

South Dakota School of Mines & Technology
Microwave Engineering Lab
Fall 2024
EE 481L/581L-M01 (3-1) 4 credits

Instructor Information

Instructor's Name- Thomas Montoya

Instructor's Contact Information- (605) 394-1219, Thomas.Montoya@sdsmt.edu, EEP 314

Office Hours- 8:30-9:15 am & 3-4 pm MWF, or when available (open door policy). No appointments.

As I do not always notice voicemails in a timely fashion, e-mails or in person are the preferred contact methods. Unless I am traveling or it arrives after 5 pm, I typically respond to e-mails the same day.

Course Information

Course Start/End Dates- 8/26/2024 to 12/18/2024

Course Meeting Times and Location- Th from 12-1:50 pm [9-10:50 am & 2-3:50 pm alternate times will be available as needed] in EEP 338

Course Delivery Method- The course will be delivered in-person for labs. The syllabus and link to my webpage <http://montoya.sdsmt.edu> will be posted on D2L. This webpage will be used for posting assignments, information, etcetera. E-mail will be used to notify students of course-related information/events (**check daily**) using your first.last@Mines.sdsmt.edu address.

Course Description

Presentation of basic principles, characteristics, and applications of microwave devices and systems. Development of techniques for analysis and design of microwave circuits.

Course Prerequisites- EE 382.

Course Corequisites- EE 481 or EE 581.

Student Learning Outcomes

Student Outcomes (SOs)

Student Outcomes are defined in ABET's accreditation standards for engineering programs:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Course Learning Outcomes (CLOs)

Upon completion of this course, students should demonstrate the ability to:

- A. Be able to calibrate and operate a vector network analyzer. (SO 6)
- B. Make proper microwave-cable connections using torque wrenches. (SO 6)
- C. Design and fabricate simple microstrip circuits. (SO 1, 5, 6)
- D. Measure the response of simple passive microwave circuits/devices using a vector network analyzer. (SO 6)
- E. Properly document and report results of experimental/laboratory work. (SO 3, 5)

Course Goals

The objective of this course is to introduce students to basic components, equipment, and measurements for microwave engineering as well as some design.

Course Topics

Calibration and operation of vector network analyzers, transmission line connections and measurements, fabrication of microstrip circuits, and measure the response of simple microwave circuits/devices.

Course Materials

Required Textbook(s) and Materials

Microwave Engineering (Fourth Edition), Pozar, Wiley, 2012, ISBN 978-0-470-63155-3.

Technology Equipment Needed for the Course

The course requires use of a computer and a scientific calculator (capable complex number operations) as well as a vector network analyzer.

Technology Skills Needed for the Course

Ability to navigate D2L and internet, upload/download files, use MS-Office programs, communicating via email, connecting computer audio/video, and Zoom (maybe). MATLAB and/or MathCad will be useful for some assignments. Some specialized electromagnetics software may be introduced.

Course Grading

Coursework

- Course instruction will be delivered in laboratories.
- Students in the graduate-level section will be given extra/different parts for lab assignments.
- Labs may be done individually or with 2-3 partners (TBD based on class size). No groups of 4 or more without prior permission. Avoid mixed undergraduate and graduate teams.
- Bring logbook, notes, text, and calculator to every lab.

