Electromagnetic Theory
Course Handout

August 1, 2019

1 General Information

- **Academic Term:** 2019-20 Semester I
- **Course Title:** Electromagnetic Theory (ECE F212, EEE F212, INSTR F212); Electromagnetic Theory I (PHY F212)
- **Instructor in-charge:** Raghunath Ratabole (ratabole/voip-417/CC-114)
- **Instructors:** Kinjal Banerjee (kinjalb/voip-154/B-320), P N Deepak (deepakpn/voip-431/CC-112)), Ram Shanker Patel (rsp/voip-294/C-214), P Nandakumar (nandan/voip-427/C-216)

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 Lecture Plan

The table below outlines the basic plan for lectures. This plan may undergo few changes over the duration of the course. We will update the handout as the lectures progress.

Lecture No	Lecture Title	Reference
1	Differential Calculus in Cartesian coordinates	1.2
2	Integral Calculus in Cartesian coordinates	1.3
3	Introduction to curvilinear coordinates	1.4
4	Differential & Integral Calculus of vectors in curvilinear coordinates I	1.4
5	Differential & Integral Calculus of vectors in curvilinear coordinates II	1.4
6	Coulomb's Law, Electric field and its flux	2.1-2.2
7	Gauss's law - Integral and Differential form	2.2
8	Applications of Gauss's law	2.2
9	Curl of Electric field and Electric potential	2.3
10	Electrostatic field in matter - Conductors	2.5
11	Dipoles and conductors	3.4
12	Dielectrics and polarization	4.1-4.2
13	Electrostatic equations within dielectrics, electric displacement and energy	4.3-4.4
14	Electric current and current density	5.1
15	Biot-Savart Law	5.2
16	Laws of Magnetostatics - Differential and Integral forms	5.3
17	Magnetic vector potential	5.4
18	Magnetic Dipole	5.4
19	Current density and magnetization	6.1
20	Field due to magnetized material	6.2
21	Interfaces	6.3-6.4
22	Ohm's law, moving conductors in magnetic fields	7.1
23	Faraday's law; self & mutual inductance	7.2
24	Maxwell's equations in vacuum	7.3
25	Maxwell's equations in matter	7.3
26	Wave equations and its solutions	9.1
27	Electromagnetic waves	9.2

4 Evaluation Scheme

Component	Description	Weight	Nature
Participation	Review weekly quizzes, surveys	5%	Open
Attendance	Tutorial attendance	5%	Open
Quizzes	Three proctored online quizzes	10%	Closed
Mid-Semester	Refer to timetable	40%	Closed
Comprehensive	Refer to timetable	40%	TBA

5 Course specific guidelines

- **Attendance**: The attendance in tutorials will be recorded by your section instructor. The score you make for tutorial attendance will be proportion to the number of tutorial classes attended by you in your own section. For any queries related to attendance, always contact your section instructor. No credit will be awarded if you attending tutorials in a section other than your own.

- **Participation**: There will be weekly review quizzes (consisting of 5-10 questions) for which can earn you participatory credit (i.e: if you answer the quiz entirely, you will get full credit). The instructors of the course believe that doing these review quizzes on your own will improve your conceptual understanding of the subject. Additionally, you will be requested to participate in surveys to be used for course improvement purposes.
- **Quizzes**: There will be three online proctored evaluative quizzes spread through the semester. The dates for these quizzes will be communicated shortly. All three online quizzes will be equal in weight in relation to one another. We will take best two out of the three online quiz scores towards your final evaluation.
- **Makeup policy**: Makeup will only be granted for cases of illness which would be certified by the campus medical officer.
- **Requirement for Letter grade**: You should be 20% and above to be considered for award of letter grades

6 Honor code

The following honour code (based on the handbook of academic integrity at MIT) 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.*