Flipped Teaching and Flexible Learning

Mira Peter
&
Elaine Khoo
First year Introduction to electronics engineering

Conceptually challenging

~150 students

2 lecturers (analog & digital)
6 weeks each

1 2hr face-to-face tutorial

1 lab/week

2-3 lab demonstrators
“In each academic discipline, there exist special concepts—threshold concepts—that once grasped, reveal new and previously inaccessible ways of thinking about a subject”.

(Meyer & Land, 2003)
TC ARE:

TRANSFORMATIVE: we are (become) what we know
TC ARE:

**IRREVERSIBLE**: difficult to unlearn

(learners cannot return to previous view of the world)
INTEGRATIVE: cohere key aspects of the subject
(reveal hidden inter-relatedness & connections between apparently disparate information)

Thevenin's theorem

Dynamic Resistance
TC ARE:

BOUNDDED: delineate a particular conceptual space (serving a specific and limited purpose)

BUT...
TC ARE:

TROUBLESOME! counter-intuitive, difficult to learn,

AND...
STUDENTS GET STUCK!
How can lecturers help students to transition... from being stuck... to mastering TCs
2012: De-clutter the curriculum

Thevenin's Theorem & Dynamic Resistance

TCs to KEEP
<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>∗</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>∗</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>∗</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>∗</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>∗</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>∗</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

**Total:** 32
What is the Thévenin equivalent resistance of this circuit?

**Select an Answer**
- 2290 Ohms
- 2300 Ohms
- 3200 Ohms
- 3300 Ohms

**Reason for your Answer**

Please give a reason for your answer...

---

**Resource Links**

Need some help? Try these links...

**Section Links**
- Hyperphysics - Current Law

**General Links**
- Hyperphysics
- Electronic-Tutorials.ws
- All About Circuits
- Electronics Club
- MIT Electronics Videos
Since summer 2014...
FLIPPED CLASS

A move away from traditional teaching

Move away from using class time for lecturing

Engage with new class material for the first time outside of class

Part/all of instruction through videos/other media

Class time is used for the harder work of assimilating and applying that knowledge

Class time becomes dynamic, interactive learning environment
Flipped class

In-class time is “re-purposed” for inquiry, application, and assessment

Students gain responsibility for their learning (studying course material outside of class)

Instructors = facilitators of the learning process, guides students to apply concepts and engage creatively in the subject matter

Goal = to cultivate deeper, richer active learning

Emphasis is on higher-order thinking skills and application to complex problems (through collaborative learning, case-based learning, peer instruction, problem-based learning, debates)
Looked at (what makes) good videos (e.g., coherence, redundancy, spatial & temporal contiguity)

Recorded or borrowed ~60 videos @ ~8 minutes each (3 months learning, planning, recording, watching YouTube)
CYCLE 2

Monitored student video watching

Lecturer 1 - Lightboard based videos

Lecturer 2 - Panopto lecture videos

Continuous assessment

Revised problem solving questions
Week 4 – Worksheet – Rectifier Design
(Definitely worth doing in your lab book.)

The video at [https://www.youtube.com/watch?v=cyhzpFqXwdA](https://www.youtube.com/watch?v=cyhzpFqXwdA) ("Diode Tutorial & How to build an AC to DC power supply", called "To-the-point diode/rectifier tutorial" on Moodle) has a great description of the simplest rectifiers and unregulated power supply circuits. It is NOT a good example of design, because it does not explain how to calculate the best values for components.

Design is the most important mental capacity for professionals. In this work sheet you will work in pairs to consider some design aspects of the rectifier circuit—how to calculate values before you build a circuit. We will consider the half-wave rectifier circuit that uses a single silicon diode. Your lab book might look like this as you proceed with this worksheet:

Example given

a) Draw a half-wave rectifier circuit, namely a voltage source, a diode, and a load resistor; no capacitor for now.
b) Sketch about 2 cycles of a 6 V_RMS AC waveform on a full-page set of axes. In NZ, the frequency is 50 Hz, so you want the x-axis to be about 40–50ms long. You will add various traces to this graph.
c) Using the common "constant-voltage+switch model" of the diode, sketch the voltage you would expect to measure across a 1kΩ load resistor (without a capacitor) connected to the circuit. Remember that the forward voltage of a silicon diode is about 0.7V, as you will measure in the lab this week.
d) Sketch the current you expect will be flowing in the loop.
e) Consider an RC circuit consisting of 1kΩ // 2.2μF; what will be the exponential decay time constant for this circuit? If the capacitor started out charged to +10V, what would the capacitor voltage look like over time? Make a little sketch this, and put scales on your sketch.
f) Now consider the rectifier circuit 1kΩ // 2.2μF connected. Sketch what you would expect to measure across the load resistor with the capacitor in parallel with the load resistor. Which parts of the waveform are "sine wave" shape, and which are "exponential" shape? Mark these on your plot.

So far everything you have done here is pretty much like the stuff in the video above.

