ECE 329 **Homework 14** **Due: Wednesday, December 10, 2025, 4:59 PM**

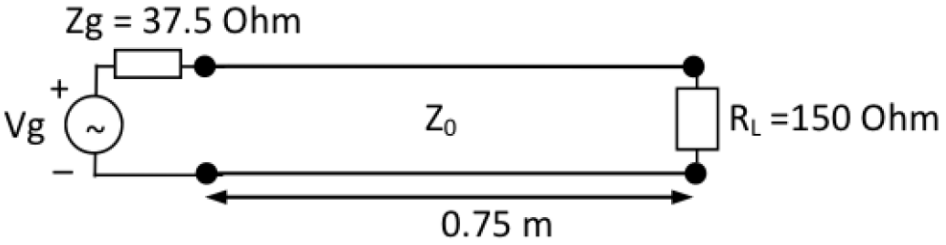
- This last Homework is due on Wednesday, December 10 (the last day of instruction in Fall 2025). However, the submission on Gradescope will be open with no penalty until Thursday, December 11 at 11:59:00 p.m. Late homework after December 11, 11:59:00pm will not be accepted.
- Homeworks are to be turned in to Gradescope.
- Any deviation from the following steps will result in a 5 point penalty:
  - Write your name, netID, and section on each page of your submission.
  - Start each new problem on a new page.
  - Scan the homework as a PDF (rather than taking pictures). Use a free scanning app if you do not have access to a photocopier.
  - Upload the PDF to Gradescope and tag each problem's location in the PDF.
- Each student must submit individual solutions for each homework. You may discuss homework problems with other students registered in the course, but you may not copy their solutions. If you use any source outside of class materials that we've provided, you must cite every source that you used.
- Use of homework solutions from past semesters is not allowed and is considered cheating. Copying homework solutions from another student is considered cheating.
- Penalties for cheating on homework: a zero for the assignment on the first offense, and an F in the course on the second offense.

Reading Assignment: Kudeki: Lectures 35-39

1. In the transmission-line circuit shown below the voltage at the load is $V_L = j15$ V. The operating frequency is 300 MHz. Given that the line is lossless of characteristic impedance of 75 Ohm with wave velocity 3×10^8 m/s, calculate the following:

   a) The time-average power dissipated at the load;

   b) The time-average power delivered by the generator.



2. A TL with characteristic impedance $Z_o = 25\,\Omega$ and length $l = 0.45\lambda$ is terminated with a load $Z_L = 100\,\Omega$.

   a) Using a SC, determine (i) the load reflection coefficient Γ_L, (ii) the generalized reflection coefficient $\Gamma(d)$ at $d = l$, and (iii) the input impedance $Z(l)$ at the generator end. Hand in your S.C.

   Hint: you start by entering $z_L = \frac{Z_L}{Z_o}$ in the SC. Express Γ_L and $\Gamma(l)$ as complex numbers in polar form — i.e, as $|\Gamma|\angle\theta$.

   b) Using $Z(l)$ from part (a), determine the voltage phasor $V(l)$ at the generator end if the generator has an open circuit voltage phasor $V_g = 10$ V and a Thevenin impedance $Z_g = 50\,\Omega$.

   c) Given the result of (b), determine V^+ such that $V(d) = V^+(e^{j\beta d} + \Gamma_L e^{-j\beta d})$.

   d) What is the load voltage phasor $V(0)$ given the result of (c)?

   e) What is the corresponding load current $I(0)$?

3. A TL with characteristic impedance $Z_o = 50\,\Omega$ and length $l = 0.4\lambda$ has an *open* termination at $d = 0$ *and* a $50\,\Omega$ resistor connected between the TL conductors (a "shunt" connection) at $d = 0.2\lambda$. Use a SC to determine the input impedance and admittance of the line at the generator end, i.e., $Z(l)$ and $Y(l)$. Hand in your marked SC.

   Hint: first move by 0.2λ from the load point (where you enter $z(0)$ or $y(0)$) toward generator on the SC, read off the corresponding $y(d)$, combine it in parallel with the shunt element, go back onto the SC with the normalized combined admittance, and move another 0.2λ toward the generator...

4. Two TL stubs of equal lengths $l = 0.3\lambda$ and identical short terminations have unequal characteristic impedances of $Z_o = 50\,\Omega$ and $100\,\Omega$. If the two stubs are connected in parallel at their input ports, what is the input admittance of the combined network. Use a SC to solve this problem and hand in your marked SC.

