

# Course Outline: Virtual Instrumentation

## OPSE 310 – 2018

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**Course webpage:** [moodle.njit.edu](http://moodle.njit.edu)

**Office Hours:** Tuesday 11.30 PM – 1.00 PM, Thursday 11.30 PM - 1.00 PM and **410 Tiernan or FMH 403B**, or by appointment

**Course Description:** Intended for all engineering, computer science, and science majors. Covers the basics of virtual instrumentation including use of IEEE GPIB, RS232 interfaces, and data acquisition boards. Interfacing of a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform such as National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisition and instrument control, instrument status, and acquisition speed.

- **Course Materials:** *LabVIEW 2009 - Student Edition* ISBN-10: 0-13-214129-9 ISBN-13: 978-0-13-214129-1, Instructor Handouts will be published on moodle.njit.edu when needed.
- NI materials: set of pdf files from National Instruments and set of programs from National Instruments: learning\_lv8\_0905\_2007 - zip files posted on moodle

**Note:** The laboratory manual will be distributed in class or via the [moodle.njit.edu](http://moodle.njit.edu)

**OPSE Lab Open Hours:** By appointment. Please find me at my office if you need the access to 403B lab.

**Prerequisites:** a 3 credit CIS programming course.

### Attendance

Attendance at lectures and recitations is mandatory; it may constitute a portion of the final grade. Missing three (or more) classes will be reported to the Dean of Freshman Studies throughout the semester and can result in failing the course. Students with absences need to discuss their extenuating circumstances for missing the classes with the Dean.

**Assignments:** You are responsible for all weekly reading and homework assignments listed in this outline or on moodle. Homework assignments must be turned in ON MONDAY each week. **(TUESDAY IS NOT A MONDAY)** All homework assignments must be submitted via [moodle.njit.edu](http://moodle.njit.edu). You should WINZIP the files before uploading a *single zipped file* to moodle. Any files that are infected with a virus will not be accepted. Group assignments will not be accepted. Each homework file must have the name (student name) and homework number in the title.

For some classes, you will have Lab assignments and in most cases; they form the basis of a Lab VI which you would be writing shortly. The Lab assignment are due at the *end of class* for which they are assigned. If you do not attend the class, you will not be permitted to submit the Labs. One purpose of the exercises is to BOOST your grade. You should not miss them.

**Exams:** One **midterm** exam (after ~ 6 weeks). You'll be required to make 4 to 5 simple programs during the regular class hours.

Final Project will be submitted at the end of semester.

Midterm exam counts as ¼ grade. Final Project each counts as 1/4 of grade. Homework counts as 1/4 of the grade. Labs/ Exercises - work done in the lab - counts collectively as 1/4 of your grade. Grades of below 70% will generally be considered as failing. Note: Failing grade in graduate school is "C" and below. Any absence will count for - (minus) 10% of the final grade.

**Late Assignments/ Missing Assignments:** Assignments that are turned in late, are graded 20% lower for each day during a "grace" period by default. After the 3 days "grace" period has expired, late/ missing / re-graded etc. assignments will not be accepted.

It is the student's responsibility to check the course web page for inaccuracies in reported grades.

**Honor Code:** For this course, the NJIT Honor code will be upheld. Any violations will be brought to the attention of the Dean of students. It is expected (but not required) that students will help each other with the course assignments. However, if two or more students turn in nearly identical work (ie. plagiarism), the students will all receive a zero score for the assignment and they will be referred to the Dean of Students. You can share ideas, but do NOT share code. If you use someone else's code (with the exception of sample problems from the class notes or textbook), you MUST cite the source of the code. Otherwise, you are plagiarizing.

**Grade Scale: (1000 points Max)**

1000>	A	>880
880>	B+	>820
820>	B	>760
760>	C+	>720
720>	C	>650
650>	D	>500
500>	F	

**Syllabus**

Students will be consulted with by the instructor and must agree to any modifications or deviations from the syllabus throughout the course of the semester.

Week	Topic	Lab Assignment will be posted on <a href="http://moodle.njit.edu">moodle.njit.edu</a>	Reading and HK Problems will be published on moodle.
1	The LabVIEW Programming Environment -Controls/ Indicators	Lab 1	Read: Chpt 1, 2 NI 1, 3, 4, 6 HK1
2	Programming Structures and Examples Auto indexing Creating Subvi's Debugging Timing issues (counters)	Lab 2	Read Chpt. 4, 5 NI 9, 15, 16, 17, 18, 19 HK2
3	Importing pictures Structures Global/ local variables. Arrays, Clusters	Lab 3	Read Chpt 6, 7, <a href="#">LFE: Chpt 12 p371-387</a> NI 20, 21, 22 HK3
4	Charts, graphs	Lab 4	NI 23, HK4

