Learning to learn circuit analysis

B.J. Shrestha, Ph.D.
Dedication

- To my dad

- Professor Kalidas Shrestha

http://thehimalayantimes.com/entertainment/events/eminent-artist-kalidas-no/
acknowledgement – gratitude

- to many good people
- and
- good things
- -wait for the last slide
Circuit Analysis I and II

- EE 2100 & EE 2120
- Various laws and their applications
- Kirchhoff’s Current Law,
- Kirchhoff’s Voltage Law,
- Ohm’s Law, ….
- Full of laws and theorems – Too many if you ask the students
So, the \textbf{BIG} question is …

How do you

\textit{inspire}

or

\textit{help}

these students to learn all of these laws, theorems and their applications?
Such a BIG question!

So, what is the answer?
Perception about this course

- or perhaps
- many other courses ...
hard course – difficult to pass – dry, no fun ..

possibly, a weed-out course!
However, these challenges are pretty generic..

Many courses have similar challenges.

- My quest here is to bring forth innovative class dynamics to help create best practices to help our students learn the most.
my aspirations is driven by
- a desire which is perhaps common to many of you in many other courses
- to help our students learn the most
FOCUS of my PRESENTATION!
Learning techniques based on

- Thrills of Discovery
  - Enhanced Discovery Learning
    - example
    - KCL
    - (Kirchhoff’s Current Law – Gustav Kirchhoff)
How much is the current coming out?
Total current going in = (3+4) A = 7 A
Total current leaving = (5+ ?) A
So, ? =
Discovery

- now they know!

Total current going in = Total current leaving

\[ \sum I_{in} = \sum I_{out} \]

- without telling them, we helped them discover the famous KCL (Kirchhoff’s current law)
Discovery

- let them discover the rules, if possible
- try not to hand them down
- don’t give the formula right away,
- it’s tempting though
Learning techniques based on

Finding Pattern

- Pattern Recognition

- example -

- Ohm’s Law

- (George Simon Ohm)
Learning techniques based on Finding Pattern

<table>
<thead>
<tr>
<th># of observation</th>
<th>Voltage (V) volt</th>
<th>Current (I) milli amp</th>
<th>Is there any Pattern?</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0.5</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>4</td>
<td>1.0</td>
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</tr>
<tr>
<td>3</td>
<td>8</td>
<td>2.0</td>
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<tr>
<td>4</td>
<td>16</td>
<td>4.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Finding Pattern

<table>
<thead>
<tr>
<th># of observation</th>
<th>Voltage (V) volt</th>
<th>Current (I) milli amp</th>
<th>V/I (R) Kilo ohm</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0.5</td>
<td>4</td>
<td>Constant</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>1.0</td>
<td>4</td>
<td>Constant</td>
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<td>3</td>
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<td>4</td>
<td>16</td>
<td>4.0</td>
<td>4</td>
<td>Constant</td>
</tr>
</tbody>
</table>

\(V/I = \text{Constant for a fixed conductor}\)

Ohm’s Law
Learning techniques based on

- Finding Pattern

\[ \frac{V}{I} = \text{Constant for a fixed conductor} \]

- Ohm’s Law

  (George Simon Ohm)
Learning techniques based on

- Many Paths
  - One destination
    - example -
    - KVL/Divider Rules
    - MC/NV methods
Learning techniques (Many Paths)

\[ R_1 = 5 \Omega \]
\[ R_2 = 8 \Omega \]
\[ R_3 = 8 \Omega \]
\[ R_4 = 6 \Omega \]

\[ R_{\text{tot}} = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]
\[ I_{\text{tot}} = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]

\[ I_1 = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]
\[ \Delta V_1 = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]

\[ I_2 = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]
\[ \Delta V_2 = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]

\[ I_3 = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]
\[ \Delta V_3 = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]

\[ I_4 = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]
\[ \Delta V_4 = \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \]
Learning techniques (Many paths)

\[ R_1 = 5 \, \Omega \]
\[ R_2 = 8 \, \Omega \]
\[ R_3 = 8 \, \Omega \]
\[ R_4 = 6 \, \Omega \]
\[ V = 60 \, V \]

\[ R_{\text{tot}} = 15 \, \Omega \]
\[ I_{\text{tot}} = 4 \, \text{Amp} \]

\[ I_1 = 4 \, \text{Amp} \]
\[ \Delta V_1 = 20 \, V \]
\[ I_2 = 2 \, \text{Amp} \]
\[ \Delta V_2 = 16 \, V \]
\[ I_3 = 2 \, \text{Amp} \]
\[ \Delta V_3 = 16 \, V \]
\[ I_4 = 4 \, \text{Amp} \]
\[ \Delta V_4 = 24 \, V \]
Learning techniques based on

