

UBC Department of Electrical and Computer Engineering

ELEC 342 - Course Syllabus (Sep 2024)

Course Title and Description

- ELEC 342 – Electro-mechanical Energy Conversion and Transmission
- Three phase power; transformers and harmonics; magnetic materials and circuits, electromechanical energy conversion; DC machines; rotating magnetic field, AC induction and synchronous machines; variable frequency operation, brushless DC machines; stepper and single-phase motors. Credit will only be given for one of EECE 373, ELEC 342, and EECE 374.
- Pre-requisites: [PHYS 170](#) and [ELEC 202](#).

Contact Information

- Dr. L. R. Linares.
- Questions by private post on Piazza. On the days of lectures, in the evening at 9:30 pm, I will open an office hour on Canvas/Zoom.
- The TAs can be contacted also by private post on Piazza.

Course Structure

- The course has three components: lectures, laboratory and exams.
- Lectures: three (3) hours per week.
- Laboratory: three (3) hours every other week. The start of the labs will be announced the week before, on Piazza.
- Exams: two (2) hours test every other week (midterms). The first midterm will be announced the week before, on Piazza.
- Tutorials deployed as videos available 24/7 to the class.

Course Content

- Brief review of AC steady state of single and three-phase circuits. AC-steady state delta to wye and wye to delta conversions.
- The magnetic circuit. Magnetic fields, currents, magnetic flux, magnetic flux density, inductance. Faraday's Law. Biot-Savart Law. Ferromagnetic materials. Losses in ferromagnetic materials: eddy currents and hysteresis losses. Crude linear approximation of magnetic circuits using resistive electric circuits.
- The power transformer. The Ideal transformer. The real transformer. Equivalent circuit (model) of the single-phase power transformer. Simplified equivalent circuit. Phasor diagram of the power transformer. Three phase connections, delta, wye, zig-zag connections. Clock diagrams, and preferred connection groups. Parallel connection of three phase transformers, connection conditions: ratio, impedance, power, and connection group.

- Short circuit and open circuit tests for three phase power transformers.
- The linear DC machines. The linear machine as a motor. Starting current of the linear machine. Dynamic behavior of the linear machine.
- Magnitudes for circular motion, angular velocity, acceleration, torque. Newton's second law applied to circular motion.
- The DC machine: motors, generators. Equivalent circuit of the independently excited DC machine (generator, motor). Starting torque and currents. Dynamic behavior of the DC machine. Series, shunt, short compounded, and long compounded DC motors.
- The rotating magnetic field. Pulsating field. Positive and negative sequence rotating fields. Three phase windings. Harmonics in AC machines. Reduction of harmonics contents through the distribution, and pitch shortening of three phase windings. Distribution factor, pitch factor, total factor.
- The synchronous machine as a motor and as a generator. Equivalent single-phase diagram of the synchronous machine. The synchronous generator phasor diagram. The synchronous generator under varying conditions of power and excitation. The synchronous motor phasor diagram.
- The induction motor. Equivalent circuit of the induction motor. Power map in the induction motor. Torque versus slip. Maximum torque.
- Small motors (reading and watching assignment).

Course Learning Outcomes

- Developing confidence in handling magnetic fields and their associated physics laws in actual engineering devices.
- Exploring, following the steps of Tesla, the two-sides of the magnetic field: on one side, the electric reality, on the other, the mechanical world.
- Developing the framework necessary to build the electric systems view in fourth year. With electric machines interfacing the electric system with the mechanical world, at the input and very often at the output end.

Course Activities and Assessment

- Students are invited to join the Piazza site for the course where they can read announcements, and post and answer questions to/for other classmates, and also to communicate with the teaching crew (by private Piazza post exclusively). **Posting publicly questions that only the instructor can answer is deemed trolling and implies turning your account into a read-only one.**
- Lectures are heavily inter-active sessions with dynamic audio visual and board presentation of the core of each topic, followed by a series of discussion questions graded in-class through Top Hat from Monocle. The average of this in-class questions carries 10% of the global grade of the course. This grade includes participation and correctness as computed by Top Hat.
- Previous to each lab experiment, the student must go over a prelab preparation. The laboratory prelab work and its report grade carry 15% of the grade of the course. The student must pass the lab to be eligible to the final exam and eventually pass the course. Missing two lab

experiments implies failing the course. Expect oral questions during the lab experiment as part of your pre-lab evaluation.