Now we address the design question: *If it is important that the voltage across the resistor never falls below 6.5 V, how large a capacitor will be needed in the circuit?*
CYCLE 3

Revised problem solving questions

Monitored student video watching (stricter)

Lecturer 2 purpose-made videos

Are steps a problem?

Not for sound as
i) speakers will not operate fast enough to follow steps so sound coming out is a smoothed version of the steps
ii) your ears can’t hear above 20 kHz (can’t sense the steps)
THE CLASS

2015, Sem. A -> PARTIAL FLIP (3 weeks) lecturer-created videos; + group problem solving activities

2015, Sem. T -> FULLY FLIPPED - 50% lecturer-created videos; + problem solving + continuous assessment

2016, Sem. A -> FULLY FLIPPED - 100% lecturer-created videos +, +

2016, Sem. T -> FULLY FLIPPED - 100% lecturer-created videos +, +

2017, Sem. A -> FULLY FLIPPED - 100% lecturer-created videos +, +
What the Flipped Class Looked Like

3/week x 50 min. lectures replaced by videos

Lecture slot allocated for group problem-solving activities

Labs = 3 hours; in-class mini-lectures

Continuous assessment; extra tutorials on demand
Practical labs
VIDEO VIEWING

2016 A

2017 A

Session (top 100 by minutes viewed)

<table>
<thead>
<tr>
<th>Session</th>
<th>Views</th>
<th>Minutes Viewed</th>
<th>Average Minutes Viewed</th>
<th>Unique Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thevenin_Equivalent_Circuit_and_Measuring_It (default)</td>
<td>780</td>
<td>4341</td>
<td>6</td>
<td>282</td>
</tr>
<tr>
<td>Handling_Cap_in_circuits_with_DC_Sources_and_Resistors (default)</td>
<td>575</td>
<td>4167</td>
<td>8</td>
<td>246</td>
</tr>
<tr>
<td>Qualitative_Lighbulb_Circuit_Examples (default)</td>
<td>506</td>
<td>3572</td>
<td>8</td>
<td>257</td>
</tr>
<tr>
<td>Intro_and_Example_of_Superposition (default)</td>
<td>633</td>
<td>3463</td>
<td>6</td>
<td>268</td>
</tr>
<tr>
<td>Reducing_a_Circuit_Using_Series_and_Parallel_Formulae (default)</td>
<td>639</td>
<td>3370</td>
<td>6</td>
<td>287</td>
</tr>
<tr>
<td>DC_AC_and_RMS_what_and_why (default)</td>
<td>516</td>
<td>3200</td>
<td>7</td>
<td>269</td>
</tr>
<tr>
<td>Diode_Small_Signal_Equivalent_Circuit_Calculations (default)</td>
<td>400</td>
<td>2964</td>
<td>8</td>
<td>189</td>
</tr>
</tbody>
</table>
VALUE OF VIDEOS?

- Helped to learn key concepts
- Videos well targeted to students
- Easy to review ideas
- Videos provided a good overview
- Learning at own pace
- Learning in own time
- Easy access

Percentage of students (%)
VALUE OF GROUP WORK?

- Better understanding of concepts covered in videos
- Finding what I do and don’t understand
- Explaining what I know/understand
- Practicing team work skills
- Learning how to apply the knowledge in real life
- Other

Percentage of students (%)
How helpful continuous assessment?

- Very much: 48%
- Somewhat: 40%
- Not at all: 7%
Flipped vs Traditional

- Strongly prefer flipped: 12%
- Prefer flipped: 15%
- No preference: 16%
- Prefer traditional lectures: 20%
- Strongly prefer traditional lectures: 37%
Lecturers’ Reflections

Lecturers liked flipping the class!

Students were more engaged and seemed to enjoy the paper more as a result of flipping.

Frequent tests were good - students had to keep up to date.

Students need guidance on the order of lecturer purpose-made videos to watch (they seemed a bit overwhelmed by the number of video clips available).

Problem solving worked well - students found some of it a bit challenging, but they help to complement the lectures.
VIDEOS: WHAT WE LEARNT

Expensive facilities/equipment are **not** required

Time and practice **are** important

Pre and post-production **are** important
IMPLICATIONS

CURRICULUM
Refine course content and structure
Ensure coherence of overall course design
Make incremental changes

PEDAGOGY
Short, educationally good quality videos are essential
Variety of learning supports
Changing lecturer role
IMPLICATIONS

ASSESSMENT

Continuous assessment

STUDENT LEARNING

Changing student role
Learning technical and non-technical skills

INSTITUTIONAL SUPPORT

Interdisciplinary collaboration
Time and incentive for lecturers
**FLIPPED CLASS**

- **Concept Exploration**
  - Video/audio recordings,
  - Content rich websites,
  - Simulations, Readings etc

- **Demonstration/Application**
  - Personalised projects,
  - Problem based learning,
  - Experiments, Presentations,
  - Role plays etc

- **Meaning making**
  - Reflective podcast (students),
  - Quizzes, Blogging,
  - Online discussions

- University of Queensland,