YOUR GUIDE TO INELEC

A product of Personal Experience

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Introduction

Throughout the years, I have encountered countless people trying their best to get through some challenging courses in our institute yet keep failing despite their best efforts. Naturally, they often wonder how others managed to tackle such subjects. The answer can't simply be pure effort. And in most cases, it isn't just a question of pulling more effort, neither is it a question of pure talent or intelligence. There are some exceptions, but I believe that students who manage to get into INELEC and possess the will power and motivation to pull enough effort can get through its subjects if only they knew what exactly to study, why they're studying it and How to study it.

This little booklet will go through each subject of the six license degree semesters of the "Institute of Electrical and Electronics Engineering" Ex-INELEC. And each section will be divided to the following parts:

Why?

In this part, I will attempt to answer a question that is commonly ignored by most teachers and students, which is the reason behind learning a specific subject. Sometimes things you learn just seem pointless and arbitrary with no practical use. And I know how demotivating it could be to feel as if all you're doing is memorizing and learning things you'll never use. However, I would argue that almost all subjects you'll encounter have something to offer you in terms of skills and ideas that help you understand many complex practical engineering systems. Many subjects seem as if they're pointless at first glance especially in the first semesters yet, by introducing the bigger picture you can see where those subjects fit in.

What?

It is unreasonable to expect any person to just remember and understand every single part of every module and be able to recall such knowledge for many years to come. Yet there are some essential skills and ideas that you need to understand in every module that might be helpful in getting through its exam or even practical knowledge that can be built upon to acquire practical skills in your career.

The "Skills you need to have" written in **Bold** can be used as a checklist to revise for exams. They are not EVERYTHING you need to know, but it's a very good starting point.

How?

What is expected of a university student is very different than what is expected from a high school student. As an adult you must take full responsibility of your own learning. Don't rely on teachers seeking your own self-interest for you. Lectures, recitations, and lab sessions on their own are rarely sufficient. And each subject has its own ways of getting through it. Some subjects can be learnt just by purely doing a million exercises, but such strategy can be disastrous in other subjects. So, in this section I will try to show the techniques tips and methods I used to get through each module hoping that it might prove useful to you.

Difficulty rating

At the end of 2019/2020 school year, we have done a survey in which 176 participants voted on the difficulty of each module individually and the average is given here over 10. By 10 being the hardest and 0 the easiest. It's just a general estimate that's all. Don't feel bad if you find a low rated module difficult it's fine, it happens to all of us.

Affiliated Specialty:

Most people don't have a Masters specialty in mind early on, but I think that most people are more inclined towards some specialties more than others. Therefore, it's always a good thing to know approximately which modules are necessary for the specialties you like the most. It's very difficult to be a jack of all trades and we all have to specialize eventually even within the Masters specialties themselves. So, the more focused you are on one specialty the better.

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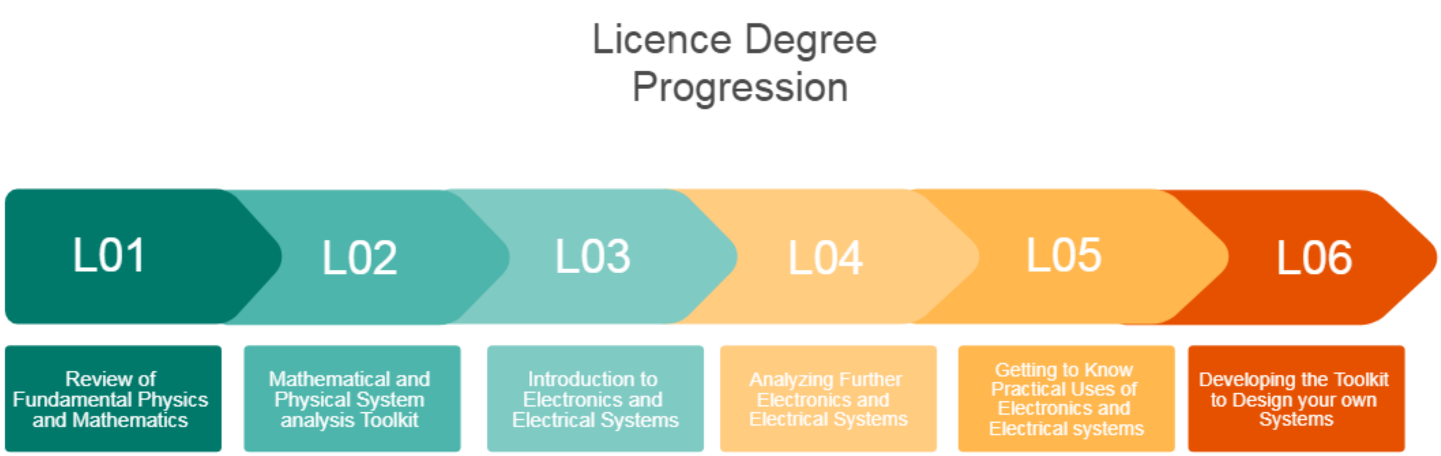


For detailed official information refer to:

http://igee.univ-boumerdes.dz/LMD/Program/Licence.pdf

Chapter 1: First year

Well, first of all, congratulations to getting into our nice little institute. There are many advantages to studying here, a more focused program, English (which is probably why you chose this), many great teachers, and many interesting opportunities for the more ambitious among you. But the journey you are about to take isn't going to be an easy one. It's a long road full of sleepless nights, stressful tests, and frustrating results. But in my humble opinion I think the final result is ultimately rewarding. I personally feel as if I learned a lot. It's a wonderful feeling to have skills and understanding and look back at things you once though were terrifying and see them as trivial. But you need to take up the responsibility of building up your own engineering skillset and not simply count on the institute's program to do it for you.

First year is, simply put, a warm up. I don't mean to discourage you if it seems challenging to you at first but it does get more and more challenging. So, use your first year wisely in developing good studying techniques, strategies, and habits. Since being disorganized will surely make you feel overwhelmed by the time you get to the next years. Alright let's begin with the subjects.

EL 103: English 1-2:

Difficulty Rating: depends on group

Why?

I don't think much can be said about how important English is that you didn't hear before. Afterall, the courses in this institute are though in English. English gives you a significant advantage in both the domestic and foreign job markets. It also gives you access to countless learning material on the internet on any topic you want.

What?

English is taught in four different modules: Listening and speaking, Reading and writing, Grammar, and English for science and technology. The content you learn usually differs by group and teacher, but if you're already decent in English then you should be just fine. Just try to improve your speaking, and gain a more technical vocabulary

How?

How to learn English for general use is a very difficult thing to answer. But when it comes to studying in English, you should read a bit of engineering related articles, and mathematical texts, and watch simple YouTube videos about it to develop your technical vocabulary and learn the terminology. It’s just terrible to lose track of a lecture simply because a word the teacher used confused you.

EE171: Mathematics I (Calculus I):

Difficulty Rating: 6.13/10

Affiliated Specialty: All of them

Why?

Engineering without math is just guess work. Math is a very powerful design, troubleshooting and optimization tool. Yes, it’s pain to get through with a lot of unnecessary detail or at least it seems like it. But it’s an investment. Math skills are hard to learn but once learnt they make so many problems much easier to deal with. Calculus I is the bread and butter of Engineering so try to get at least the fundamentals right.

What?

Calculus I in particular is not a very exciting module. It starts with what a function is and the types of functions there are, then gets to limits and proving them with the annoying delta-epsilon method (if you don't understand this method it’s not the end of the world it’s rarely used so don’t worry about it), then gets to derivatives and higher order derivatives then finally integrals.

What you should learn is: **How to prove a limit exists or doesn’t using the delta-epsilon method; How to correctly derivate most functions and solve them for critical points; How to do integration by part and use variable substitution in integrals; How to solve equations with a parametric variable (some annoying constant you don’t know); and partial fraction integration.**

How?

Don’t bother too much with the rigorous definitions and graphical explanations of calculus, for that go watch 3Blue1Brown and Professor Leonard on YouTube. The Book “Calculus one and several variables by Salas, Hille, and Etgen” is your best friend. Go through the proofs, and some exercises, it’s unlikely you’ll face the same exact problem in the exams but the fundamental trick of solving the question is usually the same. Speaking of exams, the old high school multi question step by step exercises are gone. It’s just a long list of prove this prove that one-line questions. So, don’t be afraid to think outside the box, if you think a proof works then use it. And yes, some questions might seem “too simple” and that’s because sometimes they are. And as a final tip: don’t base your expectations of what the exam will offer off the recitations. It’s a bad metric.

Note: Calculus 1 goes from “too slow” at the first few weeks to “Ohh Dear God, slow down! “by the final weeks. So, don’t get a false sense of comfort from the earlier lectures, the volume of stuff you get through is exponential not linear.

EE175: Physics I (Mechanics)

Difficulty Rating: 5.43/10

Affiliated Specialty: Control & Power

Why?

Newtonian Mechanics aren’t essential for an Electrical engineer but they have their situational uses. First of all, understanding a mechanical system is more intuitive than understanding an electrical one which means that you could use the understanding of a mechanical analog for a circuit to better know how it works. This might seem like an unnecessary step but more complex electronic devices can be very confusing without first trying to imagine their mechanical equivalent. Second of all, optimizing motor performance, power losses, and so on is a big part of both control and power engineering. Therefore, understanding rotational motion, and torque at least at a basic level is important. And finally, control engineering isn’t just about controlling big fancy circuits it also includes controlling all sorts of mechanical systems such as suspension systems, elevators, robotic arms, cars and almost any system you can think of. If it got an input and an output a control engineer is interested in it.

What?

Newtonian mechanics are fairly straight forward, but an exam contains more than just one exercise so expect some creative mechanics problems but in the end of the day they’re all just applying the same laws or using the same concepts.

So, you should know how to: **use Newton’s second law in both linear and rotational form, use the law of conservation of energy to calculate stuff, understand motion, velocity, energy and acceleration graphs and what they mean, understand how to convert between rotational and linear forces, good use of trigonometry, and drawing free body diagrams. It’s fairly self-explanatory.**

How?

The associated reference book is quite useful, but don't just read it like a novel, skim through it and only read in-depth whenever you feel confused or overwhelmed. ALWAYS draw free body diagrams, don't just do it from the top of your head. Memorize your formulas well and understand what they mean in the real world through some YouTube videos and animations and you should be just fine.

EE121/EE122: Introduction to C programming

Difficulty Rating: 3.63/10

Affiliated Specialty: All of them

Why?

This is probably the first ever, programming course for most of you. Programming is an extremely important skill. This course would prove useful to you even if you don't use the C language itself, since most concepts and even some syntax is shared by most programming languages. (Everything in C is also applicable in C++ so don't worry thinking you're learning an "old" language). Unlike other higher-level languages such as Python Java etc…, the C language is the most used language in programming Microcontrollers. Simply because it's closer to the hardware layer. Many microcontroller families only offer compilers in C/C++. What are these microcontrollers anyway? Well they are small chips you can program however you like and put in any of your systems. They are used in implementing control systems, some communication modules, monitoring systems, small embedded devices, power control circuits, safety systems… basically anything and everything. The Arduino board contains a microcontroller in it and is programmed in C so better get this module right.

