ITT Technical Institute

ET4771

Electronic Circuit Design

Onsite Course

SYLLABUS

Credit hours: 4.5

Contact/Instructional hours: 56 (34 Theory Hours, 22 Lab Hours)

Prerequisite(s) and/or Corequisite(s):

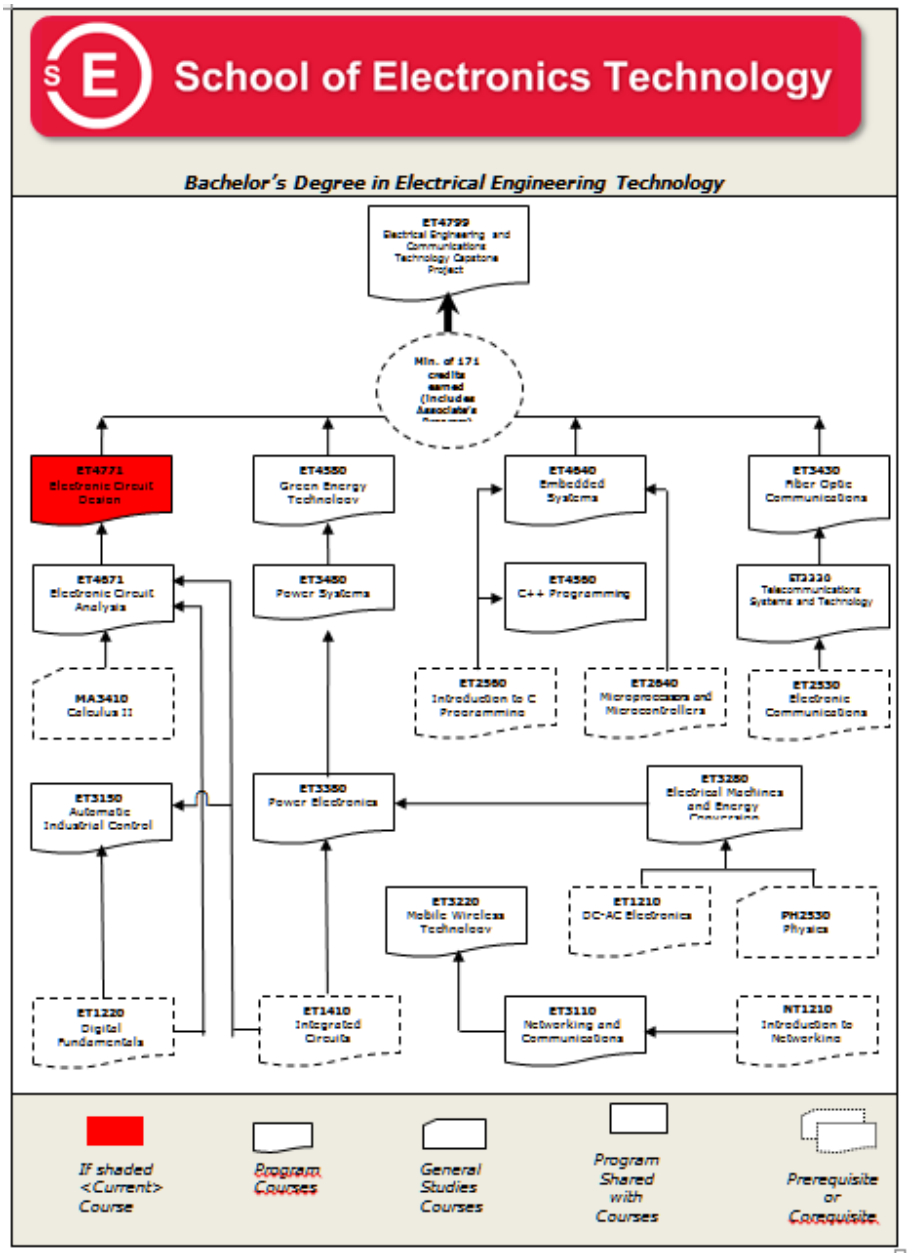
Prerequisites: ET4671 Electronic Circuit Analysis or equivalent

Course Description:

This course examines the design of electronic circuits, and includes a laboratory that utilizes computer-aided software tools for circuit design and simulation. Topics include active filters, rectifiers and limiters, digital integrated circuits and voltage regulators

Where Does This Course Belong?

