

ELEC 3004 – Systems: Signals & Controls

Tutorial 0 (Week 2): A System's A-peer-ance

Overview

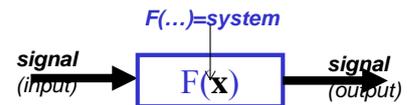
Today is to help introduce Systems and the peer-review process and good and bad forms of peer-review.

Reading

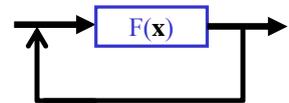
Colorado State University's "Using Student Peer Review" Guide –
<http://writing.colostate.edu/guides/teaching/peer/index.cfm>

Looking at Systems

Please look through lectures 1 and 2 (from Week 1). To note is the definition and relation of a **signal** and a **system** -- A **signal** is the data or information, whereas the **system** is the function or process on that signals. Signals can be seen as that which goes in and out of a system.



Signal Processing and **Feedback Controls** – can be viewed whether the entire ensemble is open loop or closed loop (i.e., the case where the output signal shapes the input signal). Thus, this class may be thought of as "Systems: (case) Open & Closed."



Introduction to Peer Review

We are student peer review to **increase the amount of feedback** students receive, provide diversity of feedback, and simultaneously reduce the delay in getting comments on their assignments.

Critical review skills are integral to engineering and very much part of the job. Indeed, this is a unique opportunity that you can highlight at a job interview (in Engineers Australia terminology this builds your "Analytical Skills competency"). Much like one learns music, the goal is to provide good comments towards a better solution. To goal of today is to help tune the collective ear.

Principles

Some things to consider when providing feedback:

1. *Excellence. Does this answer the question?*
Is the answer complete, yet succinct and insightful? A good answer should have an excellent signal to noise ratio. Good feedback should too. Please resist irrelevant discussion. That is, Don't repeat yourself.
2. *Clarity. Does it communicate the idea?*
Is it written effectively? The solution should provide details, be understandable, have clear comments and, of course, be technically correct. It should allow you to use the idea instead of inventing it again.
3. *Impartiality*
All submitted solutions must be treated equally and valued on their merits, irrespective of their origin.
4. *Transparency*
Decisions (particularly review scores) should be based on a solution rubric and/or course rules.
5. *Efficiency and speed*
Try to provide feedback as quickly as possible, for that is the point. You are allowed to add more feedback if you like later.
6. *Leadership*
Where possible, try to look beyond the rote answer and provide feedback on their process, trying to see past common errors.
7. *Confidentiality and Integrity*
Simply put, produce an earnest, quality review. Be honourable. You know what's "right." Just listen deep. The rules are in your subconscious.

It Helps You Be Better

Peer review is a communications tool. Communication is just plain hard, particularly written communication. How exactly do you get better at something that most engineers self-selected out of? Deliberate Practise.

Some other ways this helps:

- Alternative perspectives on the concepts at hand
- More rapid feedback and additional sources of information
- Leadership and active engagement in the learning process
- You get to building on prior knowledge and experience
- Multiple avenues and strategies for demonstrating knowledge/understanding in the subject.
- Logical presentation of the subject material

It's a System Too

Learning and assessments can be treated using Systems tools (of course). Let's look at two tools in linear system that might help understand the peer assessment dynamic:

Time Delay – This is the interval between the start an event in a system and its resulting action at another point the system. A pure delay, without attenuation, can be expressed as $F(s) = e^{-sT}$. When viewed in the frequency domain (a Bode diagram) this is a phase shift.

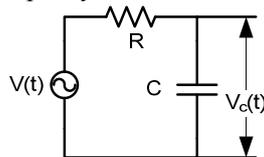
Information Gain – What is the expected value of the observed information, particularly as it pertains to the posterior mode. To what extent does the study influence your “belief” or understanding?

From this we can intuit that in the presence of delay, a greater look ahead is needed, but large gains might be destabilizing. In other words, a little bit of information now might be more stable than a large bolus of information delayed down the road. Thus, from a System's perspective, peer-feedback provides greater rapidity (via inherent parallelisation) and robustness to noise (via the number and diversity of participants).

An Example: Designing a Low-Pass RC Filter

Consider the following problem:

Question: We seek to design a low-pass filter circuit for a plain old-fashioned telephone system (POTS) line in which we want to remove the high frequency clicks of ADSL from voice conversations (typically in the 300 Hz to 3400 Hz range). Please specify a resistor and capacitor for this passive filter.



The problem is basically to select the resistor and capacitor. For the sake of discussion, image we have four answers (Distinction, Good, Weak and Incorrect). For each of these answers we have provided example of good and bad constructive feedback. This is illustrated in the following table.