What?

This subject starts with algorithms, which is basically a step by step guide on how to do something. This might seem confusing at first, but you just need to just keep asking yourself "how do I do this task?", you'd get a basic list of steps then just ask how do I do each step, until you get to a long list of steps you can write in code. Flowcharts are also a good way of visualizing loops and decision trees so make sure to understand those and use them whenever you get confused. Then you get to the C programming part.

Here, you need to know How to: **Write an algorithm for the problem at hand, draw a flowchart if necessary, know the different variable types, input and output data, use IF conditional and WHILE and FOR loops, use multidimensional arrays, manipulate strings, declare and call custom functions, use recursion in functions, know what pointers do, use pointers as variables, know how memory allocation works.**

How?

First you need to develop a programming mindset, to read a code or algorithm the way a computer reads it. And use little memory tables for variables to go through the code one line at a time in your head. Things that might seem obvious to you are not so obvious to a computer so be careful. Then you need to always think "How can I break this code?" always think of what inputs or conditions that might break your code then fix them (things like dividing by zero). Then of course, Practice, practice a lot, follow online tutorials, Coursera classes, or even YouTube playlists. And apply what you learn directly in code and test it. Nothing is better than learning from your own mistakes. And finally, you'll probably be using Code blocks software, so get used to that interface, and find a way in Code blocks or in another software to use **Breakpoints**, Google what breakpoints are, and use the step by step option in an IDE to troubleshoot your code. Trust me breakpoints will save you a lot of braincells.

Typical PIC Microcontroller Chip programmed in C/C++

EE172: Mathematics II (Calculus II):

Difficulty Rating: 6.13/10

Affiliated Specialty: All of them

Why?

This is even more useful than Calculus 1 in my opinion, simply because around half of Calculus 1 is stuff you already studied in High school, but Calculus 2 takes things a step higher. It contains multivariable functions and you'll need these a lot in designing and optimizing complex systems.

What?

Here you'll learn about Trigonometric substitution integration which offers you a nice trick in using inverse trigonometric functions. But the real focus here, is multivariable functions,

You need to know: **How to define a multivariable function and find its domain of definition, How to derivate these functions one and get a "gradient", then derivate it again and get a Hessian matrix and what does that matrix mean in terms of critical points, how to use that delta epsilon method to prove multivariable limits exist or not, how to switch between coordinate systems in double and triple integrals and then solve them, know the equations for notable conic sections, draw cross sections for 3D functions for different values of one variable.**

How?

Yup, you guessed it the book is once again your best buddy. Solve exercises and understand proofs, but exams this time are usually more straightforward and correspond fairly well to lecture content. So, it's not as confusing. Using a 3D plotting function App, is extremely useful, since you'd have to understand shapes like ellipsoids and hyperboloids. Drawing a function and changing a "parameter (constant)" and seeing how the shape changes is a very insightful experience.

EE178: Physics II (Electricity and Magnetism)

Difficulty Rating: 5.83/10

Affiliated Specialty: Telecommunications & Power

Why?

This is an institute of Electrical and electronics engineering so, obviously learning how electricity behaves along with magnetism is quite important. This is the first step in the long road of understanding electromagnetic waves used in transmitting data (including Wi-Fi, Radio, Mobile data…). It is also a building block in understanding how motors and transformers operate. And Finally, those interested in control engineering would find this course useful since many measurement devices uses these electromagnetic phenomena to measure a long list of physical variables although to a simpler degree.

What?

This course basically contains one trick you'll keep applying on different formulas. So, the trick is to have a law that applies to a single point and what you need to do is find the total effect of an area or shape of points. To do this you sum the small tiny effects of each point which is mathematically an integral. So, the challenge here, is figuring out what variables and what law to use, then finding the boundaries of each section to integrate then integrate it.

You need to know **how to do this for Gauss's laws (both of them), Coulomb's law, voltage laws, and Ampere's law. And for all three coordinate systems in different shapes (circles, planes, discs, poles…). Other than that, you got some terms and concepts to learn about just by reading what they mean. And how to use a Matrix to find a cross product.**

How?

Again, the Book is a great resource, and recitations are very useful. Just, some practice with different shapes and formulas would be sufficient as long as you review the course alongside that. Try watching videos about how electromagnetism works in pretty animations since trying to imagine it through reading the math will probably make you even more confused.

EE174: Mathematics III (Linear Algebra)

Difficulty Rating: 4.75/10

Affiliated Specialty: Control & Computer & Power

Why?

At first, this seems like some very weird abstract math nonsense that is just there because Mathematicians like to prove stuff for some reason. But the reason you start from basically the pillars of math is because of how important these concepts are. The things you study here are intentionally very broad and generalized to include a lot of applications and systems. This is the main tool of control engineering, where the abstract variables you study can be anything because in control you will try to control a lot of things, Such as: temperature, position, humidity, alarm state, number of workers, liters of water, voltages, forces, sounds, and even blood pressure. If you can measure them then they're a variable. Therefore, understanding the math in the broadest sense possible makes you able to manipulate the largest types of systems possible.

What?

This subject starts from the axioms of math, and proves what sets, groups, fields, and vector spaces are. Broadly speaking a vector space is a type of variables you can do operations on. Dimensions are like how many states this variable type has. Like how a car can have temperature, XYZ position, and volume of fuel left as variables. Then we want to know how those variables relate to each other when doing an operation. Like how you can't change the position of the car without changing the fuel left. A Basis is a set you can use to describe all things in your vector space. Like I can describe a large set of books by saying this book has these times the number of pages of my "basis" book, and has these times the length and width of my basis book etc.… Then linear mappings are an operation done to the vector space like a car moving, or a set of voltages being applied to a circuit. The Matrices are representation of those transformations in a simpler more friendly format and can be used to describe an entire system.

When it comes to the module itself, you need to know how to: **prove if a set is a vector space by respecting axioms or proving it's a subspace of a vector space you already know, you also need to know how to find the range and nullity of a mapping and their dimensions, how to find the basis of a vector space, how to represent a linear mapping with a matrix, how to prove that a linear mapping is invertible or not, How to calculate the determinant of a matrix, and how to solve a system of linear**

equations using matrix operations., and finally how to change the basis of a linear transformation or a matrix.

How?

The lecture and recitation are great resources, YouTube videos are also very good (3Blue1Brown) and finally it's all about practice and constantly asking yourself the question: "What does this imply? And how can I use this to prove something else?"

EE102: Electrical Engineering I

Difficulty Rating: 5.08/10

Affiliated Specialty: Power & Telecom & Control

Why?

Apparently, circuits can be far more complex than the typical two resistors in series we got used to in High school. You'll slowly learn methodical techniques to solve almost any circuit made of power sources and resistors. In practice you'll be using simulators and software to calculate voltages, currents and power but just looking at a circuit and knowing approximately how it behaves is a skill that requires a lot of practice to earn. To just look at a circuit diagram of an industrial process and know what each part does at a glance and make approximations on the fly is -in my humble opinion- quite satisfying.

What?

This subject is all about is having a circuit and trying to find the value of a voltage, current or resistance. And to do that you'll need some nice theorems and formals. So, what you should know is: **How to use voltage and current divider rules, source transformations, mesh and nodal analysis, superposition theorem, Delta to wye transformations, Thevenin and Norton's theorem and maximum power transfer. And as lab skills, how to connect a circuit on a breadboard from its schematic and measure the values you need from voltages and currents.**

How?

This module requires a lot of practice but when you get to that point where you look at a circuit and know what methods to use and what equations to write then it's good enough. Most mistakes in exams are just calculation mistakes or forgetting some terms and you're not going to solve that with solving more exercises. Just get a habit of writing ALL the steps without skipping any in your mind, and get used to double checking your work and of course get a hand watch to manage your time properly. Also, learn to think in voltages not just currents. It’s, easy to try to see where the current is going and get confused. So, you need to see both currents and voltages. Voltages behave exist as points not branches so keep that in mind. And finally, remember, an open circuit still contains a voltage, this might just be me but I sometimes get confused thinking an open circuit has a zero voltage. Oh, and if you have a fancy calculator you should learn how to solve systems of equations directly using it.

EE173/EE174: Chemistry I/II:

Difficulty Rating: 5.56/10

Affiliated Specialty: **None**

Why?

Points maybe? Otherwise it is definitely useless.

What?

You learn about atoms and reactions and what the different values that characterize a certain solution, then you move to study atoms and electrons deeply and how they organize themselves around the nucleus. In the second semester, you study how to draw particles and organic materials and fancy polymers. If only this was semiconductor physics instead.

How?

I have often questioned myself about this module, as I never understood why we study it, apart from wasting time! Some people seem to enjoy it since you will be discovering things on atoms and electrons but it's simply not worth the time! For exams just memorize previous exams and you got yourself a good 15 or more. Simply, DONT waste too much time with it. Other than that, save that time for more important modules or for developing yourself and building other skills.

Chapter 2: Second year

In second year, you will start learning about electronics and further develop your toolkit for analyzing mechanical and electrical systems. You will learn about electronic components both digital and analog and how to them in building simple circuits.

EE203: Electrical Engineering II:

Difficulty Rating: 5.44/10

Affiliated Specialty: Control, Telecom, & Power

Why?

In the previous Electrical engineering course, you managed to study static circuits, that only have DC currents and voltages. However, AC circuits are extremely common. Since AC is used in transmitting power, and communication signals, and powering motors. Therefore, knowing how to analyze AC circuits with ease in the frequency domain will be quite useful.

What?

You will be reintroduced to two new components (inductors and capacitors) and a small overview of basic types of waveforms and how to quantify them. There are many types of periodic and non-periodic waves but you will mostly stick to sine waves. You will then start to learn about analyzing AC circuits. To do so, you will become familiar with the general term of "impedance" which is basically a complex resistance of capacitors and inductors. Then voltages and currents are represented by "phasors" which are just complex numbers where the modulus expresses the amplitude of the signal and the angle represented the phase difference. This might seem as unnecessary complexity but it's far superior than using sines and cosines. With these phasors you will review all the previous theorems, Thevenin, Norton, Maximum Power transfer, Mesh, Nodal, Delta to wye, superposition, all of them. Next, you will be introduced to the two parts of electric power: "real" and "reactive" and how to calculate them via the power factor. Finally, you will get to "Frequency response" which is a function that tells you how the circuit will react to any given frequency and how to use Bode Plots to express this response. A small taste of "Fourier series" and "Three phase systems" is sometimes given in the end.

What you should learn: **Finding RMS, Period, and Average of any waveform ; Calculating impedance and phasors of any component or signal; Using Mesh, nodal, Superposition, Thevenin (all three cases), Norton, and delta to wye transformation on complex circuits; Calculating the power factor and improving it; Finding transient waves of capacitors and inductors with non-zero initial values; Extracting Frequency response functions, Drawing Bode plots for a given function, Calculating Fourier series coefficients for a periodic waveform.**

How?

