

# hw03\_MATLAB

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## 59(a)

```
1      syms t n a;  
2      T = 4; % 周期  
3      w0 = 2 * pi / T; % 基本角频率  
4  
5      % 定义矩形波函数  
6      f_t = a * heaviside(t + 1) * heaviside(1 - t) + 0 * (heaviside(t  
          + 2) - heaviside(t - 1));  
7  
8      % 计算傅里叶系数  
9      Cn = (1 / T) * int(f_t * exp(-1i * n * w0 * t), t, -T/2, T/2);  
10     C0 = (1 / T) * int(f_t, t, -T/2, T/2);  
11  
12     % 替换参数 a 的具体值 (假设 a = 0.5)  
13     a_val = 0.5;  
14     Cn_val = subs(Cn, a, a_val);  
15     C0_val = subs(C0, a, a_val);  
16  
17     % 显示傅里叶系数的数值结果  
18     disp(['Cn: ', char(simplify(Cn_val))]);  
19     disp(['C0: ', char(simplify(C0_val))]);
```

Listing 1: 题 59(a)MATLAB 代码

Answer:

$$a_0 = \frac{1}{4}$$
$$a_n = \frac{\sin\left(\frac{n\pi}{2}\right)}{2n\pi}$$
$$b_n = 0$$

## 59(b)

```

1      syms t n m;
2      m = pi;
3      T = 2 * pi / m; % 信号的周期
4
5      % 定义原始信号
6      f_t = sin(m * t);
7
8      % 定义滤波器
9      filtered_f_t = (1/2) * (f_t + abs(f_t)); % 滤波器只保留信号的正
      值部分
10
11     % 计算滤波后信号的傅里叶系数
12     a0 = (2 / T) * int(filtered_f_t, t, 0, T/2); % 直流分量
13     an = (2 / T) * int(filtered_f_t * cos(n * 2 * pi / T * t), t, 0,
      T/2); % 正弦项系数
14     bn = (2 / T) * int(filtered_f_t * sin(n * 2 * pi / T * t), t, 0,
      T/2); % 余弦项系数
15
16     % 显示傅里叶系数的符号表达式
17     disp(['a0:', char(simplify(a0))]);
18     disp(['an:', char(simplify(an))]);
19     disp(['bn:', char(simplify(bn))]);

```

Listing 2: 题 59(b)MATLAB 代码

Answer:

$$a_0 = \frac{2}{\pi}$$

$$a_n = \begin{cases} 0 & n = -1 \vee n = 1 \\ -\frac{2 \cos\left(\frac{\pi n}{2}\right)^2}{\pi(n^2-1)} & n \neq -1 \wedge n \neq 1 \end{cases}$$

$$b_n = \begin{cases} \frac{1}{2} & n = 1 \\ -\frac{1}{2} & n = -1 \\ -\frac{\sin(\pi n)}{\pi(n^2-1)} & n \neq -1 \wedge n \neq 1 \end{cases}$$

## 61(1)

```

1      syms t w;
2      f_t = exp(-1i * w * t) * dirac(t - 2); %原信号
3      F_w = fourier(f_t, t, w); %计算傅里叶变换
4      F_w_simplified = simplify(F_w);

```

```
5 disp(F_w_simplified)
```

Listing 3: 题 61(1)MATLAB 代码

Answer:

$$\exp(-4iw)$$

## 61(2)

```
1 syms t w;
2 f_t = sign(2*t^2 - 4); % 定义函数 sgn(2t^2-4)
3 F_w = fourier(f_t, t, w); % 计算傅里叶变换
4 F_w_simplified = simplify(F_w);
5 disp(F_w_simplified)
```

Listing 4: 题 61(2)MATLAB 代码

Answer:

```
>> run hw03_61_2.m
fourier(sign(2*t^2 - 4), t, w)
```

Actually it doesn't satisfy the condition of Fourier Transform.

## 61(3)

```
1 syms t w;
2 f_t = exp(-5 * t) * heaviside(t + 2); % 定义函数 e^(-5t)*u(t+2)
3 F_w = fourier(f_t, t, w); % 计算傅里叶变换
4 F_w_simplified = simplify(F_w);
5 disp(F_w_simplified)
```

Listing 5: 题 61(3)MATLAB 代码

Answer:

$$\frac{\exp(10 + 2iw)}{5 + iw}$$

## 61(4)

```
1      syms t w;  
2  
3      ut_shifted = heaviside(t - 1); % t-1的单位阶跃函数  
4  
5      Fw = fourier(ut_shifted, t, w); % 计算傅里叶变换  
6  
7      Fw_simplified = simplify(Fw);  
8      disp(Fw_simplified)
```

Listing 6: 题 61(4)MATLAB 代码

Answer:

$$\pi \delta(w) - \frac{\exp(-iw) i}{w}$$