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课程编号 30217000101

**深 圳 大 学 实 验 报 告**

**课程名称：­ 信号与系统实验**

**实验名称： 一阶、二阶系统的幅频特性测试实验**

**学 院： 电子与信息工程学院**

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**实验地点： 致信楼N413**

**实验时间： 2024 年 6 月 13 日 星期 四**

**实验报告提交时间： 2024年6月27日**

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| **I. Experimental Objectives:**   1. Learn to use basic operational circuit units to build simple experimental systems. 2. Learn the methods for testing the frequency response of systems. 3. Understand the step response characteristics of first and second-order systems. |
| **II. Experimental Content:**   1. Build first and second-order experimental systems as required. 2. Test the frequency response and step response of first and second-order systems. |
| **III. Experimental Equipment:**   1. One ELF-BOX experimental box (main board). 2. One piece of linear system comprehensive design module. 3. One computer. 4. Several connecting wires. |
| **IV. Experimental Principles:**   1. Basic Operational Units   (1) Proportional Amplification    TL084  TL084  Figure 5-1 proportional amplification circuit  1) Reverse phase multiplier  From:  We have：  2) In-phase multipliers  From：  We have：  (2) Integrator and Differentiator    TL084  TL084  Figure 5-2 integral differential circuit1) Integrator:  by:  then：  2) Differentiator: by:  then：  (3) Adder    TL084  TL084  Figure 5-3 Adder circuit  1) Reverse adder  by：  2) Forward adder  by： then  2, N order system system    According to the zero state response (the starting state is zero), the Laplace transform is performed as follows:    Then its transfer function can be expressed as:    3, as a first-order system, generally can be expressed as:    First-order system is the basic unit of complex system. Learning the characteristics of first-order system is helpful to understand the characteristics of general system. The circuit provided for this experiment is shown in Figure 5-4.  TL084  Figure 5-4 first-level system analysis  Its transfer function is expressed as:    among  ,  Then the frequency response characteristics of the system are:    During the construction, the parameters of the components should be reasonably designed, and the parameters can be changed in the experiment, or other first-order network systems can be designed according to their transfer functions.  4. As a second-order system, it can generally be expressed as:    On the basis of the first-order system, it has another system pole. The circuit provided by this experiment is shown in Figure 5-5:    TL084  TL084  TL084  **8**  **10**  **9**  Figure 5-5 Second-level system analysis  Its transfer function is expressed as：  among  Compared with a standard second-order system:    则有：  is the undamped natural frequency, is the damping coefficient of the second-order system. By changing the resistance in Figure 5-5，The damping coefficient of the system can be changed.  During the construction, the parameters of the components should be reasonably designed, and the parameters can be changed in the experiment, or other second-order network systems can be designed according to their transfer functions. |
| **V. Experimental Steps:**   1. Frequency response test of the first-order system:   (1) Plug in the power cord of the ELF-BOX experiment box, turn on the power switch, and self-test the motherboard. Then connect the USB cable and install the software with the computer. Open the intelligent signal and system experiment platform software, connect the serial port, and plug the "linear system integrated experiment module" into the main board. Note that the module uses +12V, -12V and GND, so the power end should be facing the power hole on the left, as shown below. Make sure that the endpoint contact is good, click Stop scanning and start scanning, and the module will appear on the main interface of the software.  图2-2  **+12V**  **-12V**  **GND**  **-5V**  **+5V**  Figure 5-6 Power jack on the mainboard  (2) Figure 5-4 shows the recommended circuit. The parameters are as follows (you can select the component parameters according to the calculation) :,. According to the provided circuit and component parameters, build a first-order system circuit using a jumper. In order to avoid the voltage limit of the laboratory motherboard (0V-5V, outside the range will clipper), be careful not to connect pin 1 of the TL084 to any output port. TL084 on the module is a four-op amplifier, and the pin figure is shown as 5-7:TL084.jpg  Figure 5-7 Pipe layout of the TL084 four-transport pipe  (3) Signal source channel 1 is connected to input 1, select -12v +12V, and click POWER OFF to form POWER ON to make the connection effective. Special note: If the module connection error is found during the experiment, you must click POWER ON to POWER OFF, delete the + 12V-12V option, click reset, and reconnect the jumper circuit after the green connection on the main board of the experiment box disappears.  Figure 5-8 first-level system cable connection  Turn on the function signal generator so that it outputs a sinusoidal signal with a amplitude of 1 and a bias of 1V. Change the frequency of its input signal while keeping its amplitude constant. Channel 1 of the external oscilloscope is used to observe input 1 and channel 2 to observe output pin 1 of the TL084. The black clamps of the two oscilloscope wires are connected to the GND of the module. The amplitude-frequency and phase-frequency characteristics of the system are tested. Table 5-1 is complete.