You've guessed it, this module is all about countifying the behavior of circuits so you need to practice and be totally familiar with the complex calculations and analysis methods. (get yourself a calculator that can do complex numbers math, trust it's a good investment for years to come) Always, triple check your applied rules before moving forward and simplifying the equations. Labs are about characterizing practical circuits using the different equipment and comparing the measured results to the theoretical ones so you better get familiar with using the oscilloscope.

EE273: Physics III (Vibrations and Waves):

Difficulty Rating: 6.92/10

Affiliated Specialty: **Telecom & Control**

Why?

The simple motion of a harmonic oscillator can be the analog for a lot of systems (It is what is called a second order system which is an extremely common type of systems) and by understanding how these oscillators behave we will be able to analyze and design better systems. The similarity between electrical and mechanical phenomena allows us to better understand complex electrical systems via their mechanical counterparts. This is important in electrical oscillators and AC circuits. Mechanical oscillators are a stepping point in developing an intuition for concepts that will be generalized to most other systems, such as forced and natural response, frequency response, resonance and so on. And of course, oscillations are quite important in control applications as well as analog electronics.

What?

In this course you will be introduced to the different types of oscillations (simple, damped, and forced). First, you will study oscillating systems (mass spring, pendulum, and LC circuits) in the ideal world without friction as well as the superposition of multiple simple oscillators and the resulting motion. Then you will study these systems with friction included. Later on, you will study the behavior of such systems when an extremal sinusoidal force is applied. Afterwards, you will connect two or more oscillating systems together (couple them) and see what the result will look like. Lastly, Waves are introduced as an infinite number of small oscillators coupled together.

What you should learn: **Finding the differential equations for mass spring, pendulum, LC circuit, and rolling systems using Newton's second law, conservation of energy or circuit theorems; Finding superposition of beats and simple harmonic oscillators of the same frequency; finding damped equations of motion and their solutions for underdamped overdamped and critically damped cases; finding amplitude and**

phase of the forced response; understanding resonance and half power points; finding coupled oscillation normal mode frequencies and amplitudes using Matrix method.

How?

Lectures and recitation are a fitting way to get through this subject. Watching some YouTube videos and animations is quite useful. I suggest you watch some videos from the awesome teacher Walter Lewin (MIT 8.03). Again, this is a module about practicing rules and understanding terms so don't worry if you didn't understand how the solutions for the equations are obtained. You will understand that when go through differential equations module. And in reality, you will be using the Laplace Transform in solving most of these systems much more easily later on so grasping the concepts is all that matters.

EE271: Mathematics IV (Ordinary Differential Equations):

Difficulty Rating: 3.38/10

Affiliated Specialty: **All of them**

Why?

A lot of natural and artificial systems can only be described using differential equations. This allows us to create an abstraction of a complex system and use reliable mathematical methods in understanding the system. It also enables us to understand one type of system then develop an intuition concerning the math behind it then use that mathematical intuition to understand a different less intuitive system. Control engineering in particular, relies on these mathematical abstractions in optimizing and designing control systems without having to understand every system individually but rely on the mathematical principles shared by most systems.

What?

Firstly, you will finish some residual stuff from the linear algebra course (eigen-values and matrix diagonalization). Then, you will start by classifying differential equations according to their properties (linearity, homogeneity, order). This course is only concerned with single variable differential equations. So, first, you will study four techniques used to solve first order differential equations ordered in terms of complexity (separation, substitution, exact differential equations, and using the integrating factor) Then move to the higher order ones and again you will see two techniques on how to solve them and obtain a general solution namely the variation of parameters and undetermined coefficients methods. Finally, you will get to see how to use Laplace transform to solve non-zero initial condition differential equations (just how to use it and not what it actually is).

What you need to learn: **Find the eigenvalues and eigenvectors of a Matrix and their multiplicities; diagonalize a matrix directly or through the Jordan form; find the inverse via the Cayley-Hamilton theorem; solve first order ODE via: Separation, substitution, exact equation format, and integrating factor; Solve Higher order differential equations by finding the homogeneous and particular solution via Variation of parameters and undetermined coefficient methods; Apply Laplace transform to solve initial value problems; apply inverse Laplace transform to find time domain solution via fraction separation.**

How?

Lectures and recitation are a good enough way to go through this subject. Watching some YouTube videos is quite useful as well. If you could understand the used techniques, I highly suggest you watch some videos from professor Leonard. Also, the videos by Gilbert Strang (MIT 18.009) are quite useful. Using MATLAB symbolic math toolbox or even a website like Wolframalpha will help you checking your results. All in all, this is a module that is all about practice and patiently applying specific rules, no weird tricks, no understanding required just apply the rules. Although, if you do wish to do control, it would be useful to take a look into why these methods work.

EE241/ EE242: Active Devices I & II:

Difficulty Rating: 6.68/10

Affiliated Specialty: **Telecom & Power & Control**

Why?

Building any sort of electronic system requires understanding the behavior of its basic building blocks. By understanding simple analog component and modelling them mathematically we tend to gain more insight and flexibility in designing bigger and more complex systems out of those simple components. This module is concerned with Analog electronics. In the past few decades this type of electronics has gone down in popularity simply because digital electronics are much more robust and simpler to use. Yet, there are at least three branches of electronics where analog still reigns supreme. These are: Power applications, Wired and wireless communications and instrumentation (interfacing measurement devices). It is also useful in troubleshooting some problems with digital circuits most notably at very high frequencies since digital components are essentially analog in nature.

What?

In the first semester, you will learn about semiconductors and how doping them with different materials affects their behavior. Then, you will build a diode (PN junction) and model its behavior in different operating conditions through different equivalent models. Afterwards, you will use this diode to build some useful circuits (rectifiers, peak detector, voltage multipliers.) then learn about some other types of diodes (LED, Zener, Schottky…). Later on, you build a Bipolar Junction transistor, model it, then use it as simple switch in some circuits. Then you will start the journey of building amplifiers by knowing about DC biasing and small signal operation. After that, you will construct some amplifiers and compare their parameters (gain, in/out impedances) and when to use each type. And then, you will move on to building "power" amplifiers and their different classes and study their pros/cons.

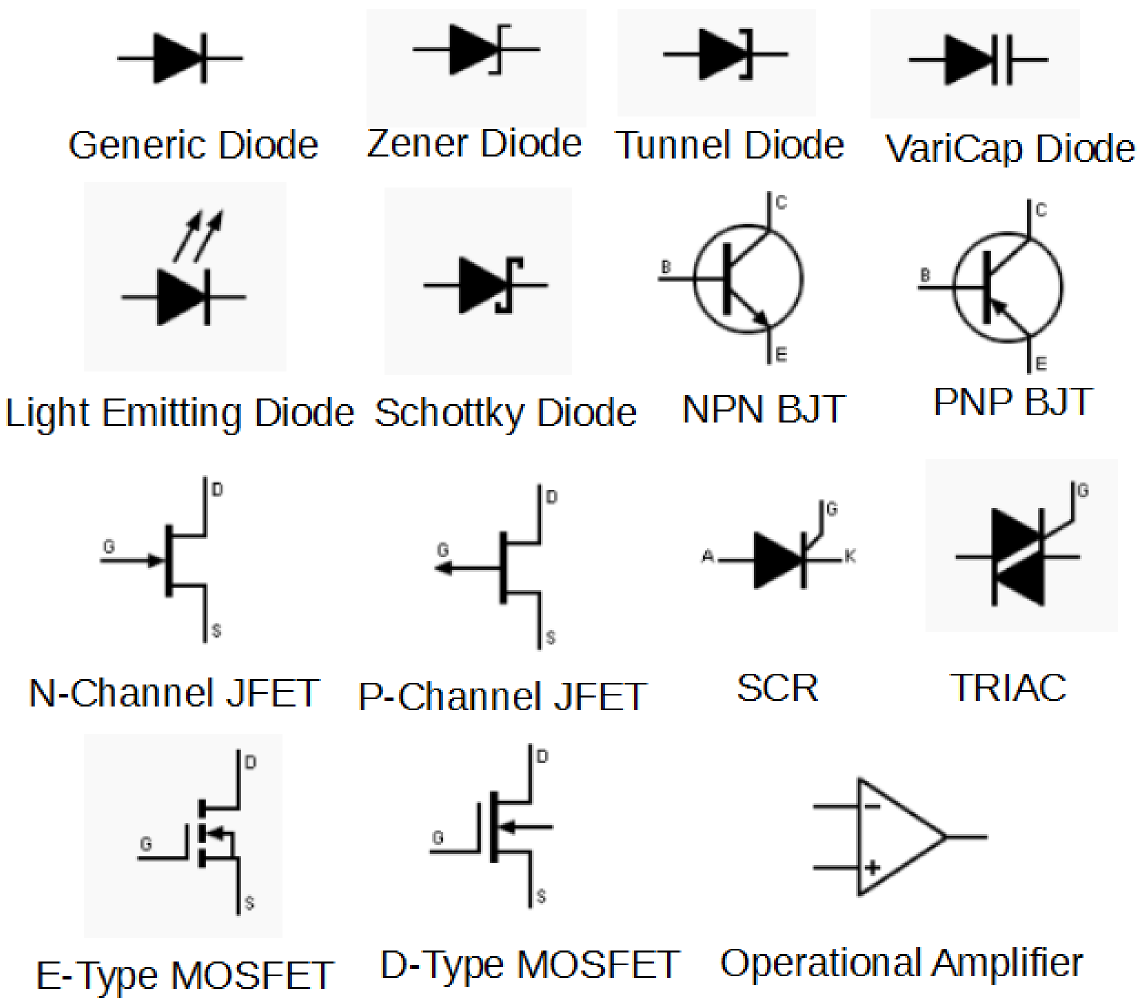
In the second semester, you will learn another way of building transistors (The FET architecture) where you will be introduced to three transistor types (JFET, D-MOSFETT, and E-MOSFET) then use them to build amplifiers. And last but not least, you will move to a very useful device called the Operational Amplifier and understand its behavior and use it to build some interesting circuits (comparators, amplifiers, filters, buffers, analog adders, subtractors…). Then finally, (if you have enough time), you will see a few other devices (SCR, TRIAC, DIAC) and how to use to control the power going to a certain load.

What you should learn for Active Devices I: **Semiconductor concepts (doping, holes, valent electrons…) , use Shockley's equation, speculate if a diode is on or off in a circuit, find diode operating point, find the characteristic values (RMS, Conduction angle…) for Half wave and full wave filtered and unfiltered rectifiers, identify waveform distortions caused by clipper and clamper circuits, analyze Zener diode circuits, figure out properties of all three BJT operating regions; find operating point for simple bias and voltage divider bias circuits; analyze BJT switch circuits; analyze Large signal BJT operation via maximum symmetrical swing approximation; find gains and in/out impedances for all three configurations via the pi model; find total gain and phase for cascaded amplifiers; analyze class A & B power amplifiers and find their efficiency.**

What you should learn for Active Devices II: **understand structure, pinching behavior, and IV curves of FET transistors; Analyze DC JFET and MOSFET biasing; Analyze AC small signal model JFET and MOSFET circuits in all configurations; Calculate the gains of the differential amplifier; calculate CMRR normally and in dB ; memorize all Op Amp configurations and analyze their circuits; analyze the variable gain instrumentation amplifier (it's the one where you can't use formulas directly).**

How?