5	Strings, Local variables, tabs, SUB VI's	Lab 5	NI 33, 38, 39, HK5
6	Saving to files, reading from files File I/O	Lab 6	HK 6
7	GPIB setup / IBIC 488 vs. 488.2 commands GPIB serial poll byte. Timing of VI's Testing Device Status,	Lab 7	Read Chpt A, LFE: <a href="#">Chpt 11 p354-359</a> Lock-in Manual <b>p.21</b> , Funct. Generator Manual HK7
8	RS 232	Lab 8	general information on RS 232 <a href="#">LFE: Chpt. 11 p359-364</a> Read Chpt 7 Hk 8
9	Attribute nodes (graphs), Saving front panels Turning on /off controls/ indicators Menus, Idiot proofing	Lab 9	Read LFE Chpt 12, P 388-405 Read LFE Chapt12, p405-411 Hk 9
10	DAQ boards analog I/O	Lab 10	Read Chpt. 9
11	DAQ boards digital I/O Real-Time Control Systems	Lab 11	LFE: Act. 11-9
12	LabVIEW Advanced Topics (ActiveX)	Start working on final project.	
13	Advanced Topics - FFT, Frequency Filters, Time Domain Filters	Work on Final Project	
14	Finish up Labs and Final Project	Finish Final Project	

Lab Number	Topic
1	Getting Started with LabVIEW – Basic operations, controls and indicators, simple programming structures
2	LabVIEW – Debugging a VI, Sub-VI's
3	LabVIEW – Traffic Light - Programming Structure, Sub-Vis, Clusters
4	Charts, Graphs, Waveform graphs
5	Strings, Local variables, tabs, SUB VI's

6	Saving to files, reading from files, File I/O
7	Basics of GPIB - Setting up GPIB, addresses, simple read/write
8	Communication via RS232 / Serial Port. GPIB – Serial Poll Byte
9	Oscilloscope - Attribute Nodes, Menus
10	DAQ - controlling LED's, step motor
11	RC Circuit measurement - Timing issues
12	LabVIEW – Incorporating user written C subroutines, ActiveX
13, 14	Working on Final Project

**Final Project:** Using LabVIEW, create a VI program that controls an experiment consisting of at least three instruments. (Fewer Instruments can be used if MANY functions are controlled by the VI.) The VI should include:

- Plotting of data on the screen
- Saving of data to a file. Saved data must be readable by a spreadsheet program (like Excel or Lotus).
- At least 3 sub-VIs and at least 1 sub-VI embedded within another sub-VI (Student written).
- User-friendly instructions and controls
- At least one imported graphic and at least three different fonts and colors on the user interface window
- Adequate annotations within the block diagram window of all VIs and sub-VIs.
- For additional requirements, consult Final Project grading sheet on the course Web Page.

If you do not have an experiment in mind, a suitable one will be provided. For example:

- Measure the light intensity of two separate Light Emitting Diodes as a function of current. Instruments required: Power Supply, Photodiodes with Voltmeter (or Oscilloscope).
- Measure current versus voltage characteristic of two diodes and compare. Instruments required: Power supply, Voltmeter (or oscilloscope).
- Measure (and plot) intensity of light along an x - axis. The intensity sensor should be moved along the x – axis using Step Motor connected to DAQ. The intensity values are measured by power meter connected to Lockin Amplifier.

**A)** the light passes through a diffraction grating. Find positions of bright and dark spots. Fit the data into equation  $n\lambda = d\sin(\theta)$  where  $\lambda$  = wavelength,  $d$  = grating constant,  $n$ =order of diffraction, and  $\theta$  = angle with normal to diffraction grating

**B)** the light passes through single narrow opening. Measure the intensity of light as a function of sensor position and fit the data into equation:  $\left[ \frac{I}{I_0} = \left( \frac{\sin(0.5 \phi)}{0.5 \phi} \right) \right]^2$  where  $\phi = \frac{2 \cdot \pi \cdot a \cdot \sin(\theta)}{\lambda}$  and  $\theta$  = angle the light makes with normal to opening.

- Measure the value of a lens focal length. Use a laser beam splitted into two parallel beams (or 2 laser beams) directed to pass through measured lens. The light intensity meter is connected to a Lock-in Amplifier and moved along a straight line using Step Motor connected to DAQ.
- Measure capacitance of a semiconductor diode vs bias voltage using HP CV meter (if available). Find a slope of  $1/C^2$  vs bias voltage  $V$ .
- Additional projects may be added during the semester.

Note that points will also be awarded for creativity and difficulty level of the projects.