Syllabus

ELECTRONICS AND INSTRUMENTATION 3 SEM HRS Fall 2015

PHY3722C TuTh 12:00 A.M. -- 2:45 P.M. MAP 333A

Instructor: Dr. Christos Velissaris **Office:** PS 130 **E-mail:** Chris.Velissaris@ucf.edu.

Office Hours: Tuesday & Thursday 2:45 – 3:45 p.m. or by appointment. We can agree on a time to meet me if you talk to me after class or if you send me an e-mail.

Textbook: The class has a theory component and a laboratory component. The lab text book is required for the course since it contains all the exercises you will do in the lab. It is:

Experiments Manual to accompany Electronic Principles by Albert Malvino and David Bates McGraw Hill. 7th Edition.

The recommended textbook that matches the lab manual is the:

Electronic Principles by Albert Malvino and David Bates McGraw Hill. 7th (or 8th) Edition

Dr. Malvino explains electronic circuits in a very elegant way. The book though is written in a somewhat simple, introductory level. The circuits presented in the book refer extensively to the MultiSim electronics simulation program but unfortunately the book does not contain a student edition of the program. A student's edition of the MultiSim program can be bought separately for $40. Multisim is an electronic circuit simulation package, product of National Instruments. You can build virtual Analog and Digital Electronic Circuits at your PC and you can examine their properties and behavior using virtual multimeters and oscilloscopes incorporated in the program.

I can recommend you more books on electronics and Electric Circuits.

Microelectronic Circuits by Sedra and Smith, 5th edition, Oxford University Press. It comes with a very nice student's edition of the PSpice electronic circuit simulation program. It is a large book with very detailed information on the operation of microelectronic circuits. It is written in a more advanced level than Malvino's book and I recommended if you already know some electronics.

Analysis and Design of Analog Integrated Circuits Electronic Circuits, by Robert Mayer and Paul Gray, 5th edition, Wiley Publications. Together with Sedra nad Smith's textbook are considered the best in Analog Electronics. However they are written in an advanced level with emphasis to integrated circuits. The books are recommended but if you already know analog circuits with discrete components.

Fundamentals of Microelectronics by Behzad Razavi, Wiley. It is a rather advanced textbook at the level of Mayer-Gray and Sedra-Smith. However the writing style is easy to read and contains a lot of examples. Like Gray's and Sedra's books it is for the advanced student with solid Circuit and Electronics background.

Microelectronic Circuit Design, Richard Jaeger and Travis Blalock, McGraw Hill . Written also at the advanced undergraduate level it is recommended for the student already familiar with electronics and with very good knowledge of AC and DC circuits.

Foundations of Analog and Digital Electronic Circuits by Anant Agarwal and Jeffrey Lang, Morgan Kaufmann. It is an Excellent Introduction to AC/DC circuits, Analog and Digital entry level Electronics. I strongly recommend this book to students who wish a refresher to AC and DC circuits along with Electronics. Its strength lies not only on its simplicity but also on the fact that unifies AC/DC circuits with Electronics in a single pedagogical treatment.

Analog Electronic Circuits by Robert Northrop, Addison Wesley. It is a Classic book on Analog Electronics with Discrete components. Very elegantly and clearly written, it is very easy to read keeping the level of the content high. It is out of print and a copy of the book has been placed on the reserves at the Library.

Fundamentals of Electronic Circuit Design by David Comer and Donald Comer, Wiley Publications. It is a good introductory book on Analog Electronics, easy to read, covering all the material we encounter in the lab. A copy of the book has also been placed on reserve in the Library.

The Art of Electronics by Paul Horowitz and Winfield Hill, 2nd edition Cambridge University Press, together with the ***Student Manual for the Art of Electronics*** by the same authors containing laboratory applications. A classic, well known book on Electronics for Scientists more advanced than Malvino's book.

Shaum's outline of Electronics devices and Circuits by Jimmie Cathey. It is an inexpensive book with emphasis on problem solving and in depth analysis of circuits with FETs and BJT transistors. It contains though only a limited number of topics and it lacks the practical component that Malvino and Horowitz & Hill books have.