Well, in all honesty, there is no perfect way to get through this. You will have to follow lectures, and labs and along with that you will also need some textbooks (and for your sake don't even try the one the library gives you) and YouTube videos. You should get this module right because it forms the basis for analog electronics especially for designing power electronics, modelling control systems and analyzing communication circuits. Doing simulations is a highly recommended and it's preferable to learn more about the equipment used in the lab to get a better user experience with them. Multisim, Simulink/MATLAB and Proteus VSM are decent simulation tools for analog circuits. Simulate everything you go through; 1.5 Hours in a Lab is not going to be enough to build to circuit nevermind testing it properly.



Symbols of the Different Devices encountered in Active Devices I & II

EE221/ EE222: Digital Systems I&II with VHDL:

Difficulty Rating: 4.89/10

Affiliated Specialty: **All of Them**

Why?

Modern electronic gadgets and devices are overwhelmingly digital rather than analog. By digital, we mean it uses binary digits (1s and 0s) to encode information rather than a continuous voltage or current signal. These various devices are mainly made of Microcontrollers and microprocessors nowadays. Using simple flip flops and logic gates to implement a circuit is redundant and counterproductive with how cheap microcontrollers have become. However, understanding the fundamental building blocks of digital devices allows you to properly troubleshoot and optimize your system. They are still useful in interfacing smaller peripherals as well as in "glue" logic that links different components together. You don't want to use a whole microcontroller to control some alarm LED now do you?

What?

In the first semester, you go through an introduction to the digital world and understand the different "perspectives" of representing numbers (counting systems) and how to switch between them. Then, you will learn about Boolean algebra: its axioms, operations and some methods used in simplifying Boolean expressions (Karnaugh maps, and Quine-McCluskey Method) and implement them using logic gates. Afterwards, you take a step up and use VHDL (a programming language) to describe your desired circuit. Then, you will study and build some useful systems (adders, subtractors, comparators…) and experiment with them using FPGAs (simply saying: it's a way to test the VHDL code physically). Finally, you will combine all what you have learned in coding a basic Arithmetic Logic Unit.

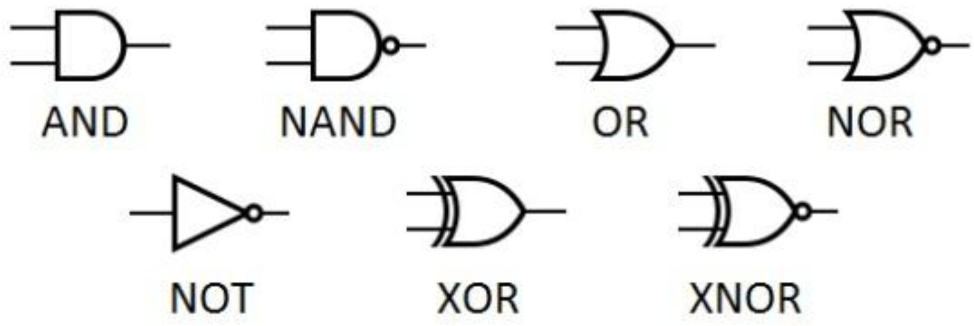
In the second semester, you will move on to sequential circuits (digital circuits with memory). First of all, you will create the simplest memory element a "Latch" then improve it to get a "flip flop" then get to know all four Flip Flop types. Second of all, you will use these Flip Flops to make counters (there are a LOT of them). Then use them to create Registers, which store more than one bit of data (usually 8-Bits). Then you will get back to combinational circuits making some fundamental circuits: Multiplexers, Encoders, Decoders and Demultiplexers. These are Building blocks of CPUs and very useful in interfacing Digital chips with one another if you don't wish to use like 50 Logic gates. Later on, you will get to Finite state machines which aren't THAT type of machines. They're a concept used to represent the operation of a device or structure. They're used in Basic software AI (Half Life 1 most notably), High level Robotics AI, modelling advanced Digital components, and networks.

What you should Learn in Digital Systems I: **Converting between decimal, octal, hexadecimal, and binary systems, Binary arithmetic (do not forget 2's complement subtraction), Writing Floating point numbers, Simplifying Boolean expressions by theorems, Simplifying Boolean expressions via K-Maps, drawing logic gates from Boolean expression, VHDL for Boolean expressions, Convert OR/AND network to NAND-NAND or NOR-NOR networks, prove a gate set is universal, design Half and Full Adder, subtractor, and n-Bit comparator using both Gates and VHDL(for different datatypes binary BCD. Duodecimal etc…), Implement simple ALU in VHDL (4bits opcode), write simple Structural design style in VHDL.**

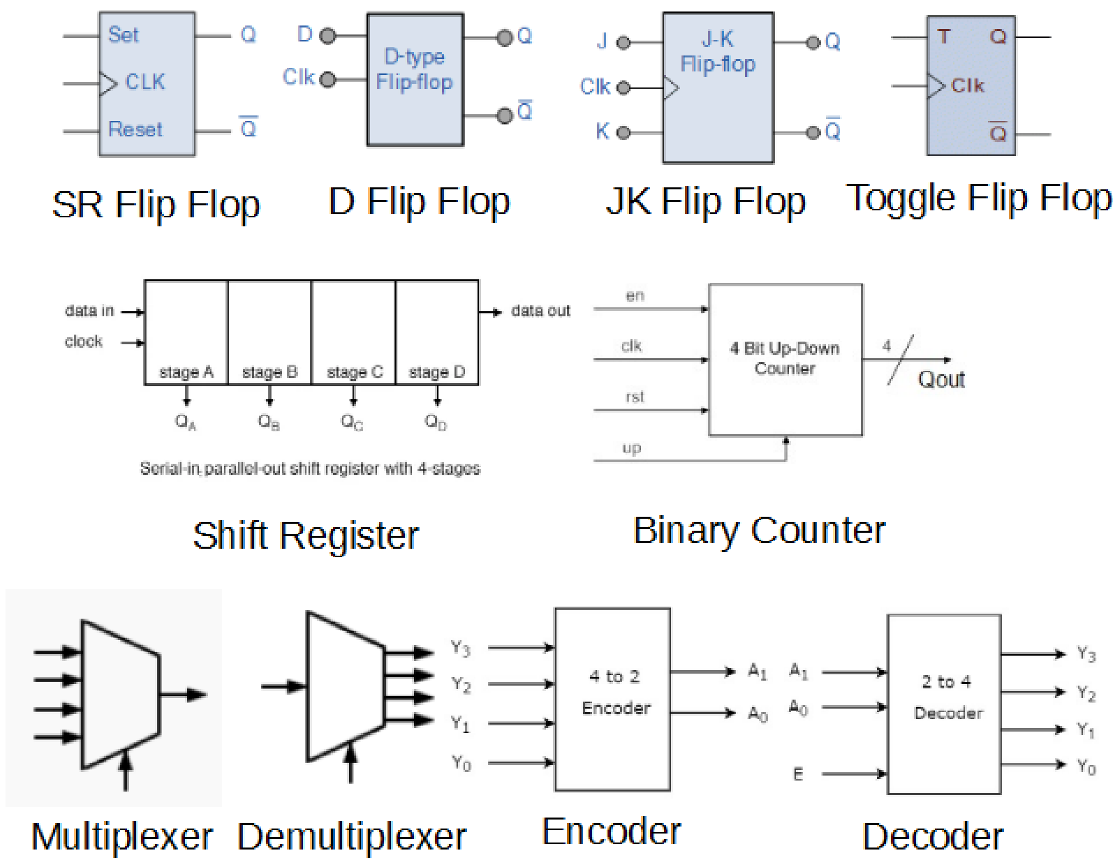
What you should learn in Digital Systems II: **design Latches and Flipflops off of gates, understand excitation tables timing diagrams, state tables and state diagrams, understand Master-Slave edge detection, use K-Maps to design a Flipflip from another, FFs via VHDL, design counters (up/down binary/decade synchronous/asynchronous…) , frequency division via timers (diagram and VHDL), find counting sequence of any counter (careful do this slowly clock cycle by clock cycle), Modelling counters via VHDL, design SISO SIPO PISO PIPO registers with direction control via FF and VHDL, implement universal registers, use combinational modules to implement Boolean expressions, implement combinational modules via VHDL, model a system via the two different FSM types.**

How?

Lectures are very useful in getting through this module. Practice a lot with the initial conversions and expressions but they're fairly simple. Try to write the VHDL code using your hand not just the computer and please install Quartus software on your pc this would make the labs easier to finish. You should also use simulation software: something as simple as Logisim, or Deeds software or even Proteus and play with some circuits. You can read a practical electronics book but I do not advise getting in-depth with this type of basic circuits. If you didn't understand anything google, YouTube, Stack Over Flow and the VHDL documentation are your best friend.



Logic Gates Symbols



Digital Components Symbols encountered in the course

EE252: Linear System I:

Difficulty Rating: 4.69/10

Affiliated Specialty: **All of Them**

Why?

Mathematics is the language of engineering, and therefore can be used to simplify complex systems to easily manipulatable equations. This module gives you an abstraction layer (similar to the one you got with linear algebra) which will enable you to think of systems a process of transforming one signal to another. This abstraction allows us to understand and build may useful systems especially in control and computer engineering. It is also extremely useful in designing communication systems. This module is all about giving the mathematics necessary to describe and design linear systems in the continuous time. These tools might be cumbersome at first but they are a worthy time investment.

What?

You will start by understanding the different types of signals and systems and their properties then learn about some basic signals. Later on, you will start focusing only on linear time invariant systems in which you would characterize them by a function (impulse response) where the output is just the convolution of the input and said impulse response. Then, you will enter the frequency domain starting by Fourier series and then genialize them to the Fourier transform which lets you decompose a signal and know the response of systems to different frequencies. Finally, you would generalize the Fourier transform into the Laplace transform and redefine systems using their transfer function.

What you should learn: **Types of signals (power / energy integrals, odd/even parts, discrete, continuous etc..); Types of systems (Linear nonlinear, Time variant or time invariant, memoryless or not , Causal or not , BIBO stable or not); Convolution (graphical and analytical); system interconnections: (how to derive differential equation from a block diagram); Find the properties of delta(t) function ; Fourier series formula and coefficients formula; Verify Dirichlet conditions; Fourier transform of well-known pairs and properties; How to find transfer function H(s) , frequency response H(w) or impulse response h(t); Laplace transform of common pairs and Region of convergence; Derive the Inverse Laplace transform and find regions of "stability".**

How?

This module is relatively straightforward. But it needs a lot of practice to know what properties to use and when to use them. It also takes a while to develop a deep understanding of these properties and what they TRULY mean, and by that I mean how

different concepts are HIGHLY related to one another. It seems a bit odd at first but with enough practice you will understand why every rule applies and that will help you in solving problems and checking your results.
Lectures and recitations are a great place to start and expose yourself to some interesting ideas. You should definitely watch the “Iman” playlist on this subject and 3blue1brown about some topics on it. The source book: “Signals and Systems by AV Oppenheim is a Phenomenal source I highly recommend you skim over and practice many exercises off of.