The following diagram demonstrates how this course fits in the standard program:



NOTE: *Refer to the catalog for the state-specific course and program information, if applicable.*

Course Summary

Major Instructional Areas

1. OP AMPS
2. Active Filters
3. Fourier Analysis
4. S-Domain Circuit Analysis

Course Objectives

1. Describe the design of interface circuits.
2. Design OP AMP circuits that provide signal conditioning in instrumentation systems.
3. Describe Signal Waveforms and how they can be combined to create more complex signals.
4. Apply capacitance and inductance in the design of a circuit.
5. Describe and solve first and second-order circuits.
6. Analyze AC circuits driven by a single-frequency sinusoid.
7. Calculate transient response, frequency response, and phasor techniques using Laplace transforms.
8. Design circuits that realize a desired network function.

Learning Materials and References

Required Resources

Complete Textbook Package	New to this Course	Carried over from Previous Course(s)	Required for Subsequent Course(s)
Thomas, R. E., Rosa, A. J., & Toussaint, G. J. (2012). *The Analysis and Design of Linear Circuits* (7th ed.). Hoboken, NJ: John Wiley & Sons Inc.	■		■
Other Items	**New to this Course**	**Carried over from Previous Course(s)**	**Required for Subsequent Course(s)**
MultiSim Circuit Design Software		■	

Recommended Resources

Wiley Portal:

- Wiley Student Companion Sites

  Wiley offers a Student Companion Site for the course's required text. Log on to: http://bcs.wiley.com/he-bcs/Books?action=index&itemId=1118065581&bcsId=7050

  Or you can log on to www.wiley.com, then type the text ISBN (978-1-1180-6558-7) in the search bar on the upper right hand side of the Web page and click the search button. You will then be taken to a screen with the text cover image and title listed. Click on the "Visit the Companion Sites" link under the text title and then click on the "Student Companion Site" link from the drop down menu.

Books

- Nilsson, J. and Riedel, S.(2000). *Electronic circuits* (6th ed). Upper Saddle River, NJ: Prentice Hall.
- Johnson, D., Hilburn, J. Johnson, J. Scott, P. (1995) *Basic electric circuit analysis* (5th ed). Upper Saddle River, NJ: Prentice Hall.

Professional Associations

- Institute of Electrical and Electronics Engineers (IEEE)

  www.ieee.org

  This organization offers publications, standards, and access to different activities.

Professional Journals

The following journals are recommended from the IEEE professional association:

- IEEE Spectrum Magazine
- IEEE Transactions on Biomedical Circuits and Systems
- IEEE Circuits and Systems Magazine
- IEEE Circuits and Systems Digital Library
- IEEE Circuits and Systems Parts I and II, Regular Papers and Express Briefs
- IEEE Combined Power and Systems Journals
- IEEE Consumer Electronics Magazine

ITT Tech Virtual Library (accessed via Student Portal | https://studentportal.itt-tech.edu)

Search via Books> Ebrary

- Kishore, K. (2008). *Electronic circuit analysis*. Hyderabad, IND: Global Media.

Search via Periodicals> ProQuest

- The switching function; analysis of power electronic circuits. (2007, *Scitech Book News, 31*(3), n/a.
- Research and markets: The analysis and design of linear circuits, 7th edition. (2012, Apr 24). *Business Wire,* pp. n/a.

NOTE: All links are subject to change without prior notice.

