# Syllabus for MATH 324, Complex Variables (3cr)

Spring 2021 at UWSP Hybrid Format: (Meet live Via Zoom W 3:00-3:50, and other lectures available in Canvas)

**Instructor:** Paul Martin, Office at Wausau Campus: 087-B, Ph 715-261-6272, email pmartin@uwsp.edu

**Office Hours:** M-F 10:00 –10:50 and other times other than 8:00 or 11:00AM as available. Simply send an email to request a meeting. Due to COVID restrictions, all office visits will be virtual. You can enter the virtual office which is open 24-7 to all of my students at:
https://us.bbcollab.com/guest/6907413811a44e868ccab5fff794fb33
In this blackboard collaborate room, we can share video and applications and a shared whiteboard. I will be in the room at 10:00 on M-F. Students are also encouraged to use the room to study together. I am also happy pop into the virtual room at other times, just send an email.

**Text:** Complex Variables and Applications, 9th ed, by James Ward Brown and Ruel V. Churchill. I was able to find a free download online.
The content of this course is a beautiful piece of mathematics. It will require active participation on your part as the content steadily builds starting with the basics of complex numbers. I encourage you to read through the textbook, watch the lectures, work through and at least put in a serious attempt at the assigned problems and ask questions during our weekly Zoom class meetings.

**Course Catalog Description:** Complex numbers, functions of a complex variable; power series; elementary functions; conformal and bilinear transformation; integral theorems; Taylor/Laurent expansions; theory of residues; applications.
The Main content in reference to the textbook is chapters 1-7 with a brief description of each below.

1. Complex numbers and the complex plane. Rectangular and Polar form, arithmetic and $n^{th}$ roots…
2. Analytic functions: Limits, continuity, differentiability, Cauchy Riemann equalities, harmonic functs…
3. Elementary Functions $f(z)$: $e^z, \ln(z)$, $z^c$, trig(z), trigh(z), invtrig(z), polys, rational functs,
4. Integrals: Contour integrals, Antiderivatives, Cauchy Integral formula, Liouville's Thm…
5. Infinite Series: Taylor series, Laurent series, Absolute/Uniform conv of power series, integr and diff…
6. Residues and Poles: Singular points, residues at poles, at infinity, Cauchy Residue Thm…
7. Applications of Residues: Evaluation of improper real integrals using contour integrals and residues.

**Homework:** There will be homework sets due each non-exam week. These will mostly be from the textbook, but I will post pdf copies of the problem sets along with notes sheets that go with the lectures that will be posted in Canvas. Your homework solutions will typically be due on Wednesdays as file uploads to Canvas. Each week's homework submission will count 25 points toward the course total. I will drop the lowest homework score.

**Exams:** There will be three one-hour exams(100 pts ea) in-class about once every four weeks or so according to the schedule opposite. The tests will consist of problems very similar to problems from the homework. I plan to have these exams during our Wednesday meetings at 3:00. I will ask that you join a zoom meeting with cameras on for proctoring purposes. There will also be a comprehensive final exam(150pts) on **May 19 from 10:15 -12:15pm** with Zoom proctoring as well.

| | | |
|---|---|---|
| **Grades:** The three hour-exams will count for a total of 300 points. In addition to the in-class tests there will be a Final Exam worth 150 points. The cut-off scores for A,B,C,D,F-grades will be very close to 90, 80, 70, and 60%. | Homework | 250 |
| | In-class Tests | 300 |
| | Final Exam | 150 |
| | Total | 700 |

The final exam score will normally count as 150 points out of 700. However, the final exam % will replace up to any 100 point input that is lower than the final % score. Thus the final could replace an hour exam score or up to 4 homework scores. Homework/exams missed for less than adequate reason will count as zero.

