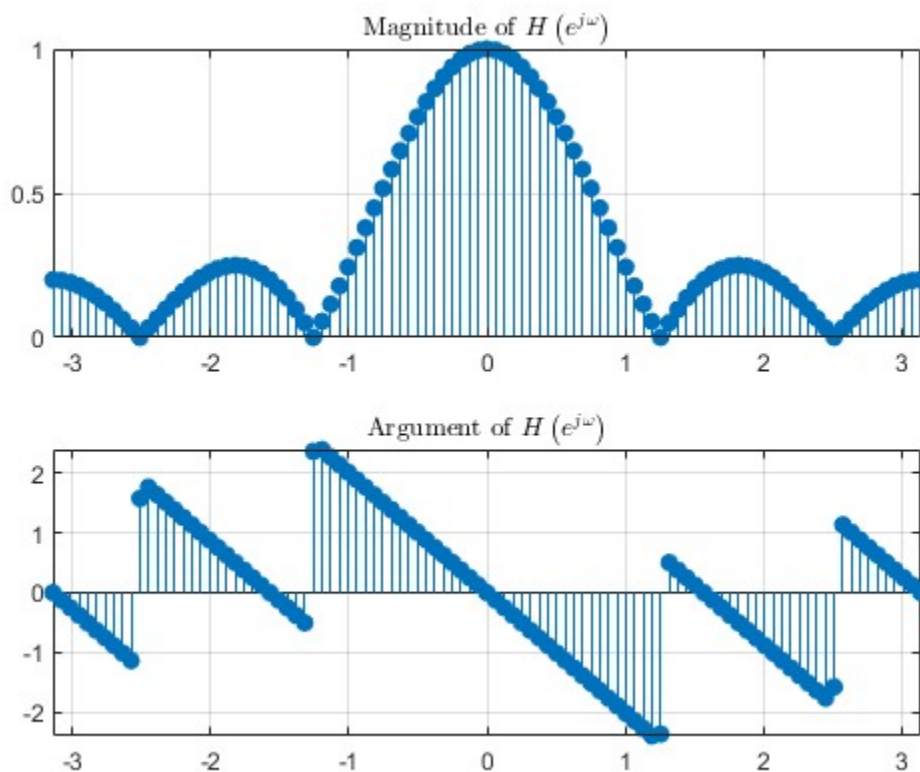
H = 0.2 * (1 + exp(-1i.*omega.*1) + exp(-1i.*omega.*2) + exp(-1i.*omega.*3) + exp(-1i.*omega.*4));
figure();
subplot(2, 1, 1); stem(omega, abs(H), 'filled');
title("Magnitude of  $H\left(e^{j\omega}\right)$ ", 'interpreter', 'latex');
```

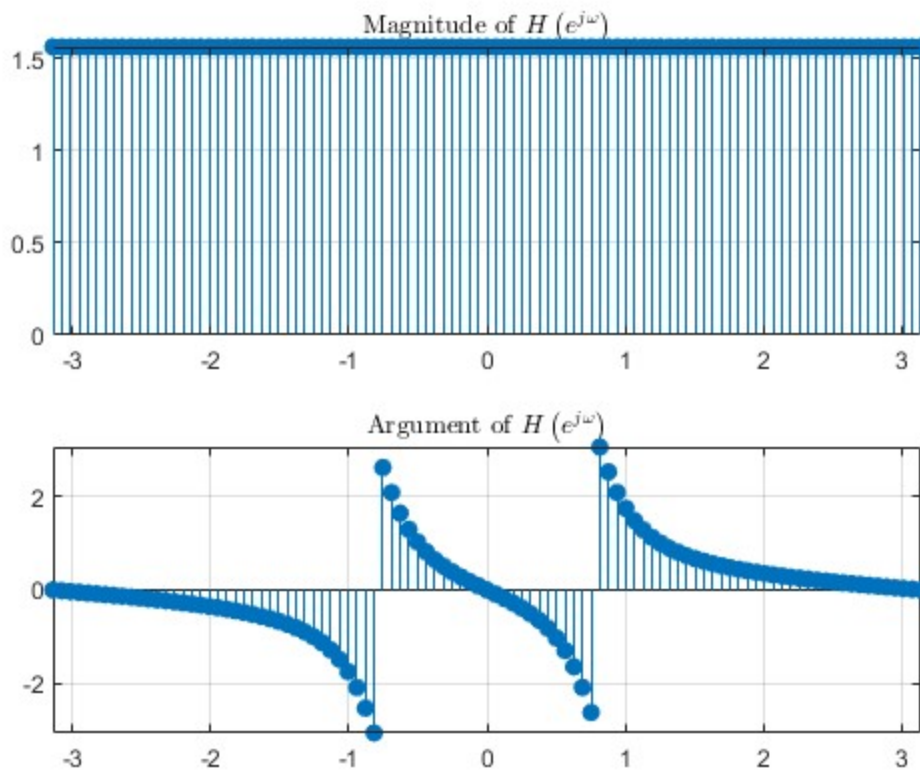
```

