# Physics 320, Mathematical Methods in Physics: Fall 2022-2023

**Instructor:** Dr. Nicola Lanatà
**Email:** nxlsps@rit.edu
**Class:** Monday, Wednesday, Friday 11:00am – 11:50am; Gosnell Hall GOS-3305 (3rd floor).
**Office hours:** By appointment (preferably on Friday)
**Time of year:** August 2022 – December 2022
**No. hours of work:** ***
**Capacity limits:** 65 participants

**Objectives of the course:**
This course serves as an introduction to the mathematical tools needed to solve intermediated and upper-level physics problems. Topics include: linear algebra, vector analysis, Hilbert spaces, Fourier analysis, an introduction to series solution of partial & ordinary differential equations.

**Learning outcomes and competences:**
At the end of the course, the student *should be able to*:

- Derive and explain mathematical proofs, solve practical problems and present solutions inherent in the topics of in the course.
- Use matrix algebra and matrix operations and apply them to physical problems.
- Explain the physical & mathematical meaning of gradient, divergence and curl.
- Explain and apply Green's theorem, the divergence theorem and Stokes' theorem, both in the "traditional" formulation, and using differential forms (modern Stokes' theorem).
- Write and apply differential vector operators in general curvilinear coordinates.
- Define and explain the properties of Hilbert spaces (completeness, orthogonality, etc...), both in general and within the context of function spaces.
- Solve the partial differential equation for transverse waves on a stretched string.
- Use separation of variables, series methods and boundary conditions for solving linear partial differential equations.

**Compulsory program:**
The course is structured in 4 modules (linear algebra, vector calculus, Hilbert spaces, Fourier analysis). Note that these modules are not independent, but deeply interconnected. Teaching is structured in weekly cycles consisting of 3 face-to-face class alternated with out-of-class activities, see Fig. 1. Active participation in out-of-class activities and weekly face-to-face classes is *mandatory*.

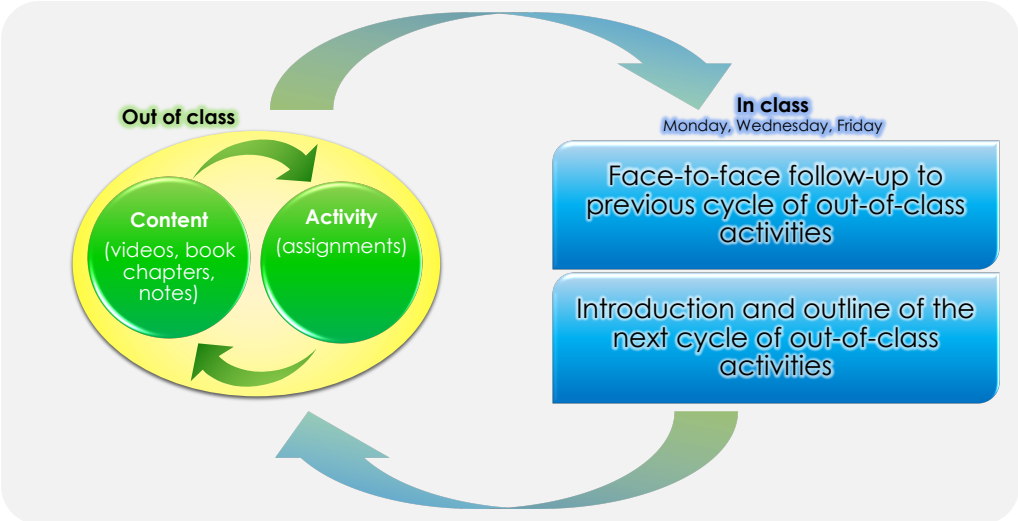


Fig. 1: Schematic representation of teaching format

**Type of course/teaching methods (indicatively):** Based on the "STREAM-model" *[Godsk, M. (2013). STREAM: a Flexible Model for Transforming Higher Science Education into Blended and Online Learning. In T. Bastiaens & G. Marks (eds.), Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2013, (pp. 722-728). Chesapeake, VA: AACE].***)**.