- Repetition & Reflection
  - Reinforcement of Knowledge
    - example -
      - Read, Recall, Review, Recap, Recite, Reflect, Repeat
        - (Wow – all the good R’s !)
Learning techniques based on

- Working under Pressure
  - Thrills of Challenge
    - example -
  - Solving a problem in a limited amount of time
Learning techniques based on

- Group Identity
  - Sense of pride
    - example -
Group activities – perform the task as a team
Learning techniques based on

- Enjoying
  - Element of Chance
    - Lottery Box
    - example -
Learning techniques based on

- Enjoying
  - The keyword here is “Enjoyment”
Learning techniques based on

- **Brain Storming**
  - Coming Together
    - example -
Learning techniques based on

- Playing Games
  - Even just the word triggers fun
    - strategies
    - example -
      - KCL
Learning techniques based on

- Playful Use of Phrases
  - Having fun with words & concepts
    - example -
    - Only the lonely – Use one source only when applying Superposition principle.
    - Diamonds are forever – when you eliminate sources, the diamonds stay, they can’t be killed.
Learning techniques based on

Playful Use of Phrases

- Having fun with words & concepts
  - example -

  - Let the kids go – Low Pass Filter.
  - Let the teens go – Band Pass Filter.
  - Let the adults go – High Pass Filter.
Learning techniques based on

- Judgement
  - Engineer’s eye balling
    - example -
  - Common sense
Learning techniques based on

- Examples of road crossing, roundabouts
  - Circuit networks, nodes, loops, path to avoid, etc
Learning techniques based on

- Are we done?
  - Not done listing yet
  - Open ended possibilities
Learning techniques based on...
Once again back to the same issue, this course is a requirement … (!)

- Now that

- triggers negative emotions

- unless ..

- something is done to change their perception
So far, the perception is that the course catalog has required them to take the course but denied the joys of engagement, not on purpose, but ...

that is the crux of the problem!
Need -

* a new **pedagogical approach** to involve students actively in the teaching – learning process

* reward them for their initiative and involvement

* give them a venue where genuine conversation takes place

* guide them to discover the connecting dots of their endeavor to their desired goals
A P A T H Y

Solution

- Engage the students
- Help them realize the relevance of the course
- Have them connect the dots .... ..... ....
- Give them a direction but let them find it
- Reward their discovery of the connection
Empower

- Empower them by awarding their leadership and involvement.

But first,

Let them see how this course is relevant to their chosen field of study ...
What they feel right now is

Chained to some unpleasant course ...

Disconnect ...

Dissatisfaction ...

Powerless ...

Unmotivated ...
Calibrated peer-instruction

Students learn more when they have to teach others what they have learned

Circle of learning process – knowledge, articulation, and implementation
Problem based learning

- teams are formed of students
- they are handed pre-assigned list of problems/tasks
- following a schedule, they take turns to teach peers in the team about how to solve a problem
- explore alternate paths to solve the problem and weigh pros and cons
- they receive points for such an activity
Way out – Wikis on the go

Facebook, Twitter generation:

- Social media – comfort zones for the bulk of our students

- Use this techno-savvy culture to increase the engagement effectively in the class room

- Students are asked to post course related assigned topic as a wiki post within the “Blackboard” where their peers are encouraged to comment on each other’s work

- They receive points based on their activity
– enhanced exchange of ideas – horizontally across peers besides vertically with the professor

* Getting them do the tasks they are socially more comfortable doing is the key!

* Students do better when they feel emotionally and intellectually safe – this gets everyone on the bus.
* wikis have become a place where the students can really show off and they love it

* encouraged to add graphics, audio/videos clips to enhance the presentation

* instills the sense of being techno-savvy – builds confidence

* encourage students to examine case studies where they investigate how the circuit theory they are learning in the class is applied to solve a real life problem, for example, “Using resistance to measure the strain”, etc.