EE262: Electromagnetic Field Theory:

Difficulty Rating: 6.62/10

Affiliated Specialty: **Telecom & Power**

Why?

All electronics are built around the concept of manipulating the flow of charges and the fields around them. This module provides a solid understanding of the relationship between electricity and magnetism using Maxwell’s equations. Simply, this module is the bread and butter for understanding electromagnetic waves and an introduction to why they are important in our telecommunication systems.

What?

You would start by doing a review on vector calculus (which presumably you wouldn’t be able to get to in the first year Calculus course) and how to transform between different coordinate systems. You will also use two theorems significantly namely Stokes’s theorem and the divergence theorem which allow to simplify many problems. Then, you will start digging into the laws that govern electrostatics and magnetostatics. Then, you will generalize those laws onto time-varying quantities and get the four Maxwell Equations. Finally, you will study a simplified model of electromagnetic waves and their behavior in different mediums.

What you should Learn: **Vector operations (divergence, curl, dot product, cross product, and Laplacian). Coordinate system conversions, Using Divergence and curl theorems. Integrating equations of common shapes in different coordinate systems by finding integrating boundaries, Using All 4 Maxwell equations in integral and derivative forms and how to jump between the two and prove if they apply to certain fields or not. Uniform plane wave characteristics (frequency, amplitude phase.), and finally introductions light polarization patterns**.

How?

This module is somehow calculus extensive but with some practice it will be very easy especially if you get a good grip on vector calculus first. The lectures, recitations, textbooks are a good place to start from and for more "practical" ideas check "CEM Lectures" playlist about this subject and of course 3blue1brown for some visualization of those mathematical theories. Diagrams and videos are very important in visualizing many concepts involved in this module. You should also take a look at the Book: introduction to Electrodynamics by Griffiths.

EE232: Electric Machines:

Difficulty Rating: 4.62/10

Affiliated Specialty: **Power & Control**

Why?

Well, the main purpose of electronics is to facilitate human life and one way to do that is by pushing their work to electrical machines. This module will give a deeper understanding of most of electromechanical devices you face every day (motors, pumps...) and allows to troubleshoot them easily. In addition, it will give an introduction to how electrical machines are controlled, optimized and maintained.

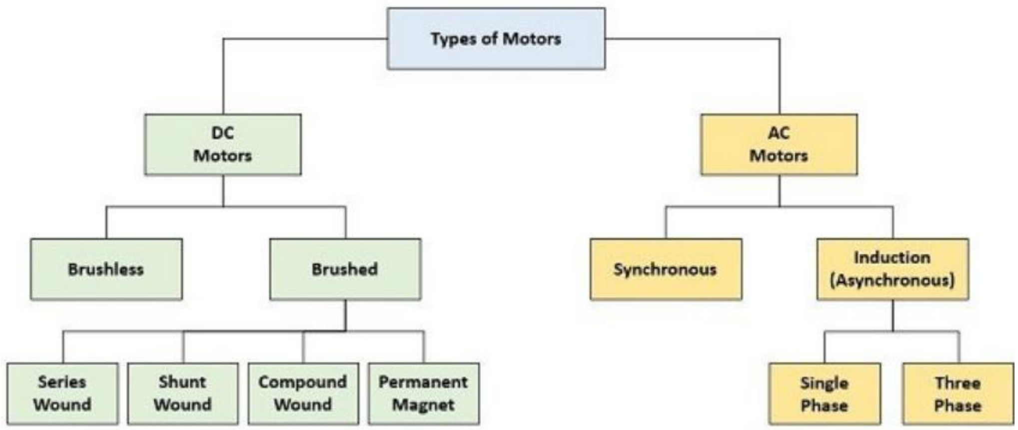
What?

You start by studying the 3-phase circuit and their analysis as well as a review on reactive and real power. Then, you will study magnetic circuits and how to use simplified Maxwell equations to model a magnetic circuit. Afterwards, you will be introduced to the transformer and create a model for it and analyze it along with the two phenomena of hysteresis and Eddy currents before jumping to three phase transformers. Then you will study DC machines (DC motors & generators) and their applications. Then, you will finally study AC machines: both synchronous and asynchronous ones.

What you should learn: **delta to wye conversions; calculating real and reactive power; solving balanced and unbalanced three phase systems; Model Magnetic circuits with and without airgap; use open and closed-circuit transformer tests to find transformer parameters; Calculate transformer power efficiency and utilization ratio, basic construction of dc machines, their connections pros and cons, and the difference between a generator and motor working. the same applies to AC machines.**

How?

This module is very straight forward. Lectures and recitations along with some glances to the textbook are good enough for the purpose of understanding. Doing labs and really absorbing them is highly recommended. You should also watch some videos and animations on YouTube to how those machines are constructed. Practice well on Three phase circuits and magnetic circuits, it's very helpful. Understanding phasor diagrams might seem as a chore at first but it is helpful in the long term although it is not necessary. You can also use [Adel Gastly Playlist] as a proper reference for this course.



Motor types classifications

EE203: Economics Engineering:

Difficulty Rating: 3.05/10

Affiliated Specialty: **N/A**

Why?

This is a simple module that is more of a diversion than necessary material. It covers the financial aspect of engineering. In other words, it's about calculating the expenses of a project and the benefit it would make and the deprecation cost of the materials involved in an interest-based banking economy.

What?

You start by understanding what money is and how its value change with time (time dependent money). Then you would do some money involving operations (investment, buying, selling …) and study whether you gain or lose under different investment conditions and operations.

What you should learn: **P is the money you got NOW, F is the money you will have at some point in the future, A is how much you have to pay each time, G is how much you make or have to pay if the amount gradually gets bigger. Switching between all those types of money, finding the REAL compounding interval and the REAL interest rate (banks hide that to make the numbers sound more appealing), calculate deprecation cost.**

How?

This module is really a last week module. Just go through the lectures and examples and maybe take a glance at some 80s textbook and you would be fine. Make sure you memorize the laws or learn how to use the “table” of values.

Chapter 3: Third year

At this point there is only one more year ahead of you before you obtain your License degree. Such a degree is far from being highly regarded in Algeria today, but it does offer you the chance to apply for foreign programs. But more importantly, it is the satisfaction you'd get when obtaining said degree that I consider quite valuable. If you managed to spent your years efficiently slowly building up your skills, you'd be surprised how much you've learned compared to the moment you signed up to this school, or at least I was surprised. But this journey is far from over, there is still third year to get through. It is a year that is in my opinion far more enjoyable since now you can actually learned about practical uses of electronics and learn how to design systems with real life applications, and to top I all off, you get to do your own project to test what you learned and explore what you like best in the vast field of electronic and electrical engineering.

EE331: Power Electronics:

Difficulty Rating: 5.43/10

Affiliated Specialty: Power & Control

Why?

Power electronics is all about power conversion. It is a very valuable skill with wide applications in motor drives, smart grids, and even electric vehicles. So, your purpose here is to create a circuit that converts one form of power to another (both electrical in this case). AC/DC, DC/AC, AC/AC, and DC/DC. However, the game is not that simple, you need to learn about circuits that create the closest possible wave form you want (frequency, shape, amplitude etc…) with the smallest power wasted on heating and hopefully with the smallest simplest components possible.

What?

First you will learn about Power electronics in general, and what components are used in such circuits, although you'll assume them to be ideal later on. Next, you will get to know rectifiers, (AC/DC). You already met these in Active devices but it's going to get a lot more complicated. Since, the "load" which the thing you connect at the output of the rectifier is going to be different (capacitive, resistive or inductive) [This is important because motors are inductive loads]. Then instead of rectifying one phase, why not rectify all three? Three times as fun am I right? Lastly, you'll get to "controlled" rectifiers. Which don't use normal diodes they use fancier diodes you can turn on at specific times so you can control with decent precision the output voltage (useful if you got a battery to charge or a bulky DC motor). Afterward, after spending what would feel like ages with rectifiers, you'll meet the rest of the convertors, Buck and/or Boost Converters (it's just PWM but filtered), AC convertors (these are just controlled rectifiers but don't actually rectify), and finally Inverters (DC/AC) (Not the logic gates inverters) which in our case are just H bridges. Unfortunately (or fortunately depending on your perspective) there is no chapter about designing the controllers for these things.

What you should learn:

- **Uncontrolled Rectifier circuits with: R, RC, RL, RLE loads.**
- **Three phase uncontrolled Rectifiers with: R, RL, loads.**
- **Controlled rectifiers with: R, RC, RL loads.**
- **And controlled three phases with R and RL loads.**
- **Then: Buck and Boost converters, AC (half and full wave converters), and Inverters.**

How?

This module seems intimidating at first, but overhaul it's quite simple. It has a lot of formulas but most of them are derived from simple second order differential equations, so there is like an exponential transient hooked up with a sinewave, that's the general format for most of the rectifiers. So, most of those equations are very similar with a few angles being different here and there. A great source is the Book: **Power Electronics by Daniel W. Hart** and I do recommend looking up a few animations on YouTube for rectifiers and convertors so it's easier to distinguish the different conduction angles and what they mean. Other than that, it's all about memorization and doing a fair amount of exercises.

EE311: Communication Principles:

Difficulty Rating: 7.95/10

Affiliated Specialty: Telecom

Why?

I'll be honest, if you're not intending to go Telecom there is very little use of spending more effort in this module that it is necessary to pass its exam. Although, some things you might find useful is how frequency spectrums work and why we use them which would be useful in analyzing some signals in the lab. How and why Filters are used. How frequency bands work (good for wireless communications in IoT and industry), and finally, what modulation is and what is it used for. It's the sort of module that allows you to explain what FM and AM are, why Vinyl is NOT better than digital, why Audio files have a 44.1 KHz sampling rate and why increasing it is not going to make it better, Overhaul, stuff that is **GOOD to Know** but not **NEED to Know.**

What?

This subject is split into three main chapters. The first one is centered around the Fourier Transform, a review (well to be fair it's a very long review) of Phasors, Fourier Series, Fourier Transform and finally their properties and theorems. So, overhaul just Linear systems. Next chapter, is all about Amplitude Modulation, it is split into: Normal AM, Double Sideband Suppressed Carrier AM, Single Sideband AM, Vestigial Sideband AM. These seem like confusing things but they're just spin offs on how to send information from A to B with minimal power and bandwidth possible. You'll get to know how they're generated (theory not hardware), how they're demodulated, their properties with a lot of math.

The final chapter (if we don't count digital modulation which I have no clue about) is about Frequency modulation. This type of modulation unlike AM is highly nonlinear so it's far worse to analyze mathematically. Therefore, you will only deal with two simple special cases the narrowband approximation and sinusoidal modulation. And then get to how they are generated (Linear systems can't change the frequency on an input signal meaning you'll have to use non-linear systems and nobody likes those) although one way of generating them (Phase Locked loop) is useful to understand since it's used in digital applications as well (even some microcontrollers have PPLs inside them).