A key feature of this problem is that there is no one distinct “correct” answer as there are two unknowns and one constraint. Good answers will try to tease this out, whereas poor answers will simply give values without consideration of their practicality or their effect on current draw, impedance, or other attributes of the circuit.

Good feedback will engage the answer and see if there are ways that it could be better so as to help them enhance understanding. It will also highlight features of the answer that has been done well. It can intellectually challenge the answer and encourage deep (intrinsic) rather than surface (extrinsic) approaches to the study of the material. A poor form of feedback is simply the value or a token remark. Pithy feedback that does not enhance learning, or worse, snide remarks are not constructive.

Distinction Answer

In this problem we have to determine a filter to remove unspecified, presumably ADSL, high frequency from the line. We recall that the cutoff frequency for an RC filter is $f_c = \frac{1}{2\pi RC}$, however this has an attenuation of 3dB or 30%. So, we nominally pick the cutoff to be around 10 kHz. There are two design variables (R and C) and one equation.

We pick $R=100\ \Omega$. A quick check (Macassey, "Understanding Telephones," *Ham Radio Magazine*, September 1985) shows that the nominal resistance for a phone line is $100\ \Omega$ and that if the resistance is too large that the phone might not function. Thus:

$$C = \frac{1}{2\pi R f_c} = \frac{1}{2\pi(100\Omega)(10E3Hz)} = 1.59E - 7F$$

A $0.159\mu F$ is not a single standard part. Switching to a $0.15\mu F$ capacitor instead gives 10.6kHz , which results in a 5% attenuation of frequencies at the 3400Hz range. This is one of many possible combinations. We note that even with two "standard 5% value" parts there are approximately 32k combinations of resistors and capacitors. Factoring the chosen cutoff frequency still gives 268 combinations between 9 and 11 kHz. The problem shows a single stage. Better filter performance can be had by higher order filters (more stages), but that this is beyond the scope of this question. Curiously, Wikipedia shows that the ADSL filter is multi-order set of passive components with ferrite cores (presumably for impedance matching).

Good Feedback

This answer gives a clear discussion of the filter's design and provides justification and references with consideration to the purpose. While it is good to not attenuate the voice channel, might a 10kHz cutoff frequency not be too high and thus allow more noise in? Near the end, the answer includes values without showing where they come from (e.g., number of combinations) there is also an incomplete citation to Wikipedia (which page). The reference to the HAM Radio Magazine is neat. Thanks!

Weak Feedback

The answer is complete, but perhaps too long. Why 10kHz and not 6.8KHz for the f_c ?

Good Answer

The cutoff frequency for an RC filter is given by $f_c = \frac{1}{2\pi RC}$. However this has an attenuation of 3dB or 30%, So, we nominally pick the cutoff to be around 5 kHz. There are two design variables (R and C) and one equation. We pick $R=100\Omega$ for convenience.

$$C = \frac{1}{2\pi R f_c} = \frac{1}{2\pi(100\Omega)(5E3Hz)} = 3.2E - 7F$$

The closest "standard" capacitor value to this is $0.33\ \mu F$.

Good Feedback

Correct. It would be better to justify where the cutoff frequency and resistance values came from. It's good that a standard value was selected.

Weak Feedback

Okay. Why not pick C instead? ☺

Weak Answer

For a low-pass filter $f_c = \frac{1}{2\pi RC} = 3400 \text{ Hz}$. We set $R=1\text{M}\Omega$. Solving for C gives 46.8 pF, which is approximately 47 pF.

Good Feedback

Correct! While the value is technically correct, there result is a circuit with two very large impedances (recall that $Z_{\text{cap}}=1/j\omega C$). The selection of values (f_c , R, etc.) are not explained. That the 47pF capacitor selected is a standard part is not explained and looks “lucky,” did you remember to check if the solution is easily implementable?

Weak Feedback

Correct!!!!
The resistor is too big and the capacitor is too small. May the force be with you. Thank you.

Incorrect Answer

We solve $f_c = \frac{1}{RC} = 3400 \text{ Hz}$. We set $R=1\text{M}\Omega$. We get $C=294.118 \text{ pF}$.

Good Feedback

It's an incorrect solution. Sorry!

It seems that the formula for the cutoff frequency was noted incorrectly and is missing the 2π term in the denominator. The correct formula is $f_c = \frac{1}{2\pi RC}$.

Additionally, it might help to try a higher cutoff frequency so as not to attenuate the high voice frequencies. Also, don't forget about “standard” resistor and capacitor values.

Thanks!

Weak Feedback

Wrong.