* They receive points for presenting these cases
Occasional “Jeopardy–like:” game playing can provide additional intensity in the engagement process

* Students feel more energized in the face of the idea of a game

* Study sounds burdensome and tiring while the words “game” or “playing” bring out all of the positive emotions

* Trick is to transform a study session into a game–like activity without losing its core values

* learning occurs without having to carry a burden of chore.
Way out –
Old tools of the trade

- combine new technology with old tools of the trade

* regular exam and final exam – traditional tools – don’t eradicate them, balance them with the new set of activities

* another problem – decline in attendance

* Allocate attendance points (less than 10% of the total)

* Notion of “Just showing up to the class bring some points” does a good trick
Way out – 
Striking a balance

* Good balance – key to success

* Overall grade distribution is spread over various parts of the methodology to keep a good balance
Change the hype behind the notion of homework assignment

* a homework is not done when you calculate the answers, not yet..

* it is done when you go back and see if the answer makes sense, if the little pieces fit the big picture ...

when it does, it ceases to be a work, it becomes a pleasure
The trick is to make homework assignment not feel as a chore.

A chore takes all the fun away ...

Make it feel like anything but work ...
Methodology

1. Calibrated peer instruction
2. Wikis on the go
3. Learning by playing
4. Old tools of the trade
5. Striking a balance
Learning outcomes

- students when trusted and allowed to explore tend to engage in the learning process

- The methodology described here is pragmatic and is transformational in nature
Get Ready for engagement & excitement

Excitement builds expectation and engagement helps us meet them
Use technology as a great tool to reach out, to excite, to empower to let them feel .. that they’ve got it

help’em build their confidence
• Use wiki posts

• Use tutorial sites or build one

• I built one for circuit analysis
Welcome to drshrestha.us.

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Research Interests:
Photon transport in semiconductors, Statistical Physics, Monte Carlo Techniques, Neutral particle transport algorithm development, Neutronics and Photonics, Medical applications, Computer vision and Image processing, Feature extraction and Identification
Use gadgets

- interactive white boards
- iPhones
- iPads
- video podcasts
- use music, as appropriate
- use interactive exercise

- be prepared to learn yourself as you “go”
Knowing where we stand

Belief in limitations – blocks

Logical block
Emotional block
Moral block

We build expectations and meet them by breaking these blocks.
Society constantly pulse suggestions about our capabilities, and these suggestions underestimate what we can be.

Belief in limits creates limited people. We can fly, but that cocoon has to go.
Many of the strands that bind us are unconscious suggestions.

From the moment we are born we begin to pick up suggestions from those around us on how to act and what we should be like.
blocks ..

- we have to overcome our preconceived ideas about the limitations of our personality and abilities
Three big rocks or .. blocks
Three Big Blocks

- Logical Block
- Emotional Block
- Ethical Block
The logical block

– “it’s not for me, I could never do it because I’ve never done it”

– some people are skeptical to try anything new
The emotional block

- someone might have said at some point, “You certainly are hopeless at Mathematics”.

- this negative suggestion may have been accepted at face value by a student who then proves it to be true.
The ethical block

- many people are conditioned to feel that learning has to be hard work, drudgery, and painful.

- in fact, gaining knowledge is quite joyful.
Life should be a stream of happiness and yet the lives of many people are full of fears, fear creates tensions and poisons the climate of one’s life.

Many of us are victims of methods of education.
Joy in learning is a basic tenet of a good learning system.
Joys of learning

- small children have this joy naturally; if they didn’t they would never learn to walk, talk or feed themselves.
Useful rules

1. Meaningful
2. Efficacy
3. Support
4. Group work
5. Positive Relationships
6. Mastery of materials
Meaningful

- Students need to feel the learning activity to be meaningful for them, if not, they might not engage in a satisfactory way.
Efficacy

- "Can I do this?"

- to help foster students' sense of efficacy in learning activities, encourage them and provide feedback that helps them make progress.
Support

Welcome students' opinions and ideas into the flow of the activity
Group work

- When students work effectively with others, their engagement is consequently amplified, mostly due to experiencing a sense of connection to others during the activities.
Positive Relationships

- Positive teacher–student and student–student relationships are key factors in enhancing student engagement.
- Builds trust and a sense of comfort.
Mastery of the material

- When students pursue an activity because they want to learn and understand, their engagement is more likely to be full and thorough.
about your students ..