Information Search

Use the following keywords to search for additional online resources that may be used for supporting your work on the course assignments:

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- Node voltage
- OP AMPS
- Mesh currents
- Linear circuits
- Signal waveforms
- Capacitance
- Inductance
- Transient response
- Frequency response
- Phasor techniques
- Fourier series

- Fourier Transform
- Impedance parameters – z-parameters
- Admittance parameters – y-parameters
- Hybrid parameters – h-parameters
- Voltage gain
- Current gain

Suggested Learning Approach

In this course, you will be studying individually and within a group of your peers. As you work on the course deliverables, you are encouraged to share ideas with your peers and instructor, work collaboratively on projects and team assignments, raise critical questions, and provide constructive feedback.

Use the following advice to receive maximum learning benefits from your participation in this course:

DO	DON'T
▪ Do take a proactive learning approach ▪ Do share your thoughts on critical issues and potential problem solutions ▪ Do plan your course work in advance ▪ Do explore a variety of learning resources in addition to the textbook ▪ Do offer relevant examples from your experience ▪ Do make an effort to understand different points of view ▪ Do connect concepts explored in this course to real-life professional situations and your own experiences	▪ Don't assume there is only one correct answer to a question ▪ Don't be afraid to share your perspective on the issues analyzed in the course ▪ Don't be negative about the points of view that are different from yours ▪ Don't underestimate the impact of collaboration on your learning ▪ Don't limit your course experience to reading the textbook ▪ Don't postpone your work on the course deliverables – work on small assignment components every day

Course Outline

Unit 1: CIRCUIT ANALYSIS TECHNIQUES

Out-of-class work: 10 hours

Upon completion of this unit, students are expected to:

- Apply Kirchhoff's Current Law (KCL) to perform a nodal analysis.
- Use the super node technique.
- Identify loops and meshes.
- Analyze circuits with currents in a shared branch.
- Develop mesh current equations.
- Use the super mesh technique.
- Describe the proportionality property.
- Apply superposition to analyze linear circuits.
- Apply unit output modeling to analyze linear circuits.
- Construct Thevenin and Norton circuit models.
- Design interface circuits.
- Calculate a proportionality constant.
- Evaluate alternate circuit designs.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 3, Sections 3-1 to 3-6, pp. 73-153	Assignment	Unit 1 Assignment 1: Problem Set	3.5%
	Lab	Unit 1 Lab 1: Interface Design Evaluation	3%

Unit 2: ACTIVE CIRCUITS AND SIGNAL WAVEFORMS

Out-of-class work: 10 hours

Upon completion of this unit, students are expected to:

- Analyze linear active circuits.
- Analyze inverting and non-inverting op-amp circuits.
- Analyze basic waveforms.
- Solve problems using basic waveforms.
- Apply time shifting to exponentials.
- Apply time shifting to a step waveform.
- Interpret the results after combining multiple waveforms.
- Analyze, design, and test a circuit.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 4, Sections 4-1 to 4-6, pp. 154-238, & Chapter 5, Sections 5-1 to 5-6, pp 239-279	Assignment	Unit 2 Assignment 1: Problem Set	3.5%
	Lab	Unit 2 Lab 1: Circuit Analysis and Design	3%

Unit 3: CAPACITANCE AND INDUCTANCE

Out-of-class work: 10 hours

Upon completion of this unit, students are expected to:

- Design with the capacitor and the inductor.
- Analyze the behavior of a capacitor.
- Illustrate dynamic op-amp circuits.
- Analyze dynamic op-amp circuits.
- Compute circuit component responses.
- Analyze integrators and differentiators.
- Analyze equivalent capacitance and inductance.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 6, Sections 6-1 to 6-6, pp. 280-312	Assignment	Unit 3 Assignment 1: Problem Set	3.5%
	Lab	Unit 3 Lab 1: Circuit Design	3%
		Unit 3 Lab 2: Design Analysis and Evaluation	3%

Unit 4: FIRST ORDER CIRCUITS

Out-of-class work: 10 hours

Upon completion of this unit, students are expected to:

- Analyze RC and RL circuits.
- Examine first order circuits.
- Explain and illustrate the step response in an RC circuit.
- Examine first order circuits.
- Explain the RC circuit response to a step input.
- Analyze circuits with initial values, final values, and time constants.
- Analyze first order circuit response.
- Analyze dynamic response to a step input with initial conditions.
- Generate and plot the voltage and current waveforms.
- Compute the natural and forced response.
- Examine initial and final conditions.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 7, Sections 7-1 to 7-3, pp. 313-337	Assignment	Unit 4 Assignment 1: Problem Set	3.5%
	Lab	Unit 4 Lab 1: Circuit Design	3%

Unit 5: STEADY STATE RESPONSE AND LAPLACE TRANSFORMS

Out-of-class work: 12 hours

Upon completion of this unit, students are expected to:

- Explain basic phasor concepts.
- Analyze phasor circuits.
- Convert sinusoids into phasor form.
- Examine inductor and capacitor impedance as a function of frequency.

- Compute AC impedance using superposition.
- Compute circuit response as phasors using superposition and Thevenin Models.
- Compute power and energy transfer.
- Compute Laplace and inverse Laplace transforms.
- Formulate a Laplace transform from a pole-zero plot.
- Apply the initial and final value theorems.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 8, Sections 8-1 to 8-6, pp. 379-476 & Chapter 9, Sections 9-1 to 9-4, pp.447-479	Assignment	Unit 5 Assignment 1: Problem Set	3.5%
	Lab	Unit 5 Lab 1: Circuit Design	3%
	Quiz	Unit 5 Quiz 1	14%

Unit 6: S-DOMAIN CIRCUIT ANALYSIS, FREQUENCY RESPONSE, FOURIER ANALYSIS, AND NETWORK FUNCTIONS

Out-of-class work: 12 hours

Upon completion of this unit, students are expected to:

- Explain basic circuit analysis in the s-domain.
- Develop Thevenin equivalent circuits in the s-domain.
- Illustrate superposition in the s-domain.
- Demonstrate mesh analysis in the s-domain.
- Compute Impedance.
- Analyze a circuit and solve for its poles and zeros.
- Analyze a circuit and compute its Thevenin impedance.
- Explain the meaning of pole-zero plots in the time and frequency domains.
- Explain network functions.
- Analyze network functions and compute impulse and step responses.
- Analyze network functions and compute their impulse and sinusoidal response.
- Design a network transfer function.
- Design and test a circuit to meet a specification.
- Compute network transfer functions.
- Compute the driving point impedance.
- Compute the voltage transfer function.
- Compute the impulse response.
- Compute the step response.
- Compute the poles and zeros.
- Compute the sinusoidal steady state output.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 10, Sections 10-1 to 10-6, pp. 490-534 & Chapter 11, Sections 11-1, 11-2, 11-7, pp. 545-561, 581-596	Assignment	Unit 6 Assignment 1: Problem Set	3.5%
	Lab	Unit 6 Lab1: Circuit Design	3%
		Unit 6 Lab 2: Design Analysis and Evaluation	3%

Unit 7: FREQUENCY RESPONSE AND FOURIER SERIES

Out-of-class work: 10 hours

Upon completion of this unit, students are expected to:

- Explain bode plots and give examples.
- Illustrate high-pass and band-pass filter design.
- Give examples of high-pass and band-pass filter design.
- Compare and contrast filter designs.
- Demonstrate band-pass and high-pass filter design.
- Calculate first order circuit responses.
- Demonstrate the Fourier series.
- Compute RMS and average power.
- Compute the Fourier transform.
- Calculate Fourier coefficients.
- Calculate transfer function, gain and frequency response.
- Calculate band-pass and band-stop filter responses.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 12, Sections 12-1 to 12-5, pp. 606-661 & Chapter 13, Sections 13-1 to 13-5, pp. 673-725	Assignment	Unit 7 Assignment 1: Problem Set	3.5%
	Lab	Unit 7 Lab 1: MultiSim Solutions	3%