axis tight; grid on;
subplot(2, 1, 2); stem(omega, angle(H), 'filled');
title("Argument of  $H(e^{j\omega})$ ", 'interpreter', 'latex');
axis tight; grid on;

H = (1 - 1.7678*exp(-1i.*omega) + 1.5625*exp(-2i.*omega))./(1 - 1.1314*exp(-1i.*omega) + 0.64*exp(-2i.*omega));
figure();
subplot(2, 1, 1); stem(omega, abs(H), 'filled');
title("Magnitude of  $H(e^{j\omega})$ ", 'interpreter', 'latex');
axis tight; grid on;
subplot(2, 1, 2); stem(omega, angle(H), 'filled');
title("Argument of  $H(e^{j\omega})$ ", 'interpreter', 'latex');
axis tight; grid on;

```





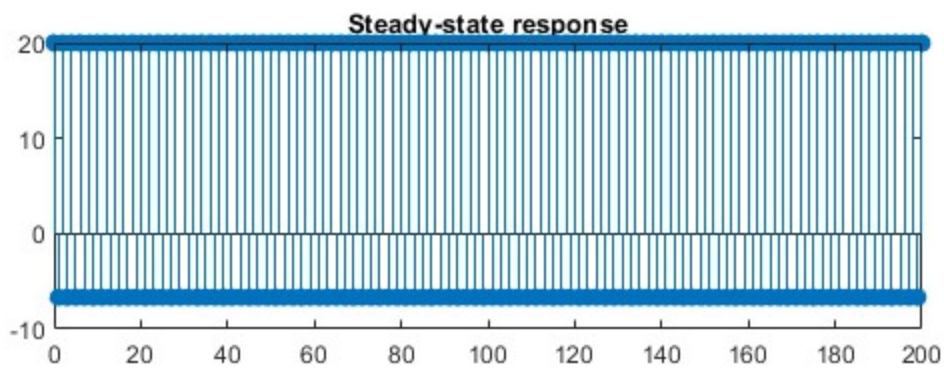
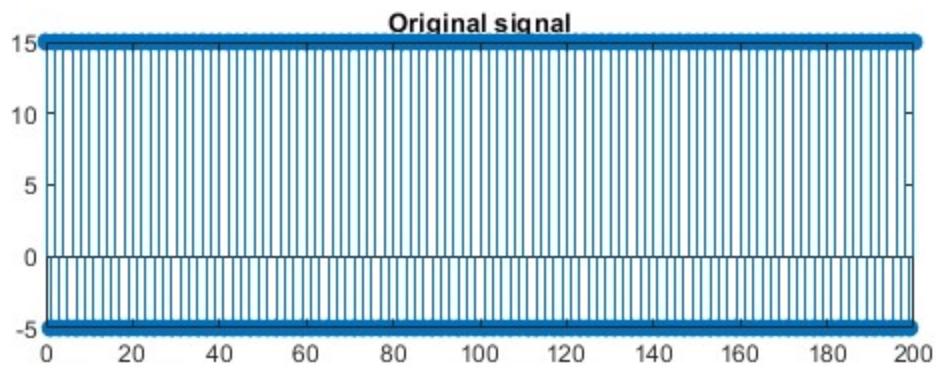
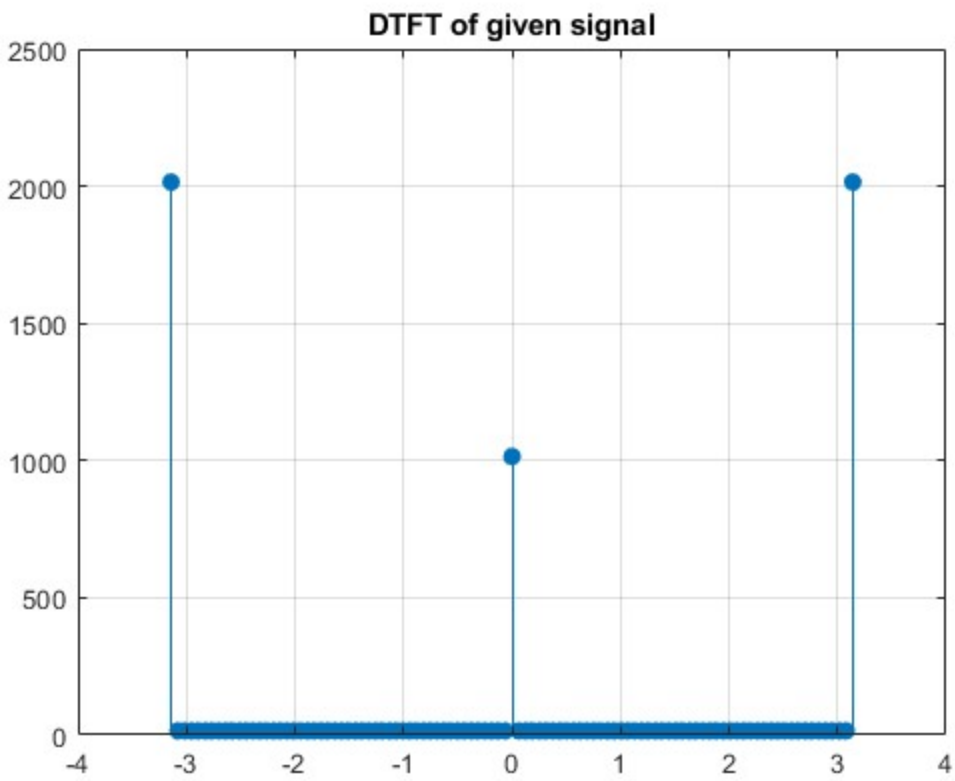
### 3.18

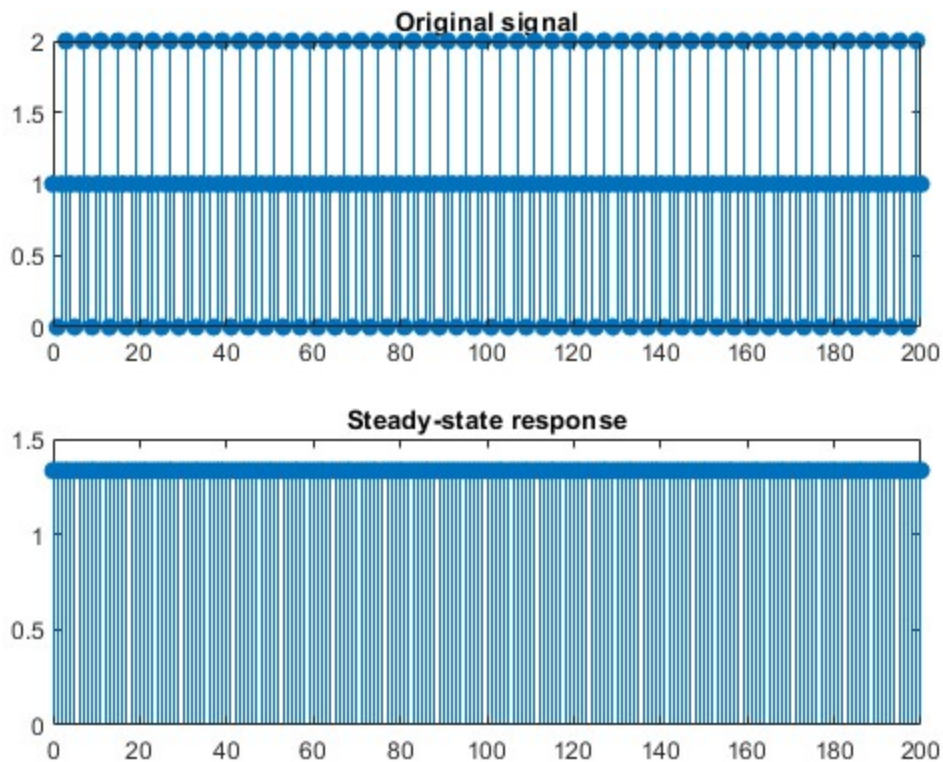
```
omega = linspace(-pi, pi, 101); n = 0:200;
H = @(omega) (1 + exp(-2i.*omega) + exp(-4i.*omega) + exp(-6i.*omega))./(1 + 0.81*exp(-2i.*omega) + 0.81'