- let them show off – wiki posts
- let them be peer models
- let them lead – at times
Let them grow – naturally!
at the end..

- it’s the ...
- joys of teaching
- helping the students succeed
- hopefully, helping create a better world

- Bring it home
Bring it home!
Get Ready to Celebrate!

Learn more by teaching
Mathematical modeling

- Student’s initial attitude – state function
  \[ |s_{\text{initial}} \rangle = |s_i \rangle \] (A.1)

- Educator – agent of change – Operator
  \[ \tilde{O} |s_{\text{initial}} \rangle = |s_{\text{final}} \rangle \] (A.2)

- Representation
  \[ \{ s_{\text{final}} \mid \tilde{O} \mid s_{\text{initial}} \} = \{ s_f \mid \tilde{O} \mid s_i \} = T_{if} \beta_{if} \] (A.3)

  - \[ \beta_{if} = 0 \text{ for } i = f \text{ and } \beta_{if} = 1 \text{ for } i \neq f \] (A.4)

- Incremental transformation
  \[ T_{if} = T_{ia} + T_{ab} + T_{bc} + \ldots \ldots + T_{zf} = \sum T_{jk} \] (A.5)

- \[ |s_p \rangle = \sum c_n \left[ |s_i \rangle \right]^n \] (A.6)
Mathematical Modeling
Mathematical Modeling
An attitude of a student can be represented by a state function (a mathematical function that represents the state), $|s_{\text{initial}}\rangle$ or $|s_{i}\rangle$, in short, which may be dependent on host of other parameters, such as educational background, $e$ (in short for educational), cultural background, $c$, incentives, $i$, perception, $p$ etc.
In other words, once the attitude $|s_i\rangle$ is operated by the operator, $\mathcal{O}$, it changes the attitude $|s_i\rangle$ to an attitude $|s_f\rangle$. Such a transformation may be expressed mathematically by a transformation function, $T_{if}$, as given by, equation (1) below:
Mathematical Modeling

\[ T_{if} = \{ s_f \mid \bar{O} | s_i \}, \ i \neq f, \ \beta_{if} = 1 \]  \hspace{1cm} (1)
Mathematical Modeling
Our desire here is to realize that equation (1) captures our aspiration as an educator, meaning that the agent of change, Ō. will transform $s_i$ to the desired $s_f$. Here, we also see a new parameter, $\beta_{if}$.
The construct of a meaningful $T_{if}$ for an existing set of parameters $\{e,c,i,p, \ldots \}$ is the ultimate goal to effect the desired change.

From the eyes of a traditional sit-in class, the $T_{if}$ required in an online class involves a different trajectory.

It really needs a shift in the paradigm
To recap
Mathematical Modeling

- Student’s initial attitude – state function
  \[ |s_{\text{initial}} \rangle = |s_i \rangle \] (A.1)

- Educator – agent of change – Operator
  \[ \tilde{O} |s_{\text{initial}} \rangle = |s_{\text{final}} \rangle \] (A.2)

- Representation
  \[ \{ s_{\text{final}} | \tilde{O} |s_{\text{initial}} \rangle = \{ s_f | \tilde{O} |s_i \rangle = T_{if} \beta_{if} \] (A.3)

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- Incremental transformation
  \[ T_{if} = T_{ia} + T_{ab} + T_{bc} + \ldots + T_{zf} = \sum T_{jk} \] (A.5)

\[ |s_p \rangle = \sum c_n [|s_i \rangle]^n \] (A.6)
Mathematical Modeling
Some advice to the students

- Enjoy the learning process
- Know that there may be more than one way to solve a problem
- Articulate your ideas without worrying if someone would ridicule it
- When you teach someone how to solve a problem, you do two things at one time – earn a great friend and reinforce your own knowledge.
ALTERNATIVE LEARNING:
How one S&T professor is encouraging students and helping them succeed through an alternative lecture style

