Electromagnetic Theory
Course Handout

August 17, 2020

1 General Information

- **Academic Term:** 2020-20 Semester I
- **Course Title:** Electromagnetic Theory (ECE F212, EEE F212, INSTR F212); Electromagnetic Theory I (PHY F212)
- **Instructor in-charge:** Section L1 to L8 - Raghunath Ratabole (ratabole/voip-417/CC-114)
- **Instructors:**
  - T1 and T5: P N Deepak (email: deepakpn)
  - T2 and T6: Kinjal Banerjee (email: kinjalb)
  - T3 and T7: Ram Shanker Patel (email: rsp)
  - T4 and T8: P Nandakumar (email: nandan)

2 About the course

Purpose The purpose of this course is to build the theoretical foundations of the classical theory of charged particles and their interactions (also called classical electrodynamics) both at a microscopic and macroscopic level. At the end of this course, you will understand how the theory of electrodynamics is formulated in the language of vector analysis and how problems & applications are formulated in electrodynamics using its fundamental theory. You will also be able to solve a few basic problems on your own. Equipped with these foundations, you will be able to delve deeper into wide ranging subjects such as atomic physics (PHY F342), quantum optics (PHY F420), microwave engineering (ECE F312) and Antenna theory (EEE F474). . The real potential of the theoretical formulation will only be unleashed in some of these future courses wherein the power of the differential formulation of the laws of electrodynamics is applied to real physical problems.

Syllabus: Vector Analysis; Electrostatics; Electrostatic fields in material media; Magnetostatics; Magnetostatic fields in material media; Electrodynamics; Maxwell's equations; Electromagnetic waves

Readings:

T1: Introduction to Electrodynamics, David J Griffiths (4th Edition) Prentice Hall India

R1: Electricity & Magnetism: Berkeley Physics Course SIE Vol 2. 2nd edition, Tata McGraw Hill 2007

3 Learning Approach

1. The course is organized in weeks, with each week beginning on a Monday and ending on a Sunday. There are total of 15 instruction weeks in this semester. The first week is 18 August - 23 August and the 15th week is 23 November- 29 November.

2. Each week's lecture material in form of videos will be released on the course page on quanta. The schedule for the release is given in the following section. You should study this assigned material within that week itself.

3. There will be one online lecture session per week (Monday 9am for L1 section and Tuesday 9am for L2 section). The purpose of this session is

   (a) Given an overview of the video material to assigned in that week.

   (b) Receive feedback/questions on the video material of the previous week.

   (c) Discuss (at periodic intervals) the answers to review questions/tests

4. The tutorials in any given week will be based on the assigned lecture video material of the previous week. The individual tutorial section instructor may make amends to this approach to adjust their pace of course coverage.

5. Worksheets of review questions will be released once every two weeks. Solving these worksheets will prepare you for the Tests and Comprehensive. The answers for the review questions will be discussed during the online lecture session.

6. About the evaluation scheme:

   (a) Review Questions consist of a worksheet of 2 -5 questions which will have to solved by doing handwritten work on plain A4 sheets. You should scan your work, serialize the pages, convert it as a single pdf and upload it on the appropriate assignment link of quanta. Review questions worksheets will be released at the beginning of Week 2, 4, 6, 8, 10 and 12. They have to be turned in by the end of that week. Each review question worksheet carries a 5%. The scheme followed for evaluating each worksheet will be given along with the worksheet questions.

   (b) There will be three tests, Test I, Test II and Test III, with weights of 10%, 15% and 15% respectively. They will be conducted as an online quiz on quanta during the week 5, week 9 and week 14 respectively. The specific details of date, time and duration will be announced by the end of the first week.

   (c) The comprehensive test will carry a weight of 30% and will be scheduled as per the date given in the timetable. The details of the conduct of this examination will be announced by AUGSD by 15 November 2020.