x = 5 + 10.*(-1).^n;
figure();
stem(omega, abs(numerical_dtft_2(x, n, omega)), 'filled'); grid on;
title("DTFT of given signal");

y = 5 * abs(H(0)) * cos(angle(H(0))) + 10 * abs(H(pi)) * cos(pi.*n + angle(H(pi)));
figure();
subplot(2, 1, 2); stem(n, y, 'filled');
title("Steady-state response");
subplot(2, 1, 1); stem(n, x, 'filled');
title("Original signal");

x = 1 + cos(0.5*pi.*n + pi/2);
y = abs(H(0)) * cos(angle(H(0))) + abs(H(0.5*pi))*cos(0.5*pi.*n + pi/2 + angle(H(0.5*pi)));
figure();
subplot(2, 1, 2); stem(n, y, 'filled');
title("Steady-state response");
subplot(2, 1, 1); stem(n, x, 'filled');
title("Original signal");
```

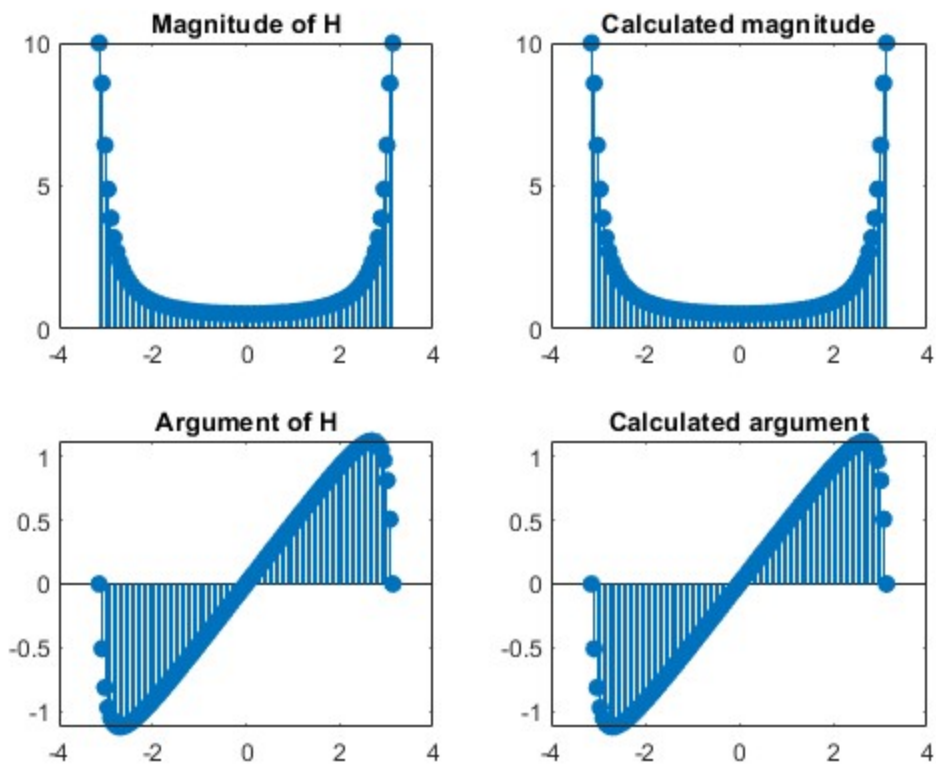




### 3.20

