PHY 311 – ANALOG and DIGITAL ELECTRONICS

Instructor: Dr. R. Ochoa
Office: SC- P132
Telephone: 771-3162 e-mail:ochoa@tcnj.edu
Office Hours: Tuesdays: 11:00 a.m. to 12:30 p.m.
Thursdays 2:00 p.m. to 3:30 p.m.

Text: Galvez, E. J., "Electronics with Discrete Components," John Wiley & Sons (2013).

Laboratory Text: Electronics Lab. Manual – Posted on Canvas.

I. Course Objectives:

1. understand the nature and scope of modern electronics.
2. describe physical and mathematical models of electrical and electronic circuits.
3. design and construct simple electronic circuits to accomplish a specific function, e.g., a computer interface for collection of temperature data.
4. understand the capabilities and limitations of electronic instrumentation and make decisions regarding their best utilization in a specific situation.

II. General Course Content:

1. Basic physical concepts of electronics (Ch. 1)
   Charge. Current. Voltage. Resistance. Ohm's law. Power. Capacitors. Inductors. Circuits.
   Homework problems: 1.1, 1.3, 1.4, 1.5, 1.6, 1.8, 1.12, 1.14, 1.16, 1.17, 1.18, 1.20.
   Additional Problems A1, A2, A3, A4, & A5.

2. Intro to Digital Electronics (Ch. 2)
   Number systems. Binary Functions. Digital Gates.
   Homework problems: 2.2, 2.4, 2.5, 2.6, 2.7, 2.9. Additional problems A6, A7 & A8.

3. Combinational Logic (Ch. 3)
   Boolean algebra. Theorems. Simplification of functions. Karnaugh maps.
   Homework problems: 3.4, 3.9, 3.12.

4. AC Signals (Ch. 6)
   AC circuits. Periodic signals. Capacitors and inductors in AC circuits. Generalized Ohm's law. Thevenin's theorem.
   Homework problems: 6.3, 6.4, 6.5, 6.6, 6.11, 6.12, 6.13. Additional Problems A9, A10, & A11.

Midterm

5. Filters and Frequency Domain (Ch. 7)
   RC filters. High-pass filters. Low-pass filters. Important considerations for filter design.Transformer.
   Homework problems: 7.1, 7.5, 7.8. Additional Problems A12, A13, & A14.

6. Diodes (Ch. 8)

Physics of semiconductors. Diodes. Designing diode circuits. Diode fauna. Diode applications.
Homework problems: 8.4, 8.5.

7. Operational amplifiers (Ch. 10)
   Negative feedback. Op-amps. Closed-loop circuits. Open-loop circuits. Real Op-amps.
   Homework problems: 10.1, 10.2, 10.8, 10.9. Additional Problems A15, A16, A17, A18, & A19.

8. Transistors (Ch. 9)
   The bipolar-junction transistor. Field-effect transistors.
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III. Laboratories:

Lab. 1 Use of the digital multimeter.
Lab. 2 Familiarization with the oscilloscope.
Lab. 3 The Basic Stamp II and the Arduino board: thermistor application.
Lab. 4 Voltage Divider Applications. Analog voltage and binary States.
Lab. 5 Digital Logic Gates. Introduction to bit crunching.
Lab. 6 Arduino board: Chapter 2. Activities 2, 3, 4, and 6.
Lab. 7 Basic Analog to Digital Conversion. Digital to Analog the Easy Way using PWM.
Lab. 8 RC circuits and filters. Robotics with Basic Stamp II: Chapter 2.
Lab. 9 Arduino board: Chapter 3. Activities 2, 3, and 4.
Lab. 10 Diodes. Impedance Matching. Robotics – Arduino or Basic Stamp II: you decide!
Lab. 11 Rectifiers: half-wave and full wave. Robotics – Arduino or Basic Stamp II: you decide!
Lab. 12 Robotics – Arduino or Basic Stamp II: you decide!
Lab. 13 Robotics competition.

Laboratory work is a necessary aspect of the course. Every student must complete all lab assignments or they will be considered not to have completed all the requirements to pass the course.

IV. Assignment/Grading Procedure:

1Quiz	5%
1Midterm Test	15%
1 Final Examination	30%
Lab work	20%
Homework	10%
Robotics competition	20%

Homework is due one week after the corresponding chapter has been completed in the lectures unless otherwise noted. Late homework will not be accepted. All assignments to be handed in for grading and credit must be done thoroughly, according to the instructions, neatly, and on time. Assignments done carelessly will be returned without credit.