What you should learn: **Fourier pairs and properties, understand said properties graphically, understand all types of AM, understand their generation (filters) and their demodulation methods, understand why we use each one (power content**

bandwidth and stuff), Understand Phase and Frequency modulations, how to analyze narrowband and sinusoidal FM, understand FM demodulation, Understand FM generation, get to know Phase Locked Loops.

How?

First of all, don't bother too much with long mathematical proofs, just stick to grasping the main ideas of said proofs. Second of all, don't underestimate the Fourier chapter it got a lot more in it than you expect. Lastly, memorize previous exams, trust me it helps.

EE351: Linear Systems II:

Difficulty Rating: 4.36/10

Affiliated Specialty: All of them

Why?

We already explained why understanding linear systems and the wide array of mathematical tools used to analyze them (Fourier and Laplace Transforms) is essential for an engineer. But why do we need to understand "discrete" linear systems? Well, it is true that most phenomena in the real-world function in continuous time. But you'll probably be using digital devices to interact with them. Microcontrollers and Digital signal processors don't use integrals and derivatives, they use discrete sums and multiplications. So, in making a control system or filtering an image file, or processing an audio file. You would begin by analyzing the system requirements and the input data (or system to be controlled) and then use discrete transforms to get a fancy transfer function, you can then turn to a difference equation which would probably be recursive. This can be interpreted into either a block diagram and hence a digital circuit or to a For loop in a block of code, (usually many for loops). It sounds like a lot of work and it is, but it is something that is useful and can be applied in real applications and that's something when it comes to a math module.

What?

First, you get to know discrete systems and how we describe them and the math to solve them (there are key differences from continuous time signals and systems it's not just a notation change, for example: Difference equations are very different compared to differential equations). Then you get to the discrete time Fourier transform (time domain is discrete but frequency domain is still continuous yet periodic), then the Discrete Fourier transform (here the frequency domain is discrete) Don't confuse the two. Then you get to the Z-Transform which is just the discrete Laplace but it's quite different since

Laplace kind of has a rectangular coordinates thing going on while the Z-transform has a polar coordinate thing. Lastly, you'll get to sampling theorems, mainly Nyquist-Shannon theorem and why that's important (ever seen that Anti-Aliasing setting in your videogame graphics settings? Well this is relevant to that).

What you should learn**: Find if a discrete signal is periodic or not, get to know discrete sums, solve difference equations via recursion, do graphical and mathematical convolution, Discrete time Fourier transform formula and properties, Discrete time Fourier transform Formula and properties, Z transform equation and properties, solve difference equations with previous transforms, do the inverse of all previously stated transforms, and finally get to know the sampling theorem.**

How?

This module is to be dealt with the same way its first part was handled, solve all your recitations, memorize your formulas properly and don't forget about block diagrams and graphical properties. And finally do many exercises from AV Oppenheim Signals and Systems book (The LS Bible). The same YouTube channels that you used in LS 1 properly have more videos on discrete systems too.

EE321: Computer Architecture:

Difficulty Rating: 6.17/10

Affiliated Specialty: All of them

Why?

We all know computers and we all know what they can do. But I feel like I need to clarify a misconception here. People assume that this module's purpose to help students understand desktop computers. But this is not completely true. This module does in fact help you understand computers on a basic level but modern computers are ridiculously complex machines beyond the understanding of a single engineer. And let's face it, I highly doubt many of us would get jobs in Intel, Nvidia or AMD and even if some do, this course wouldn't be that helpful anyway. This course is mainly towards Embedded systems, small specialized computers that do specific tasks efficiently (Controllers, PLCs, Communication hubs, medical devices and son on). A modern Intel CPU is extremely difficult to comprehend on a hardware level but an STM32, or a PIC microcontroller are within reasonable grasp of an engineer's understanding. So, in essence this is a course in understanding the architecture of processors in general, and their memory structures.

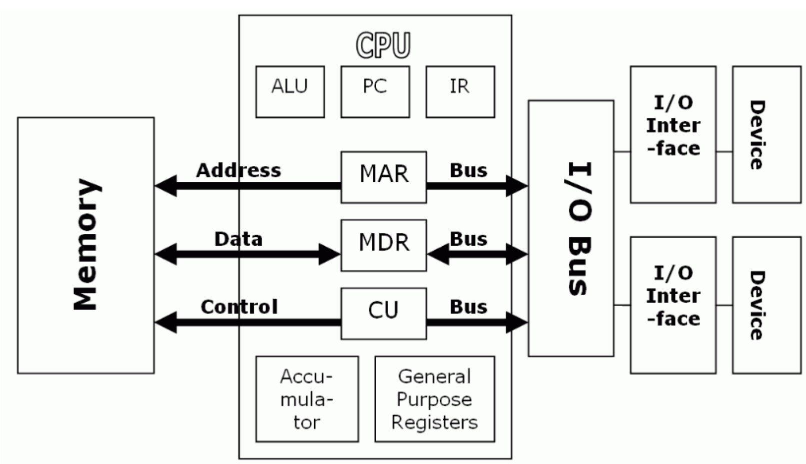
What?

The course begins with a review on digital devices in general (logic design, registers, multiplexers encoders etc…). Then it delves into a top-level overview of the main structure of a computer (CPU, Buses, Memory, I/O etc…) then goes on to the specifics starting with the CPU. There, you will learn about the Arithmetic Logic Unit and the control unit, and the different approaches in their design and of course the registers within them. Here, instruction sets are explained, along with addressing modes (This is an introduction to Assembly language). Afterwards, it would be time to explain memory (ROM, EEPROM, SRAM and DRAM maybe even Flash memory) and how they're constructed and addressed.

What you should learn: **familiarity with digital components (logic gates, registers, multiplexers/demultiplexers and encoders), Understand the buses and components of computers in general, understand the internal structure of the CPU and its buses and registers, understand the different types of addressing modes and how to write Assembly code, understand memory types structures (how they're arranged) and how to address them, understand interrupts and nested interrupts.**

How?

I highly recommend watching Ben Eater YouTube Channel since it gives you an intuitive understanding of how computers work. The key here is to learn how to simplify problems. You need to think on a clock cycle by clock cycle basis, to think of signals bit by bit. It sounds like nonsense but you really need to relax and think about the process step by step, the data is put on the bus, the control unit enables the register, the data is stored in the register, the address is put on the memory bus …. And so on. Just step by step guides, write a list for every process that usually helps and use diagrams lots of diagrams. This is not a module where you just memorize a technique or a process or a formula and apply it. This is a module all about slow methodical step by step analysis.



EE353: Process Control and Instrumentation:

Difficulty Rating: 4.94/10

Affiliated Specialty: Control & Power

Why?

Electrical and electronics engineering has wide applications in a variety of sectors industrial, commercial, and domestic. Most notably in creating control systems that use feedback to adjust to the changes of the external process. And Feedback requires sensors. This module is mostly about how to deal with different sensors and signals before you input them into your control system and finally an overview of some control systems. This module in my opinion is one of the most practical modules you'll encounter in all of your License degree.

What?

The course begins with an overview of control systems are made of, then goes on to "signal conditioning". Which is basically fixing up your sensor signal into a desired format (filtering, scaling, shifting, etc…). It is first done in Analog fashion mostly using OP Amps, and then digitally through analog to digital convertors and logic circuits. Afterwards, you would get introduced to essential types of sensors. Temperature sensors (RTDs, Thermocouples, Thermistors, ICs), Then Optical sensors, then finally Mechanical sensors (measuring force position and so on). And when and how to use each type of sensor. Later on, you will be introduced to the principles of the most famous type of controller ever: the PID controller. Lastly a brief overview of actuators (stuff you control to change the system) such as control valves and relays.

What you should Learn: **designing range convertor circuits, designing Bridge circuits, designing Lowpass and High pass and bandpass filters, designing Hysteresis comparators, adjusting DAC and ADC I/O signals (range convertors), calibrating Temperature sensors, Thermocouple cold junction compensation, designing around minimal self-heating, using interpolation in lookup tables, interfacing optical sensors, interfacing force sensors, designing PID controllers using OP Amps.**

How?

This module is fairly enjoyable to study in my personal experience. The best way to prepare for it is not to just understand and memorize sensor types and interfacing techniques, that is necessary but not sufficient. The way to go is to try different design problems yourself, from the source book or past exams or any online source. The challenge here is that design problems are no guided using step by step questions. This is why you need to learn how to design a solution by yourself. Do as many problems as you can studying for this module since even if you don't find those problems on the exam you would have still benefited significantly in understanding practical circuits and designs.

EE321: Microprocessor System Design:

Difficulty Rating: 6.52/10

Affiliated Specialty: Control & Computer

Why?

Microprocessors (these days it's mostly microcontrollers and No the Arduino is NOT a microcontroller it's a microcontroller on a development board) are the go-to problem solver in electronics. They are the link between software and hardware. They're used for monitoring, control, signal processing, communications, and a million other applications. So, understanding how they work is quite important. Unfortunately, the microprocessor used in this course is the Z80 microprocessor which is VERY old. But that also means that it is much less complex than modern commercial microprocessors and controllers so it's a reasonable starting point.

What?

The module begins with introducing the different types of assembly language instructions (more precisely the Z80 instruction set) and the assembler directives along with the programing Model (registers map) of the Z80 microprocessor. Then, the Z80 hardware features are introduced (how its pins and function and the role of each pin and what happens with each instruction on a clock cycle by clock cycle basis). Afterwards, Memory interfacing is shown (how to connect the Z80 efficiently with using minimum wires and hardware to different types of memory). Then I/O interfacing is explained (how to connect the Z80 to different I/O devices such as LCD screens, pushbuttons, LEDs, and many other simple devices). Finally, subroutines and the stack are introduced (which are used to basically create code that is all called upon often like C functions are used).

What you should learn: **understanding Z80 instructions and limitations, being able to write simple Assembly code, being able to write conditional code and loops in assembly, using registers as pointers in assembly, understanding CPU flags, understanding memory maps, understanding fetch, decode, memory read/write, cycles along with their external request signals, designing address decoders (both**

absolute and partial) , designing I/O interfacing circuits, writing subroutines while making use of the stack, and writing delay code based on CPU frequency.

How?

This module also requires the ability to relax and study the behavior of the Z80 one clock cycle at a time. You should also make use of some animations and videos for getting an intuitive sense of how it functions. You should also practice writing code yourself using an emulator and running it step by step to see how it functions.