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 测试频率 | 幅频特性的测量 | | | 相频特性的测量 | | | f | 输入信号峰峰值Vpp1 | 输出信号峰峰值Vpp2 | 计算  |H(jw)|=Vpp2/Vpp1 | 相邻两个波峰之间的时间差△X | 计算相位差  α=△X·2πf | |  |  |  |  |  |  |   Table 5-1 Test lists of amplitude-frequency and phase-frequency characteristics of the system  (4) Change the input sinusoidal signal into a square wave signal and observe the step response of the system.  2. Frequency response test of second-order system.  Click POWER ON to turn POWER OFF, delete the + 12V-12V option, click reset, and reconnect the jumper circuit after the green connection on the main board of the experiment box disappears. (1) Recommended circuit parameters are as follows (component parameters can be selected according to calculation) :，。The parameters can be selected. They can be so on (Two of them change at the same time, change the corresponding parameters, the result will be different), according to the above parameters and circuits to build the circuit.  (2) One wave signal is generated from the function signal generator, the frequency is, p-p value is 2, and the step response of the system is observed with an oscilloscope. |
| Vi. Data record: 1. Frequency response test of first-order system：=105=1uF   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | f/Hz | 500 | 600 | 700 | 800 | 900 | 910 | 920 | | Vpp1(V) | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | | Vpp2(V) | 2.04 | 2.00 | 1.96 | 1.92 | 1.92 | 1.92 | 1.92 | | △X(ms) | 0.92 | 0.9 | 0.8 | 0.712 | 0.64 | 0.632 | 0.616 | |  | 2.89 | 3.40 | 3.52 | 3.58 | 3.62 | 3.61 | 3.56 | | f/Hz | 950 | 1000 | 1050 | 1100 | 1200 | 1400 | 1500 | | Vpp1 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | | Vpp2 | 1.88 | 1.88 | 1.84 | 1.84 | 1.76 | 1.60 | 1.60 | | △X(ms) | 0.60 | 0.592 | 0.568 | 0.536 | 0.504 | 0.44 | 0.424 | |  | 3.58 | 3.72 | 3.75 | 3.70 | 3.80 | 3.87 | 4.00 | | f/Hz | 1600 | 1800 | 2000 | 2300 | 2500 | 2800 | 3000 | | Vpp1 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | | Vpp2 | 1.56 | 1.48 | 1.40 | 1.36 | 1.28 | 1.20 | 1.12 | | △X(ms) | 0.376 | 0.352 | 0.316 | 0.284 | 0.268 | 0.248 | 0.224 | |  | 3.78 | 3.98 | 3.97 | 4.10 | 4.21 | 4.36 | 4.22 | | f/Hz | 3500 | 4000 | 5000 | | Vpp1 | 2.16 | 2.16 | 2.16 | | Vpp2 | 1.00 | 0.92 | 0.80 | | △X(ms) | 0.196 | 0.166 | 0.146 | |  | 4.31 | 4.17 | 4.58 |     Figure 9 First-order system square wave input response（3.3）  2. Frequency response test of second-order system：=0.047uF;   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | f/Hz | 20 | 50 | 100 | 110 | 120 | 130 | 140 | | Vpp1(V) | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | | Vpp2(V) | 2.12 | 2.08 | 2.08 | 2.04 | 2.00 | 2.00 | 1.96 | | △X(ms) | 0 | 0.72 | 0.8 | 0.72 | 0.72 | 0.64 | 0.72 | |  | 0.27 | 0.65 | 1.30 | 1.40 | 1.50 | 1.63 | 1.72 | | f/Hz | 150 | 160 | 170 | 180 | 190 | 200 | 250 | | Vpp1(V) | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | | Vpp2(V) | 1.88 | 1.84 | 1.80 | 1.76 | 1.76 | 1.76 | 1.60 | | △X(ms) | 0.72 | 0.56 | 0.68 | 0.6 | 0.6 | 0.6 | 0.6 | |  | 1.77 | 1.85 | 1.92 | 1.99 | 2.10 | 2.21 | 2.51 | | f/Hz | 280 | 300 | 500 | 600 | 800 | 1000 | 1200 | | Vpp1 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 | | Vpp2 | 1.52 | 1.44 | 1.00 | 0.84 | 0.72 | 0.56 | 0.52 | | △X(ms) | 0.56 | 0.56 | 0.5 | 0.42 | 0.36 | 0.3 | 0.28 | |  | 2.67 | 2.71 | 3.14 | 3.17 | 3.62 | 3.52 | 3.92 | | f/Hz | 1500 | 2000 | | Vpp1(V) | 2.16 | 2.16 | | Vpp2(V) | 0.40 | 0.28 | | △X(ms) | 0.24 | 0.2 | |  | 3.77 | 3.52 |   Square wave input response of second-order system  Data processing:  the amplitude-frequency and phase-frequency characteristic curves of the system when the input is sinusoidal signal  First-order system amplitude-frequency characteristics:    First-order system phase frequency characteristics:  Amplitude-frequency characteristics of second-order system:  Phase frequency characteristics of second-order system: |
| **VIII. Experimental Conclusions and Discussion:**  **conclusion：**   * + - 1. In the frequency response test of a first-order system, its amplitude response shows a rapid initial decline with increasing frequency, followed by a slower decrease, and finally approaches stability. According to the graph, its cutoff frequency is approximately 1.5 kHz.       2. Its phase response shows a stable increase with increasing frequency, stabilizing around 4-4.5 degrees.       3. In the frequency response test of a second-order system, its amplitude response exhibits a rapid initial decline with increasing frequency, followed by a slower decrease, and finally approaches stability. According to the graph, its cutoff frequency is approximately 200 Hz.       4. Its phase response shows a steady increase with increasing frequency.       5. Compared to a first-order system, a second-order system has a higher rate of amplitude response decline and a faster rise in phase response.       6. For a first-order system, when the input signal is a sine wave, the step response output signal is also a sine wave.       7. By observing the square wave step response of the first-order system and the second-order system, it can be seen that the response of the first-order system is more gentle, and the time period of reaching 1 is more. And second-order systems change faster |
| 指导教师批阅意见： |
| 成绩评定：   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **预习**  （20分） | **操作及记录**  （40分） | 数据处理  25分 | 结果与讨论  5分 | 思考题  10分 | **总分** | |  |  |  |  |  |  |   1、报告内的项目或内容设置，可根据实际情况加以调整和补充。 |