Tentative Schedule for the Semester

| Week | Chapt./Sections | Content |
|---|---|---|
| Jan 25 | 1. 1 – 8 | Complex #'s, rect and polar form, +, -, *, ÷, Pythagorean Triples and Gaussian Integers. |
| Feb 1 | 1. 9 – 12<br>1. 13 - 14 | ÷ and × in Polar form, roots of complex #'s, Regions in $\mathbb{C}$, Some basic mappings of regions in the Domain to image regions in the Range. |
| Feb 8 | 2. 15 - 22 | Limits at a finite point and at infinity, Riemann Sphere view of infinity, Continuity, Derivatives, Differentiation rules, Cauchy Riemann Identities. |
| Feb 15 | 2. 23 - 27 | Sufficient conditions for differentiability in terms of u(x,y) and v(x,y) and also $u(r,\theta)$ $and$ $v(r,\theta)$, Analytic Functions. Harmonic functions $u(x,y)$. |
| Feb 22 | **Ex I on 2/24**<br>3. 30 – 32 | Exam I is through section 27.<br>$e^z$, $\log(z)$, $Log(z)$, properties of logarithms and cautions with $Log(z)$. |
| Mar 1 | 3. 33 - 38 | Branches of $\log(z)$, derivatives of $\log(z)$, logarithm identities, power functions $z^c$, $\sin z$, $\cos z$, Other $trig(z)$, zeros of trig functions and domains of definition in $\mathbb{C}$. |
| Mar 8 | 3. 39 – 40<br>4. 41 – 44 | Hyperbolic trig functions and inverse trig and hyperbolic trig functions.<br>Integrals of a function along a parametrized curve in $\mathbb{C}$. Contour integrals in $\mathbb{C}$. |
| Mar 15 | **4. 45 - 52** | Contour integrals contd. Contours involving branch cuts, Antidervatives. Couchy-Goursat Thm. |
| **Mar 22 Spring Break** | | |
| Mar 29 | **Ex 2 on 3/31**<br>4. 53 – 55 | Multiply connected domains, Cauchy Integral Formula for $f^n(z_0)$. |
| Apr 5 | 4. 56 – 59<br>5. 60,61 | Liouville's Thm, Fund Thm of Alg, Maximum Modulus Thm,<br>Sequences in $\mathbb{C}$, convergence of ∞ series, power series |
| Apr 12 | 5. 62 - 68 | Taylor Series, Maclaurin Series for suite of standard functs.<br>Laurent Series: (Includes negative powers of $(z-z_0)$ ) |
| Apr 19 | 5. 69 – 73<br>6. 74-76 | Continuity, Uniform continuity, Diff. and Intg. of Power Series defined functions.<br>Residue Theorem for closed contour integrals of a function about a region. |
| Apr 26 | **Ex 3 on 4/28**<br>6. 77 - 79 | Residues at ∞, essential and removable and pole singularities. |
| May 3 | 6. 80 – 83<br>7. 85 – 86 | Functions with pole of order $n$ can be written as $f(z)=\frac{g(z)}{(z-z_0)^n}$ with $g$ analytic and $g(z_0)\neq 0$.<br>Improper integrals on the $x$-axis, e.g. $\int_0^\infty \frac{2x}{x^4+16}dx$ |
| May 10 | 7. 87 - 93 | Fourier Transform type improper integrals, integrals of $F(\cos\theta,\sin\theta)$, indented paths, integrals with branch points and branch cuts. |
| | | **Final exam is on May 19 from 10:15 -12:15** |

**UWSP Statement on COVID19 Safety Precautions:**

Face Coverings:

- At all UW-Stevens Point campus locations, the wearing of face coverings is mandatory in all buildings, including classrooms, laboratories, studios, and other instructional spaces. Any student with a condition that impacts their use of a face covering should contact the Disability and Assistive Technology Center to discuss accommodations in classes. Please note that unless everyone is wearing a face covering, in-person classes cannot take place. This is university policy and not up to the discretion of individual instructors. Failure to adhere to this requirement could result in formal withdrawal from the course.

Other Guidance:

- Please monitor your own health each day using this screening tool. If you are not feeling well or believe you have been exposed to COVID-19, do not come to class; email your instructor and contact Student Health Service (715-346-4646).
    - As with any type of absence, students are expected to communicate their need to be absent and complete the course requirements as outlined in the syllabus.
- Maintain a minimum of 6 feet of physical distance from others whenever possible.
- Do not congregate in groups before or after class; stagger your arrival and departure from the classroom, lab, or meeting room.
- Wash your hands or use appropriate hand sanitizer regularly and avoid touching your face.
- Please maintain these same healthy practices outside the classroom.