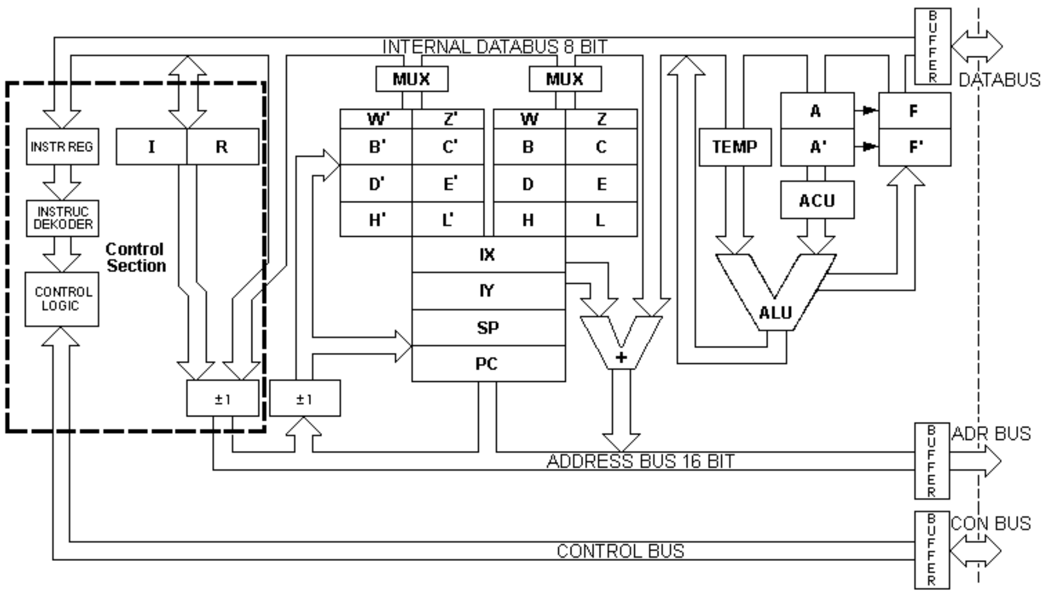


Fig 2. Z80 CPU internal organization.

EE353: Linear Control Systems:

Difficulty Rating: 6.09/10

Affiliated Specialty: Control & Power & Telecom

Why?

It is not too difficult to create basic controllers with very little accuracy using an on/off control pattern or open loop control (No feedback). But many systems have strict requirements (risetime, steady state error, settling time, overshoot, noise immunity, disturbance rejection, gain and phase margins…). Fulfilling these requirements in the optimal design possible with the simplest components possible. This module is about being given a set of standards (you could also come up with these requirements yourself if you know the exact use cases of your system) and a plant (a system to control), then you will use the mathematical toolkit you will learn in this course to develop a proper control system that fulfills said requirements. It's an extremely practical skill since many practical systems are roughly linear and have a single input and a single output.

What?

The content of this course begins with an introduction to control systems and their use cases. Afterwards, a review of the Laplace transforms since designing control systems in the time domain is absolutely horrible. But before you can analyze your system you need to translate a physical system into a mathematical model (There are three models for LTI systems: impulse response, transfer function, and state space representation but in this course, you will mostly use the transfer function). Afterwards, you will analyze your system in the S-domain and Frequency domain (is it stable? How stable it is? How does it respond to different inputs? How can I approximate it? What happens when I use feedback on it? What happens to it when I vary a parameter of the system? Etc…). Then you will learn how to design "compensators" to change your system response to match your requirements. Lastly you will analyze the system in the frequency domain and how it reacts to different frequencies and design compensators that fulfill frequency related requirements.

What you should learn: **How to use Laplace and inverse Laplace and their properties, How to extract a transfer function from: Op Amp circuit, Block diagrams, spring and mass systems, passive electric networks, and rotational mechanical systems, How to simplify block diagrams, How to use Routh Hurwitz to find if system is stable or the proper gain for stability, How to approximate system via dominant poles, How to find steady state and transient state metrics of first and second order systems (PO, Risetime, settling time…), How to calculate sensitivity, How to calculate steady state error for different inputs, How to draw Root locus plots, How to determine system response requirements in the S-plane, How to design PID, phase lead and phase lag compensators, How to drawn Bode plots, How to drawn Nyquist plots and tell stability margins from them, How to design compensators via Bode plots, and finally How to simplify system analysis for minimum phase systems.**

How?

An extremely helpful source in learning this module is Brian Douglas's playlist covering almost all parts of this module although in a different order. Make sure to watch it and also pay close attention to the lectures. The source Book: Modern Control Systems by Richard C Dorf is phenomenal with a wide variety of diverse and interesting problems with on a scale of difficulties. This module is very long but with enough effort and creative understanding it should be very rewarding to get the hang of it. There are a lot of good sources on the internet including MIT sources you could make great use of. Just read your lectures carefully and do exercises regularly. That last minute rush will never work on this module it's just too vast. You should also use MATLAB or Octave on this module since designing control systems in practice is done in software not with a pen in a paper even if understanding the design procedure is good to learn through pen and paper. I highly recommend using the MATLAB sisotool (type sisotool in MATLAB and wait) after you get to the compensator design part. It's an extremely valuable skill to learn.

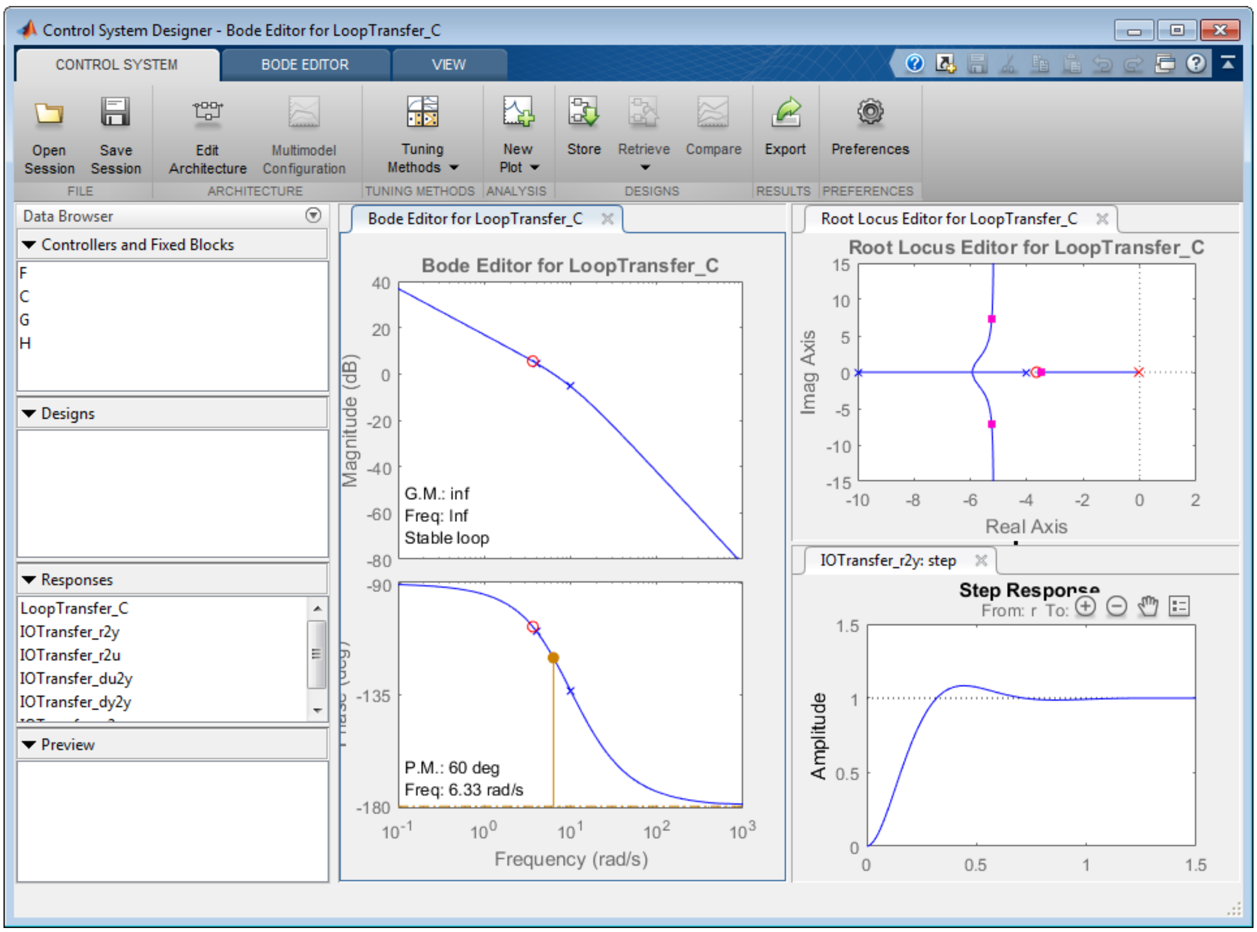


Illustration of MATLAB SISO control Toolbox

EE312: Communication Circuits:

Difficulty Rating: 7.80 /10

Affiliated Specialty: Telecom

Why?

This is in principle a course about how to design communication circuits, but it can be considered as an “Advanced Analog design” course or as I like to call it: Active devices on crack. This isn’t really a uniform module it’s more of a collection of “good to know” skills in analog design. It is not very useful nowadays with the digitalization of almost everything but Analog design is still key in three fields: Power, Telecommunications, and instrumentation. So, it’s useful to get a basic understanding of how analog signals behave in analog circuits.

What?

This course begins with a review on analog devices, (diodes, BJTs, JFETs, MOSFETs, and so on) But with a more accurate in depth look since this a course about precision and accuracy. Then you move on to frequency matching circuits, this sounds pointless but it’s quite useful. When you have two circuits of different input and output impedances, hooking them put directly would waste a lot of power and most of the signal will turn to heat. So, we just create circuits using inductors, capacitors, and transformers that “match” the circuits together so it’s like engineering a link between them. This is done through simple ell circuits and transformer circuits, but transformers are horrible so we can approximate circuits with transformers with circuits that have capacitors and inductors because math magic. Next chapter is about having nonlinear current sources, so in this chapter you try to find mathematical ways to analyze and approximate the output waveforms of these devices (sadly FETs and BJTs are somewhat nonlinear so this is unescapable math gibberish)

Finally, oscillators are introduced, it’s circuits that create sin waves. They’re basically control systems to be designed for a given amplitude frequency and distortion.

What you should learn: **Find values of BJT Q point via iterative analysis, design BJT biasing circuits (mostly voltage divider bias) with given requirements, design FET biasing circuits, design ell circuits and know which one out of the four types to use, learn how to design transformer like networks via the approximation, learn how to approximate a circuit via narrowband approximation using the S-domain graph, lean how to extract transfer functions of a circuit and impedance and admittance parameters, learn how to use harmonics tables to approximate the output of a**

nonlinear system, learn how to derive small and large signal transconductance of a circuit, learn how the function of Colpitts, crystal, WeinBridge and LC oscillators, learn how to derive their stability parameters.

How?

Unfortunately, when it comes to this module, there aren't many good resources for it, not even the source book. You should focus on understanding the key ideas of each of the things you should learn above, and do all the given exercises and then go on memorizing previous year exams. It's good to delve to the proofs and concepts AFTER you are able to solve exercises.

EE332: Energy Systems:

Difficulty Rating: 4.44/10

Affiliated Specialty: Power

Why?

Energy systems consist of all the hardware, technologies, and infrastructure used to generate and transmit electrical power to the final consumer. This field used to be a specialty that mostly benefited those who intend to work on Power stations or utility companies (in Algeria this means limiting yourself to a single employer). But times change, and the Electric grid is becoming more and more decentralized with the advent of renewable power and smart grid technologies. So, this course is useful to you if you either wish to work in such an industry or in industries where managing massive power transmission is necessary.

