



PROTEUS ProTutor

Introducing Your Intelligent Lab Assistant

- ✓ Tutor Mode helps students to think, not just follow.
- ✓ Lesson Plan Mode supports structured projects.
- ✓ Understands your schematic and source code.
- ✓ Guides students with hints and probing questions.
- ✓ Ideal for fault-finding, and investigative learning.
- ✓ Helps students develop embedded code.

Filter Circuit Analysis

Can you help me with the component values, I want to make the knee steeper, thanks.

To make the filter's knee steeper (i.e., increase the roll-off rate), you can modify the design to create a higher-order filter. The current circuit appears to be a **two-stage active low-pass filter**, but the roll-off rate is limited to **-40 dB/decade** (second order). To achieve a steeper knee, you can:

- Increase the Order of the Filter:** Add more stages or reconfigure the existing stages to create a higher-order filter (e.g., fourth-order for -80 dB/decade).
- Adjust Component Values:** Optimize the resistor and capacitor values to sharpen the transition band.

Here's how you can modify the circuit:

Step 1: Convert to a Higher-Order Filter

The simplest way is to cascade additional filter stages. For example, you can add two more stages to create a fourth-order filter.

Step 2: Optimize Existing Stages

To sharpen the knee, you can adjust the component values in the current stages. Here's a suggestion:

First Stage (U1)

- Current: R1 = 9.31k, R2 = 10.1k, C1 = 3.3nF
- Suggested:
 - Reduce C1 to **2.2nF** (to shift the pole frequency higher).
 - Adjust R1 and R2 to maintain the same gain but with a sharper roll-off.

Second Stage (U2)

- Current: R3 = 8.45k, R4 = 12.4k, C4 = 5.6nF
- Suggested:
 - Reduce C4 to **3.3nF** (to match the first stage's pole frequency).
 - Adjust R3 and R4 accordingly.

Step 3: Add Additional Stages

If you want a fourth-order filter, add two more stages with similar configurations. Here's an example:

Third Stage (New)

- Use another op-amp (e.g., U3) with:
 - R5 = 10k, R6 = 10k, C5 = 2.2nF

Fourth Stage (New)

- Use another op-amp (e.g., U4) with:
 - R7 = 10k, R8 = 10k, C6 = 2.2nF

Step 4: Verify the Design

Simulate the modified circuit in Proteus using the Frequency Response graph to confirm the steeper roll-off. The cutoff frequency should remain consistent, but the transition band will be sharper.

Component Value Suggestions

Here's a summary of the suggested changes:

Suggested Component Changes

C1: Reduce capacitance to shift the pole frequency higher for a sharper roll-off.
C4: Match the pole frequency of the first stage for consistent filtering.
R1: Adjust resistor to maintain gain while sharpening the knee.
R2: Adjust resistor to maintain gain while sharpening the knee.

Component	Current Value	Suggested Value
C1	3.3n	2.2n
C4	5.6n	3.3n
R1	9.31k	10k
R2	10.1k	10k

Please review the suggested changes and, if you are happy with them...

Ask ProTutor about your design...

Deepseek-chat can make mistakes. Please check all suggestions carefully.

ROOT - Root sheet 1

“Just tell me the answer.”

“The motor isn't moving — what's wrong?”

“Good observation! Let's start by checking if the PWM pin is producing a signal. Have you looked at it on the oscilloscope?”

“Let's work through it together. What happens if the transistor doesn't turn on?”

“Why is this output stuck high?”

“Check the logic analyser for transitions. Could there be a missing pull-down resistor?”

“How should I control the fan speed?”

“This is a perfect case for PWM. Want a quick recap on how it works?”

“Can you give me a hint?”

“Of course — try checking the timing between the MCU output and the driver input. Do they match up?”

“What code do I need for the I2C sensor?”

“It's connected to PB6/PB7. Shall we review how to initialise the I2C peripheral first?”

“What am I supposed to do in this project?”

“Your goal is to find and fix the design fault. Start by observing the simulated output — what's unexpected?”

labcenter ELECTRONICS

Sample



“ProTutor transforms electronics education by guiding students through design, coding, and debugging with intelligent, context-aware support — promoting real understanding while reducing the teaching burden.”



PROTEUS ProTutor

"Teaches, not just tells"

Guided questions and hints encourage deeper learning.



"Understands your design"

Reads the circuit and simulation to give relevant help.



LESSON PLAN INTEGRATION

In Lesson Plan Mode, the teacher defines the learning objective — and ProTutor aligns its guidance accordingly. Whether students are expected to design, test, or debug, ProTutor reinforces the intended learning pathway. Educators append a short instructional prompt (e.g. "students must write a temperature control loop") and ProTutor responds in that context — nudging students to think and explore in the direction of the lesson.

Example:

"Nice start — now think about how you'd compare the sensor input to a target value. What kind of control structure might help here?"



CONTEXTUAL SUPPORT THAT BUILDS UNDERSTANDING

ProTutor acts as a knowledgeable lab assistant — not just giving answers, but helping students explore and understand. It sees the schematic, simulation instruments, and code, and responds with theory, hints, or next steps. It can explain an op-amp configuration, help tune an RC filter, or guide students through peripheral setup — all in the context of their own work.

Example:

"That's a good question. This looks like a low-pass filter — do you remember the formula for cutoff frequency? Try calculating it, and I'll check your answer."



DESIGNED FOR FAULT-FINDING EXERCISES

Lesson Plan Mode is ideal for discovery-based learning. Teachers can include deliberate faults in a design — like a missing pull-up or reversed diode — and ProTutor will help students uncover the issue through hints, probing questions, and measured guidance. Instead of giving it away, ProTutor builds confidence by helping students develop a methodical approach to testing and diagnosis.

Example:

"Have you checked the waveform on the sensor line? Do you notice anything missing after the MCU sends a request?"



CODING HELP THAT CONNECTS TO THE CIRCUIT

When students are ready to write embedded code, ProTutor supports them by explaining what's needed, based on how the microcontroller is wired in the schematic.

Instead of dropping in code, it walks them through concepts like PWM control, ADC setup, or I2C communication, helping them structure working code while learning how it fits the hardware.

Example:

"The motor is connected to PB1 — you'll want to use Timer1 for PWM. Shall we go over how to configure the timer registers for that?"

"Helps build real understanding"

Explains concepts step-by-step — not just the what, but the why.



"Like having a lab assistant on call"

Supportive, patient, and always available in class or at home.

Labcenter Electronics Ltd.

The Stables, Hartlington Hall Estate, Near Burnsall, N. Yorks, BD23 6BY, UK

Tel: (+44) 0 1756 753440

Web: www.labcenter.com, Email: info@labcenter.com

Labcenter YouTube Channel: <http://www.youtube.com/c/LabcenterElectronicsLtd>