- A WeBWork based interactive assignment with exam-grade questions (from five to 17 per set) is deployed every week (approximately). The average of all assignments adds up to 10% of the grade of the course. Failing to submit two WeBWork sets with more than 50% by the deadline implies failing the course.
- Every other week, in the two-hour session identified as “tutorial” in your time-table, a mini-midterm, which is graded by final answer on WeBWork) is run as follows: one-hour individual exam with one or two questions, followed by a 30 minutes team-part where students form teams to discuss the exam that they just handed in. During the team-part, they are also expected to submit their solutions after the said discussion. The individual part is worth 85% of the test, and the team-part is worth the other 15% (the “leadership” component). Depending on the term, we will hold between three to five such mini-midterms. The weight of the averaged mini-midterms is 25% of the course.
- A comprehensive two-and-a-half-hour final exam, same as the midterms also graded by final answer¹ exclusively, graded by WeBWork. The final exam scope includes every lecture, tutorial (video), homework, in-class questions, lab experiments and reports. Differently from midterms, in the final exam you must submit your work, not to be graded (the work is not graded), but to witness the authorship of the final answers entered to WeBWork as recommended by the University. This final exam must be passed to pass the course, it carries the rest of the percent of the course grades. If the student fails the final exam, the grade of the course will be the lesser between the global average of grades (MTs, homework, Top Hat, final, labs.) and 45%. To summarize and repeat what has been said, the grade of the course is computed like this (where TH = Top Hat grades, WW = WeBWork assignments grades, LAB = laboratory grades, MTS = midterms average, FINAL = grade of the final exam). Note: See Course policies to compute MTS depending on BRP.

$$\begin{aligned} ACC &:= 0.1*TH + 0.1*WW + 0.15*LAB + 0.25*MTS + 0.4*FINAL; \\ DFLT &:= OR(FINAL < 50, LAB < 50); \\ COURSE &:= IF(DFLT, MIN(45, ACC), ACC); \end{aligned}$$

¹ • Grading by final answer may seem draconian, but it is not, because students are allowed the use of a Mathematica/Maple-like software (XCAS inside the HP Prime) that does all the math for them, not only the arithmetic, also the algebra, and calculus; and also, because WeBWork warns them in real time when the answer entered is incorrect so he/she can go back and review his/her process and computations. When the math cannot be wrong, and the student has been warned during the exam that his/her answer is wrong, leaving it wrong is a clear indication that the student cannot solve the question. Also, questions have different sub-parts where the student collects partial marks. In paper-based exams, the questions are more conceptual, demonstrations, theoretical developments, no feedback until the papers are graded, and the only allowable calculators are basic scientific ones (like the ones used in high-school.)

Required Materials

- Required textbook: Stephen Chapman “Electric Machinery Fundamentals”, 4th Edition. McGraw-Hill. CAN\$ 160 (Amazon.ca price).
- The CAS enabled programmable graphic calculator HP-Prime (no cost, since all students have it since the second year.) No other calculator is suitable replacement, not even the HP-50g.
- The ELEC 342 laboratory manual, purchased from the UBC Bookstore.

