# Physics 581: Classical Field Theory

Fall 2020 (3 credits) MWF 12-1pm Online


## Instructor: Dr. Matthew Duez

Email: m.duez@wsu.edu

Office hours: Monday 3-4pm


## Textbooks

**Required**: *Classical Field Theory* by Horatiu Nastase

## Student Learning Outcomes

Students will learn

- how to derive equations of motion and conserved currents from an action principle
- the ingredients in covariant equations: vectors, tensors, p-forms, spinors, etc.
- how to do physics in general coordinates and curved spacetime
- how to construct gauge field theories from internal symmetries
- some classic solutions to field and field-particle theories

## Grade Breakdown

| | |
|---|---|
| Homeworks: | 65% |
| General Participation | 20% |
| Homework Presentations | 15% |

## Homework and homework presentations

There will be 8 homework assignments, roughly one per week. Problems come in two types. Most homework problems are analytical. These are interspersed in the lecture notes. Some homework assignments include a numerical portion. For each of these, a CoLaboratory python notebook will be provided on the course google drive; it will include some of the code (input/output, grid construction, and an integration algorithm). The student's role will be to add equations of motion, run the code (which can be done on the google cloud from anywhere), and analyze results.

Homework submission will be handled through the course google drive. To turn in a homework assignment, just add a file to your private drive and then share it with the instructor (mduez137@gmail.com). For computational parts of homeworks, students should make a personal copy of the provided notebook, copy it to their private drive, and share it with the instructor. When designing files from scratch, keep in mind that Google Docs has a nice equation editor, and CoLaboratory notebooks have a latex interface in their text boxes. (Just use "$$".) It is recommended that students share their homework files well before homework is due;

they are free to modify it thereafter until the due date. Scanned hand-written notes will be accepted only if they are very clear.

At the beginning of class on the due day, a group of students will present the solutions to the class. It is strongly recommended that the presenting group comes to my office sometime before lecture (my office hour that week or by appointment) to check their work with me. Each group will present twice. Homework solution presentations are a non-negligible component of students' grades, as indicated above. After the presentation, attending students will be allowed to email a supplemental page to their homework listing things they think should be corrected in their original assignment. Depending on the quality of the supplement, students may recover up to 50% of the points they would have missed on the original assignment.

## Grade distribution

Below is a rough guide to how numerical grades will correspond to letter grades. I won't push the cutoffs up, but may push them a little bit down.

| | |
|---|---|
| A | 88-100% |
| B | 75-87 |
| C | 63-74 |
| D | 50-62 |
| F | < 50 |

## Academic Integrity

Students may discuss and work together on assignments, but all submitted work must be original and individual. Academic dishonesty, including all forms of cheating, plagiarism, and fabrication, is prohibited as stated in the WSU Handbook. (See http://conduct.wsu.edu/.)

## WSU Disability Statement

Reasonable accommodations are available for students with a documented disability. Please notify me the first week of class of any accommodations needed. Late notifications may cause requested accommodations to be unavailable. All accommodations must be approved through Disability Resource Center (DRC), Administration Annex 205, 335-1566.

## WSU Safety

For WSU's general safety statements, see http://safetyplan.wsu.edu.
For current safety alerts, see http://alert.wsu.edu.
For advice on dealing with emergencies, see http://oem.wsu.edu/emergencies.

# Course Outline

review of index notation and Lagrangian dynamics
preview of scalar fields and gauge fields
building covariant equations:  vectors and the metric tensor
p-forms, tensors, and integration
representations of SO(3) and SU(2)
special relativity
physics of particles and fields in 4D from Lagrangians
conserved currents from symmetries
covariant derivatives and fiber bundles
Maxwell and Yang-Mills gauge theories
particle-field interactions
special solutions (symmetry breaking, solitons)