PHYS4311 Syllabus

Course Description and Prerequisites

The course, Laboratory Physics (PHYS4311), is for those who plan to enhance their instrumentation skills and get experience as close as possible to real-life research. It offers experiments that are from modern physics research that are accessible with equipment of a teaching lab. This course is structured through reading, doing and observing, team work and problem-solving, with little lecturing. There will be 6 modules each with 1, 2 or 3 lab sessions. The first two modules provide basic trainings in instruments, signal transmission and data acquisition. Starting from Module 3, each one is a topic in physics: muon lifetime measurement is in particle physics, single photon double slit interference is in quantum physics, NMR or Nuclear Magnetic Resonance is in atomic physics. The last module is to use a CMOS image sensor to understand the principle of a detector, the pixel tracking device, used in particle physics experiments.

There are two 3-hour lab sessions a week. Students will be allowed access anytime to the lab with her/his SMU ID card, if more time to work with the instruments is needed. Students are encouraged to work in groups where discussions among group members will be easy. Although the measurements and data analyses may be group activities, each student must submit her/his lab report individually in Canvas, and in PDF format. No identical lab reports will be allowed. There will be one report for each module. This report will be due exactly one week after the last lab in the module. After that no lab report will be accepted. A template for the report will be provided and the students are asked to follow that.

Training and skills obtained in PHYS1105 and PHYS1106 will be needed in this course. Knowledge of basic data analysis and a computer language will help understand the observation. On top of these, the prerequisites also include the knowledge of undergraduate physics plus adequate math capability.

This study will be guided by Drs. Durdana Balakishiyeva and Jingbo Ye (dbalakishiyeva@smu.edu and yejb@smu.edu). The instructors will guide discussions on physics and instruments.

Learning objectives and textbook

Learning outcome At the conclusion of this lab course, a devoting student will

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receive training on basic instruments with data acquisition software in both Mechanical and Electrical measurements. The student will understand signal generation and transmission, with experience in constructing a real detector using a plastic scintillator. The training will complete with a real physics experiment to measure the decay lifetime of the fundamental particle muon (the second generation of leptons). The student will also learn how to research for information that is not provided in the lab manual, to analyze and present (with plots and tables) observations and measurements, and finally to write lab reports in a scientific way.

Textbook The lab manual will be provided to students in Canvas or in the lab.

Course Format and Information

This is a guided study. Students will read the lab manual and understand the requirements before coming to the lab. After discussion with the instructor and a thorough understanding of the problem in the lab, the students set out to perform the measurements, and discuss with the instructor about issues in the experiments and about the observations. The students will then turn in the lab report to earn the grade at the end of each module.

Class attendance is required, although students can have extra time in the lab if needed. The lab report submission deadline will stay firm, no late submission will be accepted.

Grading policy: Final grades will be the simple average of the grades of each lab report. The grade of the lab report has two parts: the technical correctness (95%) and professionalism (5%). This 5% professionalism in the lab report grade will be deducted if a student violates SMU and course specific policies. There will be no written tests and exams in this course. The Numerical grade and letter grade conversion is based on:

Letter	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
Numerical (%)	90.0	85.0	80.0	75.0	70.0	66.6	63.3	60.0	56.6	53.3	50.0	

SMU Required Syllabus Statements: please refer to these SMU policies and supports as posted at

https://www.smu.edu/OIT/AcademicTech/Instructional-Guidelines/Syllabus/required-syllabus-statements

Covid-19 policy related to this class: we follow SMU's policy posted at https://www.smu.edu/Coronavirus. Since this is a lab course and people have to work closely around the instruments, we require masks be worn by students and instructors when they are in the lab, even when you are alone in the lab. Students who fail to comply with this policy and after being reminded three times in the same lab session will not earn the grade of professionalism for that lab module.

Schedule:

Module # and name	Lab	Week #
1, Introduction to Essential Instruments	Time, mass and length measurements; voltage, current and resistance measurements; Oscilloscope and signal generator.	#1, Jan. 18 - 21
	Data acquisition and data analysis	#2, Jan. 25 - 28
2, Signal Transmission	Signal integrity and transmission speed in a coaxial cable	#3, Feb. 1 - 4
3, The Muon Lifetime Experiment	Set up the instrument, understand the physics	#4, Feb. 8 -11
	Acquire data and data analysis	#5, Feb. 15 - 18
4, Single photon double slit interference	Set up the instrument, understand the physics	#6, Feb. 22 - 25
	Perform measurements	#7, Mar. 1 - 4
	Analyze data and design a lab with electron	#8, Mar. 8 - 11
5, Nuclear Magnetic Resonance	Set up the instrument, understand the physics	#9, Mar. 22 - 25
	Perform measurements	#10, Mar. 29 – Apr. 1
	Analyze data	#11, Apr. 5 - 8
6, CMOS Pixel/Image Sensor and Readout	Construct the hardware	#12, Apr. 12-14(22)*
	Write the code to read out the sensor	#13, Apr. 18-21(29)*
	Analyze data and research on the readout ASIC of the ATLAS pixel detector	#14, Apr. 26-28 (May 3)*

* April 15 is a university holiday. Lab scheduled for that Friday is shifted to the next Friday. May 3 follow a Friday schedule.