4 Course Structure

Week 1 (18 August - 23 August)

Lecture Material

- V1: Scalar fields and Vector Fields
- V2: Differential Calculus of Cartesian Vectors

Week 2 (24 August - 30 August)

Lecture Material

- V3: Curvilinear Coordinate Systems
- V4: Differential Calculus of Fields in Curvilinear Coordinates

Week 3 (31 August - 6 September)

Lecture Material

- V5: The Electric Field
- V6: Gauss's Law

Week 4 (7 September - 13 September)

Lecture Material

- V7: Applications of Gauss's Law
- V8: Curl of an electrostatic field and Scalar potential

Week 5 (14 September - 20 September)

Lecture Material

- V9: Conductors - Part I
- V10: Conductors - Part II

Week 6 (21 September - 27 September)

Lecture Material

- V11: Electric Dipole
- V12: Polarization

Week 7 (28 September - 4 October)

Lecture Material

- V13: Electrostatics with dielectric media
- V14: Electric Current

Week 8 (5 October - 11 October)

Lecture Material

- V15: Biot-Savart Law
- V16: Magnetic Vector Potential

Week 9 (12 October -18 October)

Lecture Material

- V17: The Magnetic Dipole
- V18: Overview of magnetic materials

Week 10 (19 October - 25 October)

Lecture Material

- V19: Magnetic fields due to Magnetization
- V20: Concept of H-field

Week 11 (26 October - 1 November)

Lecture Material

- V21: Linear and Nonlinear Magnetic Media
- V22: Electromotive Force

Week 12 (2 November - 8 November)

- V23: Electromagnetic Induction
- V24: Electrodynamics before Maxwell

Week 13 (9 November- 15 November)

- V25: Maxwell's equations in vacuum & matter
- V26: Electromagnetic Waves in vaccum and their characteristics

Week 14 (16 November - 22 November)

- V27: Electromagnetic Waves in matter
- V28: Absorption and Dispersion

Week 15 (23 November- 29 November)

- No Lecture material in video form for this week

5 Links to access the online sessions

Section	Instructor	Day	Time	Link for joining session
L1 to L4	Raghunath Ratabole	Monday	9:00	https://meet.google.com/qkr-mtsp-szh
L5 to L8	Raghunath Ratabole	Tuesday	9:00	https://meet.google.com/sfu-sfox-vrz
T1	P N Deepak	Wed/Fri	9:00/9:00	https://meet.google.com/fxn-esgg-mgf
T2	Kinjal Banerjee	Wed/Thu	9:00/14:00	https://meet.google.com/azf-gjkz-ezi
T3	Ram Shanker Patel	Wed/Fri	9:00/9:00	https://meet.google.com/zkf-htgw-pdj
T4	P Nandakumar	Wed/Fri	9:00/9:00	https://meet.google.com/nkg-xyhd-met
T5	P N Deepak	Thu/Sat	9:00/9:00	https://meet.google.com/hem-cudb-pmn
T6	Kinjal Banerjee	Thu/Sat	9:00/9:00	https://meet.google.com/azf-gjkz-ezi
T7	Ram Shanker Patel	Thu/Sat	9:00/9:00	https://meet.google.com/mob-vzik-vjy
T8	P Nandakumar	Thu/Sat	9:00/9:00	https://meet.google.com/nkg-xyhd-met

6 Evaluation Scheme

Component	Description	Weight	Date/Time/Duration	Nature
Participation	Review Questions	30%	Week 2, 4, 6, 8, 10, 12	Solve, scan & upload on quanta
Test I	Online Quiz 1	10%	Week 5 (details TBA)	Quiz to be attempted on quanta
Test II	Online Quiz 2	15%	Week 9 (details TBA)	Quiz to be attempted on quanta
Test III	Online Quiz 3	15%	Week 14 (details TBA)	Quiz to be attempted on quanta
Comprehensive	Refer to timetable	30%	refer time table	details to be announced by AUGSD

7 Course specific guidelines

This section to be updated by the end of first week of instruction

8 Honor code

The following honour code will apply for this course: *While working on a review quiz or problem set or exam and while responding to attendance calls or signing attendance sheets, I will avoid engaging in plagiarism, unauthorized collaboration, cheating or facilitating academic dishonesty.*