- To facilitate grading, logbooks shall meet the following guidelines (see web page for some examples):
 - (a) Laboratory work should be in ink (black/blue) in a bound logbook (one per group minimum) unless otherwise specified. NO spiral notebooks or 3-ring binders.
 - (b) Use the front side of pages only, anything on backs will not be acknowledged.
 - (c) Mistakes should be neatly crossed out (i.e., don't scribble out, white out, etcetera)
 - (d) On cover, put a typed/word-processed label with: **EE 481L** and/or **581L**, **Microwave Engineering, Fall 2024**, and **your name(s)**. Optional- it is a good idea to put contact information on the cover or inside the front cover in case you misplace your logbook.
 - (e) Make a **Table of Contents (TOC)** on the first page- include lab number (if applicable), description/title, date(s), and page(s) (both start and finish).
 - (f) **Every page** in logbook should be numbered (prefer top right hand corner) whether used or not. You may start numbering on or after the TOC or use roman numerals for TOC.
 - (g) Start each lab by attaching the lab assignment sheet in the logbook (if applicable).
 - (h) Show all work in the logbook. For repetitive calculations, a single sample is sufficient.
 - (i) The goal is that another person would be able to duplicate the lab work without outside references. For example, partner(s) present, equipment list (include description, brand & model #s), dates, **block/circuit diagrams of test set-up** ... should be included, as applicable. Comments, conclusions ... are valuable in meeting this goal (i.e., they are expected).
 - (j) Leave space (e.g., 1/2") between consecutive parts of a lab, don't cram/squish entries together. Work in a single column, **NO** 'checker boarding.'
 - (k) Writing/figures/graphs must be legible (e.g., size and neatness)→ unreadable = no credit.
 - (l) Diagrams/figures/plots/graphs should be of a good size (e.g., 3" × 5"), and may contain colors. As applicable, they should be titled (at bottom), labeled (i.e., names / units on axes), scaled (i.e., numbers on axes), and clearly drawn. Tables should also be titled (at top).
 - (m) Diagrams/figures/plots/graphs/tables may be done using computer software and affixed (pasted or taped) on pages in the logbook. The bottom should be oriented toward the bottom or right hand side of the page. These items should be formatted fit logbook pages without needing to be folded over (limited exceptions for large and/or complicated drawings/tables). Leave space in logbook for them to be inserted as they occur, do **NOT** expect graders/readers to 'hunt down' or search for items inserted out of order.
 - (n) Do **NOT** insert loose material in logbook or attach multiple insert pages to a single logbook page, i.e., one insert page to one logbook page.
 - (o) Use notation and conventional engineering units & prefixes (i.e., MKS) as given in class and text. Entries with incorrect notation and/or incorrect/missing units are incomplete/incorrect.
 - (p) Answers should be boxed/double underlined or in table(s), in **decimal format** (if numeric), and the variables, values & units (if any) included.
- To facilitate grading, laboratory reports should meet the following guidelines:
 - (a) Reports should be single-sided, entirely word-processed documents with pages numbered.
 - (b) Use a font size ≥ 12 points and line spacing ≥ 1.1 .
 - (c) Include: 1) cover page (similar to logbook), 2) Introduction, 3) body (broken down into subsections based on the steps in lab), and 4) Summary & Conclusions.
 - (d) Unless otherwise specified, put calculations, results, m-files, and plots/figures in the **body** of the report in the order specified or as they occur. Appendices are NOT to be used as a

“dumping ground” for data, figures, and/or m-files. However, longer mathematical derivations may be attached as Appendices if referenced in the body of the report.

- (e) All plots/figures/tables should be **numbered and captioned** to allow easy reference.
- (f) Numerical results that are specifically requested should be put on separate line(s), not ‘buried’ in the middle of a paragraph.
- (g) To enhance readability, figures/plots should span width of page and face either the bottom or right of page. Remember that text on figures/plots that is too small might as well not exist.
- (h) On all plots, label horizontal and vertical axes, and insert a horizontal axis at 0. Put “EE 481L/581L, Lab/Project #, your initial(s), date” in the title. If a plot contains more than one trace, use different line colors/types and a legend to clearly identify each trace.
- (i) For all m-files, put filename, EE 481L/581L, Lab #, your name(s), and date in comment lines.

Attendance Policy

Attendance is required for **all** students, i.e., an individual will not get credit for a lab that they miss even if their usual partners attend/complete the lab.

Late/Make-up Assignment Policy

- Late lab assignments will be assessed a penalty of up to 10% a day.
- Make-ups for labs only allowed for school-related activities (athletic travel, conference, etcetera) or documented illness, ...