```
omega = linspace(-pi, pi, 101);
H = 1./(1 + 0.9*exp(-1i.*omega));
arg = @(omega) atan((0.9*sin(omega))./(1 + 0.9*cos(omega)));
mag = @(omega) sqrt( 1./(1.81 + 1.8*cos(omega)) );

figure();
subplot(2, 2, 1); stem(omega, abs(H), 'filled');
title("Magnitude of H");
subplot(2, 2, 2); stem(omega, mag(omega), 'filled');
title("Calculated magnitude");
subplot(2, 2, 3); stem(omega, angle(H), 'filled');
title("Argument of H");
subplot(2, 2, 4); stem(omega, arg(omega), 'filled');
title("Calculated argument");
```



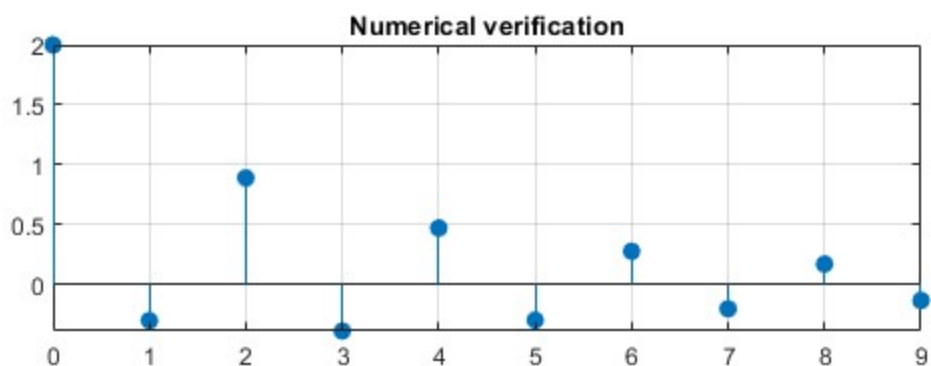
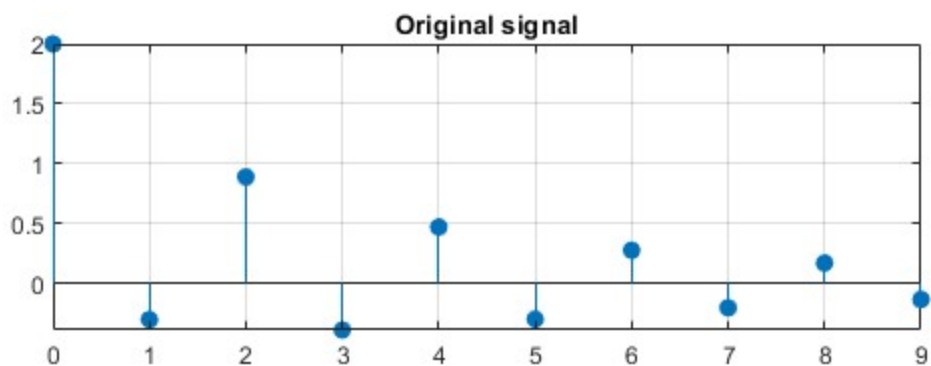
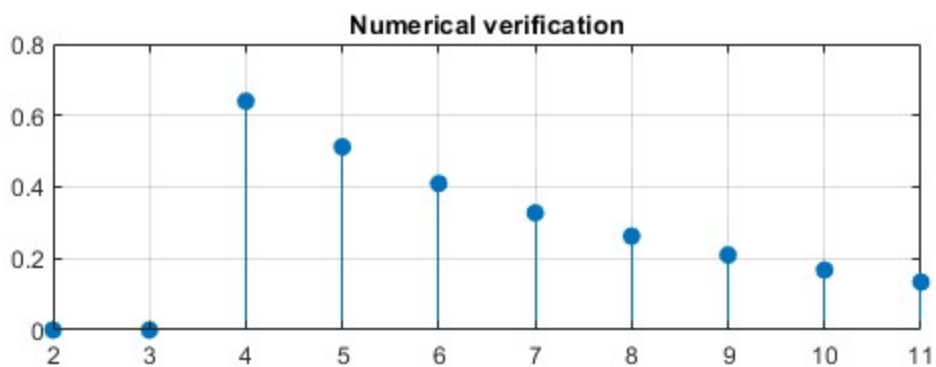
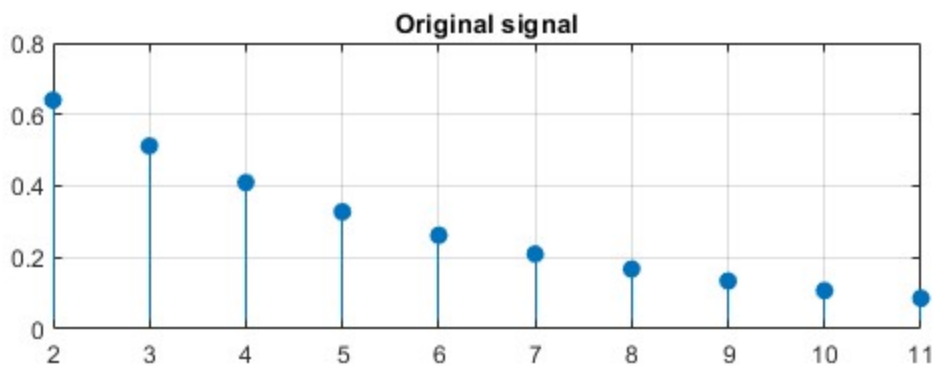
#### 4.1