Course Policies

- Formerly, students who missed a midterm or lecture, were excused with a doctor’s note (in such cases, the weight of the missed component was added to the final exam). Recently, the UBC Senate empowered students to “self-assess” themselves and present a form to the instructor if they cannot make it to a class or midterm.
- BRP: Students who have maintained a Top Hat global average better or equal than 65% and an assignment average better or equal than 85%, and have an attendance record better or equal to 90%, get their worse midterm grades replaced by the final’s grade (if the final’s is higher, of course.) In pseudo code (ATT is attendance in %, WW is homework, TH is Top Hat grade).

```
BRP:=AND(ATT>=90,AND(WW>=85,TH>=65));  
MTSr:=(MT1+MT2+MT3+MT4+MT5)/5;  
MTSb:=(MAX(FNL,MT1)+MAX(FNL,MT2)+  
        MAX(FNL,MT3)+MAX(FNL,MT4)+  
        MAX(FNL,MT5))/5;  
MTS:=IF(BRP,MTSb,MTSr);
```

Resources

- A set of several-hundreds of short videos (from 10 minutes to one hour long), prepared by Dr. L. R. Linares himself, empower students to pre-visit, and to revisit each topic as necessary in their own time, at their own pace. Those videos, made public free of charge by the author have been visited more than six million times by students, professors and engineers in more than a hundred countries, and have a following of more than forty thousand followers.

UBC POLICY ACADEMIC INTEGRITY

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the UBC codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidents of plagiarism or cheating may result in a mark of zero on an assignment or exam and more serious consequences may apply if the matter is referred to the President’s

Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

For more information, see: <http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0>

USING AI TOOLS

UBC general policy on using AI tools in courses is that “Students may use GenAI in work submitted for courses or other academic requirements only if expressly permitted within their courses’ instructor”. In ELEC 342 such tools are not permitted. For further information on UBC policies on this matter, visit <https://genai.ubc.ca/guidance/teaching-learning-guidelines/> https://it-genai-2023.sites.olt.ubc.ca/files/2024/08/Guidelines-GenAI_TL.pdf

HEALTH AND WELLNESS

UBC provides resources to support student learning and to maintain healthy lifestyles, while recognizing that challenges and crises can arise for students. There are resources in ECE and at UBC where students can find help and support, including wellness, equity, inclusion and indigeneity, resources for survivors of sexual violence, and health. Some frequently used resources are as follows:

- ECE Wellness Hub: <https://ece.ubc.ca/student-life/student-wellness/>
- ECE has an EDI.I committee whose goals are to improve equity, diversity and inclusion in the ECE Department, and support the [UBC Indigenous Strategic Plan](#). The committee welcomes feedback from all students, and can be contacted by emailing help@ece.ubc.ca.
- Central resource for supporting student success (medical and crisis support, Centre for Accessibility, and support for survivors of sexual violence): <https://senate.ubc.ca/policies-resources-support-student-success/>
- UBC Office of the Ombudsperson for Students: <https://ombudsoffice.ubc.ca/how-we-can-help/>

UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of UBC’s respectful environment policies, which all students, staff and faculty are expected to follow, can be found here: <https://hr.ubc.ca/working-ubc/respectful-environment>

ACADEMIC CONCESSION

The University is committed to supporting students in their academic pursuits. Students may request academic concession in circumstances that may adversely affect their attendance or performance in a course or program. Students who intend to, or who as a result of circumstance must, request academic concession must notify their instructor, dean, or director as specified in the link below. <https://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,329,0,0>

Students seeking academic concession due to absence from the final exam for any reason must apply to Engineering Academic Services (EAS) within 72 hours of the missed exam. This is a standard practice for all final examinations at UBC. For more information, see: <https://academicservices.engineering.ubc.ca/exams-grades/academic-concession/>

LAND ACKNOWLEDGMENT

This course is held on the UBC Point Grey (Vancouver) campus, which sits on the traditional, ancestral, unceded territory of the Coast Salish Peoples, including xʷməθkʷəy̓əm (Musqueam) First Nation, Squamish, Tsleil-Waututh, Stz'uminus, and Stó:lō First Nations. UBC is implementing its [Indigenous Strategic Plan](#), taking a leading role in the advancement of Indigenous peoples' human rights. To learn more about the Faculty of Applied Science's role in building upon the Indigenous Strategic Plan and committing to Truth and Reconciliation, please visit: <https://apsc.ubc.ca/EDI/>