What?

This module begins by introducing the electric grid in general and its components, then goes on to the types of power plants. The first type of power plants is conventional power plants. Plants that fall under this category are thermal (burning coal, natural gas or less commonly oil to heat up steam pushing the turbine), nuclear, and hydroelectric plants. The second category is, predictably, non-conventional power plants. These are upcoming power generation technologies mostly solar photovoltaic panels and wind turbines. Although tidal and geothermal plants do exist, they won't be discussed in this course. Next, after learning about power generation you'd learn about power transmission. This means learning about the electric characteristics of transmission lines and how to optimize for them. (this part involves circuits). Then afterwards substations are explained which are a big collection of transformers and other components mostly for safety that are used to step down the transmission voltage to a lower level for local distribution.

What you should learn: **analyzing three phase circuits, the types of power plants, the principle of operation and components of power plants, efficiency energy and power calculations for a given plant, Advantages and disadvantages of each plant, Solar cell model, solar cell hierarchy, MPPT operation, wind turbine types, wind turbine operating modes, transmission lines models, reading energy system circuits, per unit system calculations, and distribution network topologies, and substation components**

How?

This module is fairly simple at first glance, but it's full of trivia and many equations so give it a reasonable timespan to prepare for it. There are tons of videos about energy networks and they're kind of fun to watch so check those out. And of course, do some example exercises and read your course very carefully.

EE382: Engineering Management:

Difficulty Rating: 3.68/10

Affiliated Specialty: N/A

Why?

I know this module sounds a bit irrelevant to you as an engineer but an engineer doesn't work in a vacuum. This is both useful for those wishing to start their own businesses and those who wish to work for a business since it's always useful to know how different departments function and how the business makes its plans. This is also useful in knowing how to deal with a team and organize your workload efficiently. It's not revolutionary knowledge but it is useful knowledge for those who wish to advance in their careers.

What?

The course begins by defining management, that sounds simple enough but it's more complex than you think Afterall this isn't an exact science. Then it's up to the planning function of management which is divided into many scales and types (SWOT analysis is useful here), then the organizing aspect which is great for working in a company or your own business. Then a more psychological chapter about leading and then controlling. The controlling part is mostly trying to optimize the performance of a company by measuring certain metrics. And Finally, Network scheduling techniques (this involves counting and graphs and charts and abbreviations lots of them)

How?

Read your lecture notes once in a while, read them a few times weeks apart, and memorize the terminology and learn to draw those networks and you'll be just fine. It's not too difficult but not a last-minute review either. Just review a few pages whenever you're done studying for another module and you won't feel this module on your shoulders.

EE392: Project:

Difficulty Rating: It's up to you

Affiliated Specialty: Your Choice

Why?

So, you can put what you learned in the last three years to the test, or more commonly learn a lot of new things. It's a great opportunity to learn something you're interested in and try solving problems more complex than what fits in a 1.5 hours exam.

What?

Do not choose something over your head, trust me. You can put fancy titles on the simplest of projects if you care about other people's expectations of you. The best way is to choose something precise and simple and if you manage to pull it off with ease you can simply add more features later on. Don't just attempt a big project and fail to deliver. Choose something you wish to learn about, not just whatever sounds cool, since in a year the project is done and buried and only what you learned remains. And for your sake, don't worry about the grade, the grades are commonly about how well you pull off your project idea not the idea itself. Some teachers offer their own ideas and some allow you to do whatever you want. Both options are good if the idea itself is fitting to what you wish to learn. You can build a circuit (analog, or digital using discrete components or microcontrollers), you could also choose to do a MATLAB/SIMULINK simulation of a power electronics system or some control system. You could do a software project as well, either completely software or use a Raspberry pi to implement it (AI is a very good choice in this section). But all in all, just focus on what you wish to build a career upon even if it's something simple or had been done a million times, it doesn't matter as long as you get some skills out of it.

How?

First you need to determine EXATCLY what your project is supposed to accomplish, and if possible, make some metrics to optimize for. Then put up a list of milestones (smaller steps done to achieve the goal) with estimated dates for accomplishing them to check if you're spending your time efficiently. Then once you begin the work it's better split independent tasks with your partners. And don't just try to tell them how to exactly do those tasks unless they ask for your advice. Just determine the expectations of each one of your tasks and judge by those. Review up the material you need for your project and if its documents printing the essentials might be useful. Don't delve too deep into the theories, since you would eventually go back to researching said material when things inevitably go wrong.

Personally, the most important thing I learned of my project is that the hardest part is not to do the Math or to do the circuit analysis or to write the code, but to choose what solution to use. It's essential to know the pros and cons of every solution you come across in your path of building up your design. And this is an extremely valuable skill in my view.

Concluding Advice

Your job during, at least, those 3 or 5 years, is to learn constantly. Learning is not just studying. Effective learning includes studying, reading, solving, asking, and memorizing. In order to learn effectively, you should understand how the human mind works and how you tend to behave (which is a far more complex topic to talk about here) and the best place to learn that is the course called "learning how to learn" by Barbara Okaly or read her book "How to become a great student even if you flunked algebra".

University life style is different, especially if you stay in camps. It's great thing to take control over your own life but don't be foolish enough to forget why you are in campus. Take a couple of hours each week to practice some sport, to read some book or to just get some extra sleep because this would really refresh your mind from the mental exhaustion of university life.
One of the most helpful things that you should do in your first year is to forget about your baccalaureate exam; don't think that after all that studying to get it you will find INELEC welcoming you with good grades so easily. I don't wish to give you a bad impression but simply put, if you want to learn and get the most out of INELEC and EE in general each semester will feel like a baccalaureate exam in itself. So, study hard and don't waste your time. There are many efficient ways to succeed so try different strategies at first and stick with what works, different people study in different ways.

Students at INELEC are good (mindset speaking) and when you get in touch with many of them you will build your knowledge and skills.

Ohh and one final note, you'll find many people telling you this is all pointless, just ignore them, trust me, just don't pay them any attention.

Appendix A: Using Books

In INELEC, you will be given a lot of big textbooks, and for many reasons most notably their physical weight and responsibility almost no one picks them from the library. Instead, everyone uses the pdf version. I know physical books are easier to read but it limits your scope, so get used to reading Pdfs, you will be reading a million datasheets anyway so it's a good thing to get used to.

Using books is a great way to study but you have to be careful since some books fall into the trap of giving too much nonsensical theoretical details and care about calculations way too much. But nevertheless, they are pretty good resources especially if you want specific details or problems.

If you decide to study using the textbook (which isn't possible for all courses), I suggest you skim through the chapter first (basically, you flip through the pages and you notice the stuff written in bold and observe the images and diagrams) then you go the problems part of the chapter and read a couple of them just to know what the purpose of this chapter is. Fortunately, most text book are designed and written with skimming in mind. Then finally, you go through the chapter but make sure you read it as a textbook not a novel, i.e. put a pen and paper in front of you and mark down the big ideas in each section and the stuff that needs more explanation. But don't forget to do some scratching and basic calculations. It is also advisable to do a summary or diagram of what you learned after each big section of the chapter.

The textbook method is great but requires a little bit more focus since you tend to lose it after 15 minutes of reading and sometimes a chapter is probably 20-50 pages which might require more than a week to fully go through it.

Another way of using books is to simply go through the course in different ways and only refer to the textbook when needed in complex ideas which spares you some time. But there are situations where the textbook is simply the ideal complete source to study from.

Appendix B: Note Taking

Note taking is a complex topic and it really depends on the person and his comfort with the subject. But if you want to really benefit from lectures, I suggest you should take notes and copy down some stuff, some bullet points, main ideas but not rigorous proofs and mathematical jargon. However, this also depends on the module itself (sometimes you find yourself writing only what's on the board, or every single word the teacher said, or even the titles and diagrams or plots only).

I personally, prefer to take small notes from lectures and small notes reading books and watching videos then get back to my copybook for Electronics I suggest you keep for all three years then write down a fairly detailed explanation to be kept as future reference beyond university perhaps or for future years.

Appendix C: Personal Projects:

Doing personal projects is the best to develop your skills and learn. Having some stuff that you do for yourself and to show them on interviews is a great mental escape from the university. Getting a breadboard simple component perhaps a multimeter and a microcontroller can be a very useful way to learn and it’s not too expensive. Just start small.

You can do many types of projects, and I recommend you start in First year by writing C Code and solving problems you find on the internet or C programming quizzes.

Then from mid second year onwards you should be doing constant new projects even if only by simulation. Get to learn MATLAB and design a simple control system or design or do some simple signal processing tasks. You can also use Simulink to model circuits and especially power electronics circuits and optimize them. You can Use Proteus to simulate PIC microcontrollers or simple AVR ones.

A very good type of projects is to get a component either physical or via simulation and try to interface it into a microcontroller. This will teach you embedded system programming and reading datasheets.

For those who are big fans of control systems the book: Modern Control systems has many design problems and examples you can try and implement in MATLAB.

It doesn’t have to be big, it just needs a small scope and a VERY clear end goal.

Appendix D: Personal References

I firmly believe that 80% of the stuff you learn in university you will only use in 20% of the time if not less, while in the other 80% of the time you'll be using only 20% of what you learned. I believe so because the complexity and details they teach you in university is not to simply get a task done but to troubleshoot problems and find solutions.

However, it is just a fact that you will forget most of the things you learn in university. Like how many times did you get that feeling of: "yeah we studied this but I forgot"? well my solution was to collect small pdfs and images that function as quick references and use the same books for references so whenever I fall into a problem, I don't waste time googling or searching through hundreds of book pages. I just check my google drive. Here is an example of mine:

My Drive > Referances > Embedded Systems

Name ↑	Owner	Last modified
Arm Cortex-M Comparison Table_v3.pdf	me	13 Dec 2020 me
Battery selection Chart.jpg	me	20 Sept 2019 me
C C++ Cheatsheet.png	me	17:34 me
ESP32-wroom-32_datasheet.pdf	me	27 Oct 2020 me
K- series devices.pdf	me	19 Oct 2020 me
PIC18F to STM32.pdf	me	19 Oct 2020 me
Rapid Control Prototyping Using Thesis.pdf	me	10 Dec 2020 me
Sinewave oscillators TI.pdf	me	28 Aug 2019 me
So You Wanna Be an Embedded Engineer_ The Gui...	me	28 Feb 2020 me
STM ARM MCU.png	me	18 Jun 2020 me

Appendix E: Online Learning Platforms

You should use these as a supplementary material to a course or to learn new skills even if the certificate is not obtained, learning new skills is always useful.

Coursera: thousands of academic level courses are here and they differ by topics (from art to AI to EE to biology to self-improvement) and you can always access the course materials and if you need that completion certificate you just ask for financial help.

EDx: nothing to say but the same as Coursera but with better quality courses from top universities around the world.

Edrak: good quality courses in Arabic and fully free with the certificate.

Appendix F: YouTube Channels List

Refer to this document which should be continuously updated:

https://docs.google.com/document/d/11DkN8Z0qqYiuNh4lGHL_kgojrhJ3OXy31AS0maROciU/edit?usp=sharing