Academic Integrity

South Dakota Mines is committed to academic honesty and scholarly integrity. The [South Dakota Board of Regents Policy 2:33](#) provides a comprehensive definition of “Academic Dishonesty”, which include cheating and plagiarism. All Instructors at South Dakota Mines are required to report allegations of academic misconduct to the Student Conduct Officer. The [South Dakota Board of Regents Policy 3:4](#) provides detailed information regarding key definitions, policy information, prohibited conduct, and the Student Conduct process adhered to at South Dakota Mines. Any student suspected of violating academic integrity standards will be reported in accordance with the process outlined on the [South Dakota Mines website](#).

- Partners are expected to work together. Further, students are encouraged to discuss laboratory assignments/equipment with classmates in general terms. However, direct copying/plagiarism ... is not acceptable and will be penalized (e.g., grade of zero).

Grading and Assessment

Student learning is assessed by attendance/logbooks/reports related to lab activities/assignments.

Description	Percent
lab assignments (simple average)	100%

Special Note Regarding Final Exams: Per South Dakota Mines Policy ([II-6-2](#)), if you are scheduled to take three or more final/last exams on the same day during finals week, you may request that the middle exam(s) of the day be rescheduled. *You are required to make this request of your Instructor(s) at least 30 days prior to the last day of regular classes.*

Grading Scale- 10 > A > 9, 8.9 > B > 8, 7.9 > C > 7, 6.9 > D > 6, F < 6.

Academic Freedom Statement

Academic Freedom is the cornerstone upon which higher education is built. Academic freedom, as defined by [BOR policy 1:11](#), is fundamental to the advancement of truth, development of critical thinking, promotion of civil discourse, and contribution to the public good. Each course includes the freedom to discuss relevant matters and present various scholarly views in the classroom, as determined by the subject-matter expertise of the instructor. Students are encouraged to develop the capacity for critical thinking and to pursue the truth, debate ideas, express and evaluate their opinions, and draw conclusions. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.¹

¹ Language adapted from the American Association of University Professors "Joint Statement on Rights and Freedoms of Students".

Complaint Process

While we hope that every student has a meaningful and positive experience at South Dakota Mines, should a concern arise, students are encouraged to first attempt to resolve their concern directly with the person or office directly involved. Following that attempt, should the concern remain unresolved, students are encouraged to reach out to the Dean of Students office at DeanOfStudents@sdsmt.edu or 605.394.2416. Additionally, students may access the [online form](#) to submit their complaint, appeal, or grievance.

Grade Appeal Policy

In alignment with [BOR Policy 2:9](#), students who wish to appeal their final course grade shall first discuss the matter with the course instructor. If the concerns are unresolved following that discussion, students may utilize the [online form](#) to submit "Appeal – Academic" for a "Grade Dispute".

Opportunity for All - Student Success Services and Support

Students are provided a one-stop source for information regarding all the services and supports to ensure success. Visit the [Opportunity for All](#) page to access service and department information including ADA accommodations, Career Services, Counseling, Office for Inclusion, Slide Rule (math support), Student Success, Title IX, Tutoring, and Veterans Services, to name a few.

South Dakota Board of Regents Required Syllabus Statements

The following statements may be found online in South Dakota Board of Regents Academic Affairs Council Guideline [5.3.A](#):

- Freedom in Learning
- Americans with Disabilities Act
- Academic Dishonesty and Misconduct
- Acceptable Use of Technology
- Emergency Alert Communications

Electronic Devices Policy

Please silence/turn off your cell phone before lab starts. No text messaging or headphones in the laboratory.

Tentative Course/Lab Schedule (subject to revision).

Lab Date	Activities – Assignments
0 9/5/24	Lab syllabus and expectations. Familiarization w/ lab layout.
1 9/12/24	Introduction to Vector Network Analyzer
2 9/19/24	Lossy Transmission Lines
3 9/26/24	Terminated Transmission Line Measurements
4 10/3/24	Impedance Matching
5 10/10/24	Waveguide and Horn Antenna
6 10/17/24	Microstrip Transmission Line Design and Fabrication
7 10/24/24	Terminated Microstrip Transmission Line
10/31/24	Makeup/Open Lab
8 11/7/24	Resistive Power Divider
9 11/14/24	Power Divider
10 11/21/24	Microwave Filter Design/Fabrication
11/28/24	Holiday
11 12/5/24	Microwave Filter Measurement