```
n = (0:9) + 2; x = 0.8.^n;
doublecheck = filter([0, 0, 0.8^2], [1, -0.8], n == n(1));

figure();
subplot(2, 1, 1); stem(n, x, 'filled');
grid on; title("Original signal");
subplot(2, 1, 2); stem(n, doublecheck, 'filled');
grid on; title("Numerical verification");

n = 0:9; x = 0.5.^n + (-0.8).^n;
doublecheck = filter(1, [1 -0.5], n == n(1)) + filter(1, [1 0.8], n == n(1));

figure();
subplot(2, 1, 1); stem(n, x, 'filled');
grid on; title("Original signal");
subplot(2, 1, 2); stem(n, doublecheck, 'filled');
grid on; title("Numerical verification");
```



### 4.3

```
n = 0:9; x = [0 0 2 3 3 3 3 3 3 3];
```

```

doublecheck = filter([0 0 2 1], [1 -1], n == n(1));

figure();
subplot(2, 1, 1); stem(n, x, 'filled');
grid on; title("Original signal");
subplot(2, 1, 2); stem(n, doublecheck, 'filled');
grid on; title("Numerical verification");

n = 0:9; x = 3 * 0.75.^n .* cos(0.3*pi*n) + 4 * 0.75.^n .* sin(0.3 * pi * n);
doublecheck = filter([3, 3*sin(0.3*pi) - 2.25*cos(0.3*pi)], [1, -1.5*cos(0.3*pi), 0.5625], n == n(1));

figure();
subplot(2, 1, 1); stem(n, x, 'filled');
grid on; title("Original signal");
subplot(2, 1, 2); stem(n, doublecheck, 'filled');
grid on; title("Numerical verification");

```