Shaum's outline of Electric Circuits by Mahmood Nahvi and Joseph Edminister. (on reserve)
Shaum's outline of Basic Electric Circuits by John O'Malley. McGraw Hill.
They are inexpensive books with emphasis on analyzing and solving DC and AC Electric circuits with passive components. They have good explanations on how to analyze complex ac circuits using complex numbers for impedance representation instead of phasors. Both books devote a section on how to solve circuits with op Amps.

Fundamentals of Electric circuits by Charles K. Alexander and Matthew N. O. Sadiku. McGraw Hill. It is a very good textbook on AC and DC circuit analysis. Also contains a Chapter on Op Amps and how to analyze circuits containing op amps.

Course Description and Requirements: PHY3722C has both a theory and a laboratory component both merged into an almost 3 hour class. The beginning of the class will be devoted into the theoretical analysis of the electronic component we will study. We may have a formal lecture or questions and discussion, depending on the complexity of the material and your preference. The portion of the class devoted to the lecture also depends on the students and the material we cover. If the student thinks the material is easy we will devote more time on the experiments. For more difficult material a larger portion of lecture is possible. The students should not hesitate to participate in the class and to provide continuous feedback.

The experiments you will do are chosen from the book *Experiments Manual to accompany Electronic Principles by Albert Malvino and David Bates* and a proposed list of experiments is given with the course schedule in this syllabus. Typically the course requires 2 labs per class. The first day of class is devoted into two easy experiments that introduce the students to the Electronic Lab. A manual on how to use the tools you need for the class will be provided by the instructor along with the Syllabus.

PHY3722C is a one semester course offered for students majoring in Sciences. Emphasis is placed on qualitative understanding of the major electronic components and circuits that you will most likely meet in your lab during your scientific career as an experimentalist. No calculus is required for this course only simple algebra and some trigonometry that you have most likely met with during your physics courses. It is going to be a fast paced course. We will not concentrate on the mathematical details of the operation of the various electronic components but on the way they are used in the lab and on a qualitative (almost intuitive) description of the way they operate.

Some simple algebra is however required to analyze the circuits of your experiment. You should also brush up from your Physics 2 course Ohms' and Kirchoff's two (the node and loop) laws and how to use these rules to analyze dc circuits. You will also need to know how to analyze ac circuits. You should have encountered in physics 2 ac circuits, the behavior of resistors, capacitors and inductors in ac circuits as well as the phasor method to analyze such circuits. By using complex variables the analysis is very much simplified. Your instructor has written a short manual on how to use the complex impedance when analyzing such circuits. You are advised to read it and/or ask his help on this topic if you have any questions.

Information about this course (syllabus, class-notes, etc) will be available at WebCourses. The website will be frequently updated as the course progresses itself.

Course Objectives: At the end of the course the student will be able to:

1) Use effectively a multimeter to measure voltage, electric current and resistances.
2) Use efficiently an oscilloscope.
3) Build and test electronic circuits on the breadboard, comfortably.
4) Read and understand schematics of simple electronic circuits containing transistors, FETs, op-amps.
5) Design and analyze simple electronic circuits, useful in laboratory experiments, containing

resistors, capacitors, diodes, and transistors..
6) Have a good understanding of the usage and operation of important electronic components and circuits: Op-Amps, diodes, transistors, FETs, oscillators, Filters, etc
8) Read and correctly interpret data sheets of commercial electronic components.
9) Understand thoroughly the usage of 741 op-amp in the lab, the rules of the op-amp when in negative feedback and how to use these rules to analyze circuits.

Finally if there is enough interest and time we will learn how to use the MultiSim (or PSpice) program to analyze simple electronic circuits.

Laboratory: The second part of the class will be devoted to your labs. You will work in groups of two students and you will be assigned one breadboard per group. The laboratory exercises you will do are given at the end of this syllabus at the course schedule section. There will be 28 experiments in the course all taken from your required lab textbook *"Experiments Manual to accompany Electronic Principles"* by Malvino and Bates.

In order to receive the full participation credit (50% towards your net class score) you must hand lab reports from at least 26 experiments. The experiments are described in your lab textbook. You will work in groups of two students and you will be given a lab kit with all the components you will need to do these experiments.