Jocelyn Esparra
News Writer

Learning and succeeding at Missouri S&T can be wrought with many tough obstacles. Students, especially those in engineering disciplines, have to learn mostly in a standard classroom. Listening to a lecture, about topics that may actually be better learned in more of a hands-on approach. With the exception of labs and seminars, too few classes stray away from the style of a classroom setting. Students will come into class, take notes on a teacher’s demonstration or lecture, and study on their own, trying to commit them to memory. Dr. Shrestha’s classroom is not this typical lecture-style setting. Last Friday, I was invited to sit in and observe his circuit analysis class. Here, I was able to experience firsthand his different teaching method, combining his lectures with a holistic group-learning environment. Students are actively involved in the lecture, not just sitting idly watching him teach. Dr. Shrestha writes problems on the board, with students broken into assigned groups, solving their problems and writing on them on a board to compare answers with their peers. A healthy dose of public display spurs competitiveness with the students, and encourages more active learning. If a group member knows the answer before their peers, they are allowed to write the answer on the board, and are encouraged to share their knowledge to teach their classmates. Being able to sit in, I was able to experience the relaxed environment, where peers felt no discomfort, and the sharing of knowledge was abundant.

Dr. Shrestha is an Associate Teaching Professor in the Department of Electrical and Computer Engineering, having received his Bachelor’s and Master’s in Science from Tribhuvan University in Nepal. He
LEARNING cont.

Today

Enjoy the learning process keep an eye to find more the one way to solve a problem articulate your ideas without any fear whether they would be ridiculed by your peers.

“She’s got goals” with goals that she should accomplish for the and a piece of advice that he mattered for last particular period. When I asked Dr. Stites what advice he would give his

St. Pat’s preparations well underway with only

Steve Rusakiewicz
News Writer

With February drawing to a close, many students on campus have turned their attention to the weekend festivities that await them during the famous St. Pat’s Celebration here at Missouri S&T. The festival itself is only 10 days, but the planning goes on all year long in order to ensure that every St. Pat’s Festival put on by the board is the “best ever St. Pat’s.”

The planning for the festival involves about 30 student board members and around 10 faculty from various departments who are responsible for execution of the festival’s main functions and activities. This is a significant reduction in manpower from the 70-80 members who would plan without a hitch during the 30-day event.

The membership within the St. Pat’s board is described by Jason Pelliccione as, “a melting pot between independents, Greek their sponsorships. Overall, the membership of the board is diverse as the interpretations the festivities themselves.

When generally asked what I mean to them, student

responsible with an array interpretation ranging from St.

“letting go steam.”

“getting absolute

to “all of the

life members, and the General
The Missouri Miner
February 30, 2015

February 30, 2015

Rentals. I encourage them to see the pictures, not the words. If there is more than one approach to solving a problem, usually there is. I have been teaching most of my life, and I am very humbled by the opportunity to teach my students, it is my chance of having the world a little better in their hands.

One of my favorite aspects of sitting in a chair is what he had written on the board. He had many notes and problems, but two sections stood out. He had written "Goals for Today" and "Advice" with goals that students should accomplish for the day, and a piece of advice that he felt mattered for that particular class period. When I asked Dr. Sherrit what advice he would give his students, he responded with the following advice. "Enjoy the learning process, keep an eye to find more than one way to solve a problem, articulate your ideas without any fear whether they would be ridiculed by your peers."

"Advice" with goals that students should accomplish for the day, and a piece of advice that he felt mattered for that particular class period. When I asked Dr. Sherrit what advice he would give his students, he responded with the following advice. "Enjoy the learning process, keep an eye to find more than one way to solve a problem, articulate your ideas without any fear whether they would be ridiculed by your peers."

Operations were underway with only two weeks to go without a hitch during the 10-day event. The membership within the St. Pat's board is described by Jason Pelliciceto as, "a melting pot between Independents, Greek Life members, and the General Assembly and competition between celebrations is the development of deeper ties between friends, colleagues and faculty."

Considering the multidisciplinary makeup of the St. Pat's Board, as well as the monumental project they are responsible for directing every year along with the incredible opportunities that exist in the areas of publications and professional networking, any student who applies themselves diligently to this team of dedicated people will no doubt find themselves personally and professionally better off for the experience. This circumstance being held evident, students who are able to put the time into St. Pat's are certainly encouraged to do so. Aside from being an integral part of a century-long tradition of celebrations and friend-
Acknowledgement – gratitude

- My students from past and present
- Wonderful staff – Ed Tech (S&T)
- Shutterstock – video clips
- My better half – Puja Shrestha
- My parents, family, and friends
Any question?