Unit 8: ACTIVE FILTER DESIGN, MUTUAL INDUCTANCE, AND TRANSFORMERS

Out-of-class work: 12 hours

Upon completion of this unit, students are expected to:

- Calculate second order transfer function.
- Explain and illustrate the design of high-pass, band-pass, and band-stop filters.
- Explain and illustrate the design of low-pass filters.
- Explain coils.
- Calculate mutual inductance and coupling.
- Describe the ideal transformer.
- Calculate I-V relationships for circuits with mutual inductance.
- Calculate coupling in inductor circuits.
- Explain sinusoidal steady state behavior.
- Analyze a second order filter.
- Illustrate a Bode plot.
- Calculate a circuit transfer function.
- Analyze circuit frequency response.
- Analyze circuits with inductive coupling.
- Analyze circuits containing an ideal transformer.
- Analyze circuits containing a linear transformer.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, &	Assignment	Unit 8 Assignment 1: Problem Set	3.5%

Toussaint, Chapter 14, Sections 14-1 to 14-3, pp. 735-791 & Chapter 15, Sections 15-1 to 15-5, pp. 803-823	Lab	Unit 8 Lab 1: MultiSim Solutions	3%

Unit 9: POWER IN THE SINUSOIDAL STEADY STATE

Out-of-class work: 10 hours

Upon completion of this unit, students are expected to:

- Explain complex power.
- Calculate complex power.
- Analyze three-phase power circuits using phasors.
- Calculate line and phase voltages.
- Explain line and phase voltages using a phasor diagram.
- Analyze complex power in a circuit.
- Calculate power factor in a circuit.
- Analyze and compute apparent power, power factor, and voltages in a circuit.
- Compute power flow.
- Analyze a circuit and evaluate results.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 16, Sections 16-1 to 16-6, pp. 828-860	Assignment	Unit 9 Assignment 1: Problem Set	3.5%
	Lab	Unit 9 Lab 1: Circuit Analysis	3%

Unit 10: TWO PORT NETWORKS

Out-of-class work: 10 hours

Upon completion of this unit, students are expected to:

- Explain two port impedance parameters.
- Calculate the z-parameters for a two port network.
- Calculate the y-parameters for a two port network.
- Compute the h-parameters for a two port network.
- Explain two port admittance parameters.
- Compare and contrast admittance and impedance parameters.
- Compute a circuit's y-parameters from its z-parameters.
- Compute the hybrid parameters.
- Analyze a circuit and evaluate results.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Thomas, Rosa, & Toussaint, Chapter 17, Sections 17-1 to 17-6, pp. 868-884	Assignment	Unit 10 Assignment 1: Problem Set	3.5%
	Lab	Unit 10 Lab 1: Circuit Analysis (ePortfolio)	3%

Unit 11: REVIEW AND FINAL EXAM			***Out-of-class work:*** 6 hours
READING ASSIGNMENT	**GRADED ACTIVITIES / DELIVERABLES**		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Review all units	Exam	Final Exam	15%

Note: Your instructor may add a few learning activities that will change the grade allocation for each assignment in a category. The overall category percentages will not change.

Evaluation and Grading

Evaluation Criteria

The graded assignments will be evaluated using the following weighted categories:

Category	Weight
Assignment	35%
Lab	36%
Quiz	14%
Exam	15%
TOTAL	**100%**

Grade Conversion

The final grades will be calculated from the percentages earned in the course, as follows:

Grade	Percentage	Credit
A	90–100%	4.0
B+	85–89%	3.5
B	80–84%	3.0
C+	75–79%	2.5
C	70–74%	2.0
D+	65–69%	1.5
D	60–64%	1.0
F	<60%	0.0

Academic Integrity

All students must comply with the policies that regulate all forms of academic dishonesty or academic misconduct, including plagiarism, self-plagiarism, fabrication, deception, cheating, and sabotage. For more information on the academic honesty policies, refer to the Student Handbook and the Course Catalog.

(End of Syllabus)