Data Sheets: Data sheets, for the electronic component and chips necessary for your lab exercises, should be used by the students to check out pin assignments, maximum current and power specifications, and other data pertaining to the safe operation of the components. Data sheets for these components you can find in your lab manual or posted by your instructor at: www.physics.ucf.edu/~cvelissaris/PHY3722_DataSheets .

Lab Notebook: as part of training to be a scientists students should maintain a personal notebook just as a research scientist does. This lab notebook will not be graded, but the student must have one and use it. A lab notebook with a sewn-together binding is preferred. Here is a guideline for lab notebooks: a notebook should contain sufficient detail so that a year later the experiment could be duplicated exactly. In the notebook, the student should:

1. Draw a schematic diagram for every circuit that is built
    - Label this diagram with:
        - part numbers
        - pin designations
        - output/input designations
    - Show the major components to external power supplies.

2. List the instruments used by type and model
    - Include in this list oscilloscope, multi-meters function generators, etc.

3. Draw the appearance of the oscilloscope display, if used
    - Indicate the vertical and horizontal axis with units.

4. Record a table of all measurements
    - Include units (e.g. mV) for inputs and outputs.
    - Record the scale (e.g. 200 mV) of the meter or oscilloscope.
    - Indicate where on the schematic the measurement was made.
    - For digital circuits this table may be in the form of a truth table.

5. For measurements that have an uncertainty:
    - List more than one measurement as an error check.
    - Estimate the error bar.

Prelab: In each lab <u>you may be given</u> some prelab questions. These are intended to help you prepare for the lab. These questions are not handed in and they are not graded. You should write your response and use it as a study guide. Your prelab answer sheet is considered part of your Lab Notebook. If you do not understand a prelab question, be sure to ask your instructor.

Lab reports: For each lab each group will prepare a lab report for grading. This report is distinct from the notebook. The notebook is not a substitute. Reports should be organized as a brief introduction and then an experimental section that is organized according to the section number.

- PREFACE: Brief introductory paragraph, ≈ 30 words describing the report's theme.

- EXPERIMENTS. Repeat the following for each experiment.
    - Apparatus
    - Procedure
    - Results. Where it is appropriate this section should include
        - Table and/or graph of results
            - label each curve
            - draw smooth curves through data points
    - Label axis and indicate units (e.g. Hz, mV)
    - Estimate of errors for analog measurements
        - Sketch or print of the oscilloscope display, if one was used and discuss briefly in a few sentences the features of the waveform to demonstrate that you understand the significance of the waveform.
        - Timing diagram (or truth table for digital circuits).
        - Explanations of any problems that you encountered.

Handwritten lab reports are acceptable. Typed lab reports are unnecessary. Be, brief but write in complete sentences. If preparing the lab report consumes significantly more than two hours talk to your instructor to ask if you are doing something that is unnecessarily time consuming

Homework: Periodic Homework will be assigned. The homework will contain a number of problems with electronic circuits that you have to analyze. Expect 3 to 5 homework assignment with 3 to 5 exercises per assignment. Your average homework score w1ll contribute 10% towards your final grade.

Disability Statement: The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. Students with disabilities who need accommodations must be registered with Student Disability Services, Student Resource Center Room 132, phone (407) 823-2371, TTY/TDD only phone (407) 823-2116, before requesting accommodations from the professor.

Examinations: There will be two mid term and one final comprehensive examination. Each mid term will contribute 10% and the final exam 20% towards your total score in the class. That is 40% of your total class score will be determined from these exams. The exam times and dates can be seen in the lab schedule below. There will be problems with electronic circuits to be worked out, similar with the lab exercises.

The Office of Disabilities Services will provide reasonable accommodation to students with disabilities. All problems from in-class exams will be reviewed in class during lectures.

Missed Work Policy: Make up or missed work will be permitted for the following reasons: Family emergency, religious observance, University sanctioned activities or bona fide medical emergency. Justifying documentation and a **written request** must be submitted personally to the instructor in every case.