Grading Scale	
Final Score	Letter Grade
92.5 - 100	A
89.5 – 92.4	A-
86.5 – 89.4	B+
82.5 – 86.4	B
79.5 – 82.4	B-
76.5 – 79.4	C+
72.5 – 76.4	C
69.5 – 72.4	C-
66.5 – 69.4	D+
59.5 – 66.4	D
0 – 59.4	F

Fourth Hour:
In this class, the deep learning outcomes associated with TCNJ's 4th hour are accomplished through laboratory experiments

V. Bibliography:

Frederiksen, T. M., Intuitive CMOS Electronics: the Revolution in VLSI, Processing, Packaging and Design, New York: McGraw Hill, 1989.
Hill, F. J. and Peterson, G. R., Digital Logic and Microprocessors, New York: John Wiley, 1984.
Horenstein, M. N., Microelectronics Circuits and Devices, 2nd ed., Englewood Cliffs, NJ: Prentice Hall, 1996.
Howe, R. T. and Sodini, C. G., Microelectronics An Integrated Approach, Upper Saddle River, NJ: Prentice Hall, 1997.
Johnson, D. E., Johnson, D. R. and Hilburn, J. L., Electric Circuit Analysis, Englewood Cliffs, NJ: Prentice Hall, 1989.
Malmstadt, Enke, Crouch, Making the Right Connections, Washington D.C.: American Chemical Society, 1994.
Millman, J. and Grabel, A., Microelectronics, New York: McGraw Hill, 1987.
Osborne, A., An Introduction to Microcomputers. Vol. 1: Basic Concepts, Berkeley, CA: Osborne/McGraw Hill, 1987.
Purcell, E. M., Electricity and Magnetism, 2nd ed., New York: McGraw Hill, 1985.
Smith, K. C. A. and Alley, R. E., Electrical Circuits: An Introduction, Cambridge, England: Cambridge University Press, 1992.
Wait, J. V., Huelsman, L. P. and Korn, G. A., Introduction to Operational Amplifier Theory and Applications, New York: McGraw Hill, 1992.

VI. SELECTED TCNJ POLICIES

Final Examinations

The final exam is not scheduled until the middle of the semester. Therefore do not plan on any travel until after the

last day of the exam period. TCNJ's final examination policy is available on the web:

http://academicaffairs.pages.tcnj.edu/college-governance/policies/final-examevaluationreading-days-policy/

Attendance

Every student is expected to participate in each of his/her courses through regular attendance at all class sessions. It is further expected that every student will be present, on time, and prepared to participate when scheduled class sessions begin. While attendance itself is not used as a criterion for academic evaluations, grading in this course is based on participation in quizzes to be given at the beginning of several classes. No make-ups or extensions will be given unless a student has a genuine emergency. If a student misses an exam or assignment deadline they must contact the instructor within 36 hours to explain the situation; otherwise the student will earn a zero for that exam or assignment.

Students who must miss classes due to participation in a field trip, athletic event, or other official college function or for a religious holiday should arrange with their instructors for such class absences well in advance. In every instance, however, the student has the responsibility to initiate arrangements for make-up work.

TCNJ's full attendance policy *is available at:*

http://policies.tcnj.edu/policies/digest.php?docId=9134

Academic Integrity Policy

Academic dishonesty is any attempt by the student to gain academic advantage through dishonest means, to submit, as his or her own, work which has not been done by him/her or to give improper aid to another student in the completion of an assignment. Such dishonesty would include, but is not limited to: submitting as his/her own a project, paper, problem set, report, test, or speech copied from, partially copied, or paraphrased from the work of another (whether the source is printed, under copyright, or in manuscript form). Credit must be given for words quoted or paraphrased. The rules apply to any academic dishonesty, whether the work is graded or ungraded, group or individual, written or oral.

TCNJ's academic integrity policy *is available at:*

http://policies.tcnj.edu/**policies**/view**Policy**.php?docId=7642

Americans with Disabilities Act (ADA) Policy

Any student who has a documented disability and is in need of academic accommodations should notify the professor of this course and contact the Office of Differing Abilities Services (609-771-2571). Accommodations are individualized and in accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1992. *TCNJ's Americans with Disabilities Act (ADA) policy is available at:*

http://affirm.pages.tcnj.edu/key-documents