- The transfer of content occurs mainly in the out-of-class phase, through literature sources and videos. The out-of-class material includes concatenated series of short explanations alternated with mandatory individual assignments, whose purpose is both to integrate and activate the content. For all assignments, to be completed bi-weekly (by Sunday night of every second week), the students are requested to describe clearly and in detail the procedure used (metacognition). Support on content is provided by teacher in class, by email, Slack, in office hours.
- The out-of-class activities are alternated by face-to-face lectures (3 per week), consisting of the following activities: (I) revising the subjects that the students found more challenging and/or useful, (II) applying actively the content (with whiteboard exercises, discussions, active-learning activities), and (III) introducing the topics of the following week and of the related out-of-class activities.
- Students are allowed to re-upload their assignments any time until the deadline (Sunday night of every second week). The grades of the assignments are based on the following criteria: (1) whether the solutions of the exercises are correct or not, (2) to what extent the procedures are explained comprehensively in relation with the underlying general content, (3) the clarity of the explanations (synthesis etc…). It is essential that the assignments are easily readable.

**Assessment and grading:**
- Assignments and notes (continuous assessment, every second week): 50%
- Mid-term exam (October): 25%
- Final exam (December): 25%

**Letter grades:**
- 90-100: A- to A
- 80-89: B- to B+
- 70-79: C- to C+
- 60-69: D
- <60: F

**Useful external resources:**
- General textbook: *"Mathematical Methods in the Physical Science,"* Mary Boas.
- Linear algebra and vector calculus: *"Multivariable Mathematics: Linear Algebra, Multivariable Calculus, and Manifolds,"* Theodore Shifrin.
- Hilbert spaces & Fourier series: *"Exercises and Problems in Mathematical Methods of Physics (Undergraduate Lecture Notes in Physics),"* Giampaolo Cicogna.

**Policy Prohibiting Discrimination and Harassment/Title IX Reporting:**
RIT is committed to providing a safe learning environment, free of harassment and discrimination as articulated in our university policies located on our governance website. RITs policies require faculty to share information about incidents of gender based discrimination and harassment with RITs Title IX coordinator or deputy coordinators, regardless whether the incidents are stated to them in person or shared by students as part of their coursework.
If you have a concern related to gender-based discrimination and/or harassment and prefer to have a confidential discussion, assistance is available from one of RITs confidential resources on campus (listed below).

1. The Center for Women & Gender: Campus Center Room 1760; 585-475-7464; CARES (available 24 hours/7 days a week) Call or text 585-295-3533.
2. RIT Student Health Center August Health Center/1st floor; 585-475-2255.
3. RIT Counseling Center - August Health Center /2nd floor - 2100; 585-475-2261.
4. The Ombuds Office Student Auxiliary Union/Room 1114; 585-475-7200 or 585-475-2876.
5. The Center for Religious Life Schmitt Interfaith Center/Rm1400; 585-475-2137.
6. NTID Counseling & Academic Advising Services 2nd Floor Lynden B. Johnson; 585-475- 6468 (v), 585-286-4070 (vp).

**Integrity:**
As an institution of higher learning, RIT expects students to behave honestly and ethically at all times, especially when submitting work for evaluation in conjunction with any course or degree requirement. The School of Physics and Astronomy encourages all students to become familiar with the RIT Honor Code and with RIT's Academic Integrity Policy.
- RIT Honor Code: https://www.rit.edu/academicaffairs/policiesmanual/p030
- RIT Academic Integrity Policy: https://www.rit.edu/academicaffairs/policiesmanual/d080

**Additional information:**

- RIT is committed to providing reasonable accommodations to students with disabilities. If you would like to request accommodations such as special seating or testing modifications due to a disability, please contact the Disability Services Office. It is located in the Student Alumni Union, Room 1150; the Web site is www.rit.edu/dso. Please contact me as soon as possible after receiving accommodation approval, and we will work together on the necessary arrangements.
- This course participates in the RIT Starfish academic alert system, which is designed to promote student success through communication between students, instructors, and advisors. The scope of this tool is to raise an academic alert to notify a student and his/her advisor(s) about possible concerns inherent academic performance. If you receive an academic alert email, please contact me as soon as possible, so that we can identify resources to help move you forward. For more information about the Starfish system, visit www.rit.edu/starfish .
- Tech support: If you are having tech issues you need to contact ITS at help.rit.edu .