Grading: The score from each of your two mid-term exams will contribute 10% towards your total score in the class. The final exam will contribute another 20% towards your total score. Your home-work will contribute 10% and your lab participation will contribute 50% of your total score. Your lab participation (and performance) will be assessed from your lab reports that you will hand to your instructor. You are expected to hand one lab report per group, per experiment and you will work in groups of two students.

Your total (final) score in this class will be determined according to the simple formula:

Total score in the course = 0.1 (average homework score) + 0.1 (first midterm) + 0.1 (second midterm) + 0.2 (final comprehensive exam) + 0.5 (Laboratory participation)

Your final letter grade will be determined from your total score in the course according to the following scale:

Letter Grading Scale:
$100\% \geq A \geq 90\% > A- \geq 85\%$
$85\% > B+ \geq 80\% > B \geq 75\% > B- \geq 70\%$
$70\% > C+ \geq 65\% > C \geq 60\% > C- \geq 55\%$
$55\% > D \geq 50\% > F$

NO GRADE INFORMATION WILL BE GIVEN OVER TELEPHONE OR E-mail.
All examinations will be closed book.

Disclaimer: The instructor reserves the right to make changes to the above syllabus. Any changes will be in effect only one week after announced to the students.

Course Schedule: A tentative course schedule is given with this syllabus. Since your instructor realizes that it might be a little ambitious, he reserves the right to make any change as necessary.

Date	To be covered	Experiments	Chapters
August 25	Introduction. Circuit and amplifier basics. Voltage and Current Sources. Thevenin and Norton Equivalent circuits.	1	1
August 27 September 1	Semiconductor theory and Diode theory. The diode I-V curve and diode approximations.	2 and 5	2, 3
September 3	Full and Half Wave Rectifiers. Rectifiers with capacitor filter.	8	4
September 8	The Zener diode and the Zener regulator.	12	5
September 10, 15	The BJT transistor. Physical operation and I-V characteristic. Transistor DC operation. BJT biasing in a single stage amplifier. The common emitter and base bias. Saturation and cutoff.	15 and (16 or 17)	6,7
September 17	Setting up the Q point. Transistor Biasing.	19 or 21	8
September 22, 24	Transistor AC small signal operation. Coupling and Bypass capacitors. The CE amplifier. AC emitter resistance. The CE amplifier and cascaded CE stages.	22 and (23 or 24)	9, 10
September 29	**EXAM 1**	**Diodes, rectifiers, transistors, amplifiers.**	1 – 10
October 1, 6	Power Amplifiers. Class A amplifiers. Class B Push-Pull amplifiers Emitter followers.	(26 or 28) and (29 or 30)	11, 12

October 8	JFET and MOSFET bias and amplifiers. Circuits and Applications.	32	13,14
October 13	Frequency effects in transistors and amplifiers. Lower and upper critical frequencies. Decibels and rise time.	37	15, 16
October 15	The Differential Amplifier. AC and DC analysis. Input bias and input offset current. Input offset voltage. Common mode gain and common mode rejection ratio. Current mirrors.	38 or 39	17
October 20, 22 October 27, 29 November 3	The Operational amplifier and its uses. Characteristic parameters and analysis of an op-amp. The virtual ground. Inverting and non-inverting op-amps. Voltage followers and summing amplifiers. Negative feedback and linear op-amp circuits. Gain bandwidth product. Ideal op amp rules in closed loops. Instrumentation amplifiers. Current boosters and voltage controlled current sources. Op amp bandwidth in open and closed loops. Op amp imperfections. Integrators and differentiators.	41 and 44 and 47 and 48 and 49	18, 19, 20
November 5	**EXAM 2**	**Amplifiers, FETs, Differential and op-amps.**	
November 10, 12	Active Filters. Low pass and Butterworth Filters.	50 and 51	21
November 17, 19	Voltage Regulators. Shunt and series regulators. Operations and characteristics of voltage regulators. DC to DC converters.	59 and 60	24
November 24 December 1	Current booster and current limiting circuits. Switching regulators and their three basic topologies	61	24, Project Presentation
12:00am-2:50pm Thu. December 3	**FINAL EXAM**	**Comprehensive**	