5. A transmission line having a characteristic impedance of 50 Ω is terminated by a load of unknown impedance Z_L. Measurements of the voltage amplitude $|V(d)|$ along the line reveal a "standing wave pattern" with a maximum voltage of 8.4 V and a minimum voltage of 2.1 V.

   a) What is the voltage standing wave ratio (SWR or VSWR) on the line?

b) A voltage minimum is observed at distance $d = 2.592\lambda$ from the load. What is then the distance d_{min} between the load and the first voltage minimum (closest to the load)? Hint: successive voltage minima are $\frac{\lambda}{2}$ apart.

c) Determine the magnitude and and phase angle of the load reflection coefficient Γ_L using the S.C. and the results of parts (a) and (b). **Hint:** Given the VSWR, constant-Γ circle passes through $z = \text{VSWR} + j0$ on the S.C. The same location on the S.C. also correspond to the location of a voltage maximum on the line.

d) Determine z_L using the S.C. and the value Z_L in Ω's.

e) Determine $|V^+|$ and $|V^-|$, the travelling wave amplitudes on the line.

f) What is the average power (in W) delivered to the load?

6. We want to use a quarter-wave transformer to match a load Z_L to a T.L. with a characteristic impedance $Z_o = 50\,\Omega$. The quarter wave transformer is to be inserted at a distance $d_1$away from the load.

   a) Determine d_1 (in units of λ) and the characteristic impedance Z_{qo} of the quarter wave transformer if

      i. $Z_L = 100\,\Omega$,

      ii. $Z_L = 100 + j100\,\Omega$.

   b) For $Z_L = 100 + j100\,\Omega$, what is VSWR in the region

      i. $0 < d < d_1$,

      ii. $d_1 < d < d_1 + \frac{\lambda}{4}$.

7. We want to use a single-stub tuner to match a load Z_L to a T.L. with a characteristic impedance $Z_o = 50\,\Omega$. A shorted-stub is to be connected at a distance $d_1$away from the load.

   a) Determine d_1 (in units of λ) and the length d_s of the shorted stub if $Z_L = 100 + j100\,\Omega$ and the characteristic impedance of the stub is $50\,\Omega$.

   b) Repeat (a) if the characteristic impedance of the stub is $100\,\Omega$.

8. The next few assignments aims to enhance your understanding of electromagnetics by engaging with the AI Course Assistant – AristAI and generic AI tool(s). Through this exercise, you will navigate course materials, analyze AI-generated solutions, and reflect on the learning process. By completing this assignment, you will gain hands-on experience in leveraging AI tools for academic purposes, develop critical evaluation skills, and deepen your understanding of electromagnetics concepts.
   Accessing the AI Course Assistant:

   a) Ensure you have access to the AI Course Assistant developed for ECE 329. You can access the AristAI – TA tool from the embedded modules (left side) on Canvas website.

   b) Log in using your university email or anonymously using an alternate email address. You may need to use DUO to scan the QR code for two-factor authentication.

   c) Familiarize yourself with its functionalities, including querying lecture topics, locating specific content within course materials, and solving problems.

   Note: You don't need to submit anything for problem 8.

9. AI-Powered syllabus question
    a) Select one of topic from the course syllabus, for example, topics covered, grading policy, number of homework, office hours, exam schedule, etc.
    b) Use the AI Course Assistant to find out the answer about the topic. Record your prompt to the tool and the provided answer.
    c) Comment on the accuracy of the AI tool by cross-referencing with the syllabus on the course website.
    d) Would AI's performance change if the questions were phrased differently?
    e) Compare two other publicly available AI tools and compare the experience against AristAI.
10. AI-Powered lecture navigation
    a) Select one of the key concepts from the course, for example, Lenz's law, Poynting's Theorem, Planewave propagation in good conductor, or circular polarization, smith chart, etc.
    b) Ask AristAI where this topic appears in the lecture notes (from any professor) and recordings. Record your prompt to the tool and the provided answer, including the page numbers from lecture PDF and timestamps of lecture recordings (which recording, start and end of timestamps).
    c) Comment on the accuracy of the AI tool by cross-checking AI's references with the actual course materials.
    d) Would AI's performance change if the questions were phrased differently?
    e) Compare two other publicly available AI tools and compare the experience against AristAI.
11. AI vs. student problem-solving
    a) Choose one problem from the lecture notes or previous exam problems. Document the problem in your report.
    b) Input the same problem into the AI Course Assistant and record its solution.
    c) Comment on the accuracy of the AI tool by stating if the solution is:
        i. Correct: do nothing.
        ii. Incorrect: identify any discrepancies or errors in the AI's solution.
        iii. Not a complete solution: identify whether you can ask the AI to complete the solution or provide further steps? Document the updated answer or follow the steps indicated by AI to complete the solution.
    d) Would AI's performance change if the questions were phrased differently?
    e) Compare two other publicly available AI tools and compare the experience against AristAI.
12. Survey
    a) Finish this survey on webtool: https://forms.illinois.edu/sec/1659789829
    b) You will receive 0.5% extra credit on your final grade for answering the survey.